European Journal of Cancer Care

WILEY

REVIEW ARTICLE OPEN ACCESS

Non-Medical Interventions to Improve Functional Outcomes for Men Undergoing Radiotherapy for Prostate Cancer: A Systematic Review

Ben Hung[1] | Tenaw Tiruye[1] | Stamati Morias[2] | Kerri Beckmann[1]

[1]School of Public Health, Adelaide University, Adelaide, South Australia, Australia | [2]Department of Radiation Oncology, Royal Adelaide Hospital, Adelaide, South Australia, Australia

Correspondence: Tenaw Tiruye (tenaw.tiruye@adelaide.edu.au)

Received: 7 June 2025 | **Revised:** 16 January 2026 | **Accepted:** 13 February 2026

Academic Editor: Hammoda Abu-Odah

Keywords: functional outcomes | non-medical interventions | prostate cancer | radiotherapy

ABSTRACT

Purpose: This study aimed to identify and evaluate non-medical interventions (exercise, psychosocial, diet and nutrition, or a combination thereof) to improve functional outcomes (fatigue, mental wellbeing, sexual function, bowel function and urinary function) in men undergoing prostate cancer radiotherapy.

Methods: An electronic search of six databases (CINAHL, Embase, Emcare, Medline via Ovid, Scopus and The Cochrane Library) was conducted for studies published in English from 1990 onwards. Randomised controlled trials (RCTs) and quasiexperimental studies regarding non-medical interventions delivered before, during or after radiotherapy for prostate cancer to improve functional outcomes were included in this review. Two-stage screening (title/abstract and full text) was conducted against predefined inclusion and exclusion criteria. Data were extracted using a standardised form, and risk of bias was assessed using Joanna Briggs Institute critical appraisal tools.

Results: Twenty-five RCTs and seven quasiexperimental studies met the eligibility criteria. Aerobic and resistance exercises showed promising results in improving fatigue, while multidisciplinary rehabilitation showed promise in improving urinary function. However, inconsistent findings prevented definitive conclusions about the effect of exercise on other functional outcomes. Additionally, the impact of psychosocial and dietary interventions on functional outcomes remains inconclusive due to the limited number of studies, small sample sizes, non-randomised study design and study quality.

Conclusion: There is a lack of strong evidence supporting the effectiveness of non-medical interventions in improving functional outcomes after prostate cancer radiotherapy, except for aerobic and resistance exercises for fatigue and multidisciplinary rehabilitation for urinary function. More rigorous RCTs are needed to address this evidence gap.

Implications for Cancer Survivors: Engaging in aerobic and/or resistance exercise can likely reduce fatigue, and multidisciplinary rehabilitation may improve urinary function in prostate cancer patients who receive radiotherapy.

1 | Introduction

Prostate cancer is a significant health concern for men worldwide. In countries such as Australia, it is the most common cancer and the second leading cause of cancer-related deaths in Australian males [1]. In 2024, an estimated 26,400 Australian men were diagnosed with prostate cancer, and 33 per 100,000 died from the disease [2, 3]. While advances in screening, treatment and imaging technologies have led to an almost 96% 5-year relative survival among affected men [4], the impact of treatments on patients' quality of life can be significant.

Radiotherapy remains a common treatment option for prostate cancer. However, it is associated with a range of physical and psychological side effects, including sexual, urinary and bowel problems, fatigue and mood disturbances [5–8]. Sexual dysfunction, such as decreased libido, impotence and sexual dissatisfaction, is a particularly common consequence [6–10]. Radiotherapy can also damage the bladder and urethra, leading to complications such as cystitis, strictures and fistulae and can significantly affect bowel function [6–8]. Cancer-related fatigue can affect up to 70% of prostate cancer patients during and after radiotherapy [11]. Additionally, psychological distress and mood changes can occur at any point during the treatment process [12–14]. There is also an increased risk of developing secondary malignancies following radiotherapy [15, 16]. These side effects can have a substantial impact on patients' quality of life and overall wellbeing, both during and after treatment.

To address the side effects of prostate cancer radiotherapy and improve overall wellbeing, researchers have explored the potential efficacy of various non-medical interventions, including exercise and physical activity [11, 17–25], dietary modifications and supplements [26–31], and psychological support [32–39]. Exercise-based interventions, including aerobic, resistance or a combination of them, have been researched whether they improve fatigue, physical functioning and aspects of quality of life during and after radiotherapy [11, 17–25]. Dietary and nutritional interventions, such as fibre modification, synbiotics, cranberry extract, soy isoflavones and curcumin supplementation, have also been investigated for their potential to alleviate urinary and bowel symptoms associated with pelvic radiotherapy [26–31, 40–44]. Psychosocial interventions—including nurse-led consultations, educational interventions, group therapy and virtual reality–based education—have demonstrated potential benefits for mental wellbeing, anxiety and depressive symptoms, though evidence is limited by small sample sizes and variability in study design [32–39].

While numerous studies have described various interventions that may improve physical functioning in men with prostate cancer [11, 17–39], studies vary widely in intervention type, timing relative to radiotherapy, intensity and duration of interventions, outcome measures and methodological quality, making it difficult to draw definitive conclusions or provide clear clinical recommendations. Furthermore, a comprehensive synthesis of evidence to establish definitive recommendations remains lacking. Additionally, there is insufficient critical appraisal to provide men with specific guidance regarding interventions that could be beneficial in preserving or improving their functioning after radiotherapy. This systematic review aimed to identify and evaluate the extent and quality of evidence for different non-medical interventions designed to enhance specific aspects of physical and mental functioning, including fatigue, sexual, bowel, urinary and mental health functioning, in men who have undergone prostate cancer radiotherapy.

2 | Materials and Methods

2.1 | Eligibility Criteria

The review protocol was published in Open Science Framework (https://doi.org/10.17605/OSF.IO/UEHZR). Results are reported according to the requirements of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [45]. The following inclusion criteria were applied: original research studies published between January 1, 1990 and December 31, 2024; men diagnosed with localised or metastatic prostate cancer who received radiotherapy as part of their treatment; non-medical interventions offered pre-, during or post-radiotherapy to reduce side effects or improve functioning; outcomes measured on fatigue, sexual, urinary, bowel function and mental wellbeing; observational studies and randomised controlled trials (RCTs); and studies written in English. The timeframe from 1990 onwards was selected because modern radiotherapy techniques, contemporary outcome measures and survivorship-focused non-medical interventions emerged from 1990s, making earlier studies outdated and clinically less relevant. We excluded case reports or case series studies; studies examining medical devices or medications; observational studies without a specific intervention; studies lacking a full-text article or being only conference abstracts; studies not reporting quantitative outcomes; and systematic reviews (except for pearling). We also excluded studies with mixed samples where they did not provide separate results for radiotherapy for prostate cancer when combined with other treatments or cancers.

2.2 | Search Strategy and Data Sources

A comprehensive literature search was conducted in The Cumulative Index of Nursing and Allied Health Literature (CINAHL), Embase, Emcare, Medline via Ovid, Scopus and The Cochrane Library to identify all relevant studies that evaluated non-medical interventions, which have the potential to improve physical functioning in men who underwent radiotherapy for prostate cancer. The search strategy design was developed in consultation with experienced university medical librarians. The search terms used for Medline via Ovid are listed in Supporting Table 1, and equivalent search strategies were adapted for the remaining databases. Reference lists from relevant systematic reviews were also checked to identify any other relevant studies that may have been missed from the search.

2.3 | Screening and Data Extraction

After removing duplicates, the first author (Ben Hung) screened titles, abstracts and keywords for eligibility against inclusion criteria. The first author (Ben Hung) also independently reviewed full-text articles, with a second author (Tenaw Tiruye) screening 10% of randomly selected full-text articles to ensure reliability. When consensus on inclusion could not be reached, the last author (Kerri Beckmann) was consulted. All screening was conducted within Covidence. A specific data extraction form was developed in Word and included data items such as author, year, timing of intervention, sample size, type of intervention

(exercise, psychosocial, multidisciplinary rehabilitation, diet and nutrition), functional outcome (urinary, sexual, bowel function, fatigue and wellbeing), type of outcome measurement, key findings and study quality.

2.4 | Risk of Bias Assessment

The risk of bias was assessed using the Joanna Briggs Institute (JBI) critical appraisal tools appropriate to the specific study design, including RCTs [46] and quasiexperimental studies [47]. These tools consisted of a series of questions about study design, which were answered as 'yes', 'no', 'unclear' or 'non-applicable'. The scores of the items for each study were summated to calculate a total quality score. The quality of the studies was then classified into three categories: low quality (high risk of bias) when the quality appraisal scores less than 50%, moderate quality (moderate risk of bias) from 50% to 70% and as high quality (low risk of bias) from above 70%, according to a previous study [48]. The included studies were independently reviewed for quality by two authors (Ben Hung and Tenaw Tiruye). Any disagreements between reviewers were discussed among the whole team until a consensus was reached.

2.5 | Data Synthesis

Data synthesis was organised according to the type of intervention and the functional outcome assessed. Due to the myriad of different interventions, the wide variety of outcome measurement tools used and the variation in the timing of assessment, no attempt was made to undertake meta-analyses of results within any of the intervention-outcome categories. Instead, a narrative synthesis was undertaken and a summary of the study findings within each category is presented, indicating individual studies, which reported that functional outcomes had improved, worsened or were unchanged by the intervention and whether these findings were statistically significant ($p < 0.05$). Because no meta-analysis was conducted, formal assessment of reporting and publication biases as well as certainty of evidence were not conducted.

3 | Results

3.1 | Search Results

Our search strategy yielded 10,303 articles of which 3352 were duplicates. Results from the screening process are shown in the PRISMA flow chart (Figure 1). After removing duplicate and irrelevant papers based on title, abstract, keywords and full-text screening, 32 articles met the inclusion criteria: 25 RCTs and 7 quasiexperimental studies.

3.2 | Risk of Bias and Methodological Quality Assessment

Generally, papers were of high quality. However, three RCTs [38, 49, 50] and two quasiexperimental studies [36, 37] were assessed as moderate quality, while one quasiexperimental study [51] was considered to be of low quality. Eight of the 32 included studies were small pilot studies [17, 29, 37, 40–42, 51, 52]. Among the RCTs, the main limitations were a lack of blinding of participants and the professionals delivering the intervention. In the quasiexperimental studies, biases were related to confounding factors (differences in participant characteristics), assessment (internal validity), participant retention (failure to follow-up) and inappropriate statistical analysis. The detailed risk of bias assessment is presented in Supporting Table 2.

3.3 | Main Findings

In most studies, interventions were initiated either during or after radiotherapy, except for two studies where interventions began pre-radiotherapy [37, 38]. Most of the studies included only men who received external beam radiotherapy (EBRT). Therefore, in this study, 'radiotherapy' refers to EBRT unless otherwise specified. Regarding functional outcomes, 13 studies reported on fatigue, 9 on sexual function, 16 on urinary function, 16 on bowel function and 16 on mental wellbeing.

3.3.1 | Fatigue

A summary of included studies on interventions to improve fatigue is presented in Table 1. Ten RCTs investigated various exercise interventions, including yoga [24], Qigong/Tai Chi and light exercise [25], moderate-intensity home-based walking exercise [50], high-intensity interval training or resistance exercise [21], aerobic and resistance exercises (moderate-intensity [17, 19] or moderate to high intensity [18, 22, 53]), and aerobic exercise only [20]. Additionally, one quasiexperimental study examined home-based walking exercise programmes [54]. All the studies were high quality, except one study [50], which was assessed as moderate quality. Outcome measurements were taken at various time points, ranging from the end of radiotherapy to 10 months post-treatment. A significant improvement in fatigue was reported in 10 studies, including those involving yoga [24], aerobic and resistance exercises [17–19, 22, 53], high-intensity interval training or resistance exercise [21], aerobic exercises alone [20] and walking exercise programme [50, 54]. Only one RCT that involved Qigong/Tai chi or light exercise [25] reported an improvement in fatigue but without significant difference compared to the control group.

Two studies on psychosocial interventions for cancer-induced fatigue were identified: one RCT assessing an informational intervention [38] and one quasiexperimental study examining a group logotherapy intervention [36], which emphasised the spiritual components of humans through the concept of personal meaning of life. Both these studies were assessed as moderate quality [36, 38]. The informational intervention, which measured outcomes during the fifth week of radiotherapy, observed a slight marginally significant improvement in fatigue levels. In contrast, the group logotherapy intervention, which measured outcomes at the end of the intervention, reported a significant reduction in fatigue, with a greater effect among intermediate- and high-risk prostate cancer patients [36].

3.3.2 | Sexual Function

The studies assessing interventions to improve sexual function are summarised in Table 2. All the studies were assessed as high quality.

Four studies (all RCTs) examined exercise interventions [17, 18, 24, 53]. Two studies showed improvements in sexual function [18, 24], while two others [17, 53] reported no significant change. Significant improvements in sexual function were reported for yoga [24] and for moderate-intensity aerobic and

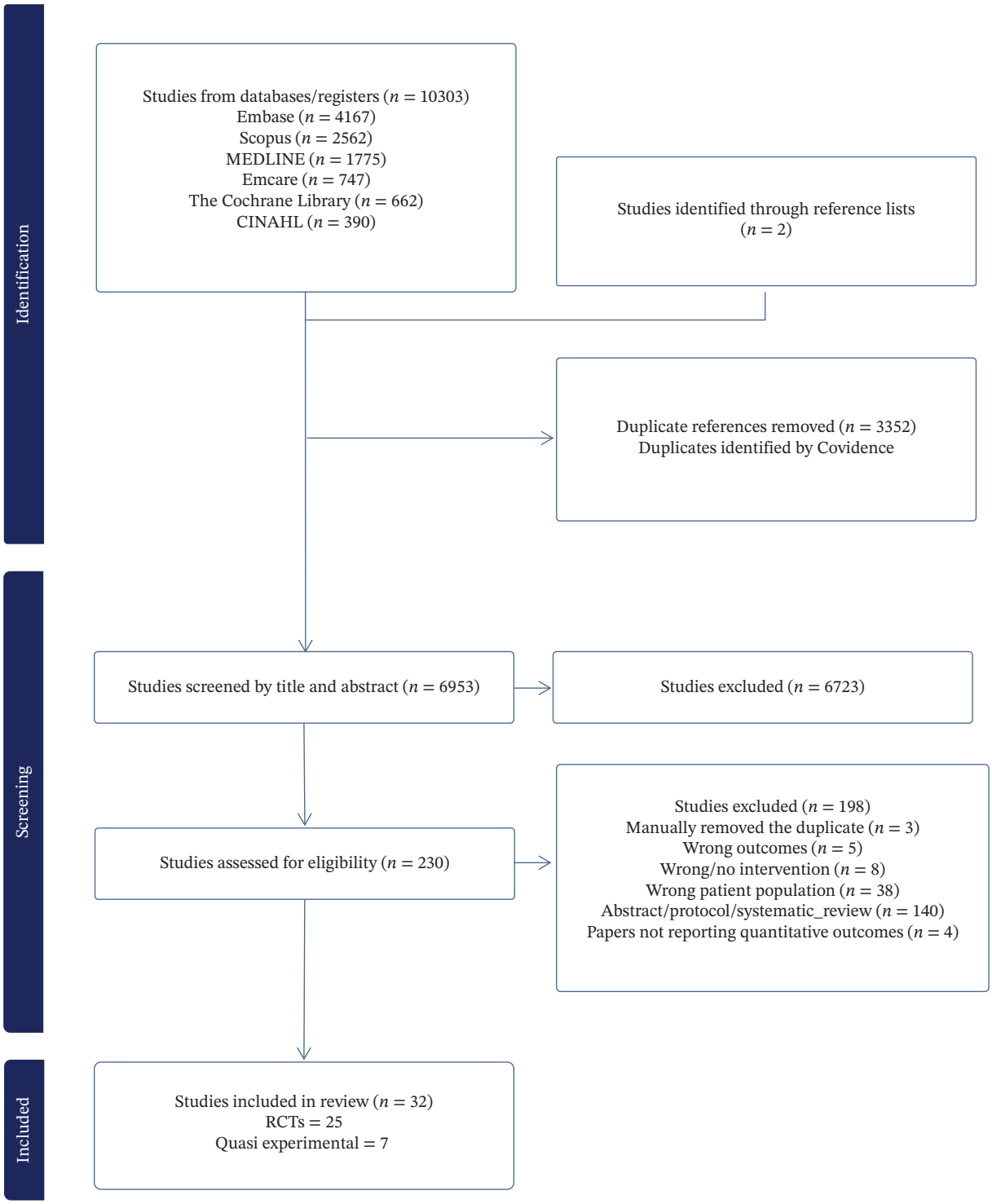

FIGURE 1 | PRISMA flowchart.

resistance exercises [18]. Moderate-to-high intensity aerobic and resistance exercises appeared to prevent worsening sexual function [18].

One RCT found that a nurse-led group consultation intervention had no effect on sexual function 6 months post-radiotherapy [39]. Two RCTs assessing dietary interventions yielded conflicting results: one reported that soy isoflavone consumption improved erectile function at 3 and 6 months [42], while another showed that curcumin consumption did not improve sexual function [40].

Two studies reporting the results of a multidisciplinary intervention found no difference in sexual function between multidisciplinary rehabilitation and usual care groups in the short term [55] or long term [56].

TABLE 1 | Summary of included studies on interventions to improve fatigue.

Intervention	Reference	Timing of intervention	Sample size	Intervention details	Outcome measurement	Key findings	Study quality
Exercise intervention	Ben-Josef et al. [24]	During radiotherapy	$n = 50$ Intervention group (22) Control group (28)	Eischens yoga	BFI	Significant improvement in cancer-related fatigue	High
	Hojan et al. [17]	During radiotherapy	$n = 54$ Exercise training group (27) Usual care group (27)	8 weeks of moderate-intensity exercise: aerobic and resistance exercises	FACT-F	Significantly improved fatigue	High
	Hojan et al. [18]	During and post radiotherapy	$n = 66$ Exercise group (35) Usual care group (31)	12 months of moderate- to high-intensity exercise	FACT-F	Significantly improved fatigue	High
	Hojan and Milecki [19]	During radiotherapy	$n = 72$ Exercise training group (36) Usual care group (36)	8 weeks of moderate-intensity exercise: aerobic and resistance exercises	FACT-F	Significantly improved fatigue	High
	McQuade et al. [25]	During radiotherapy	$n = 76$ Qigong/Tai Chi (26) Light exercise (26) Wait list control (24)	Qigong/Tai Chi Light exercise	BFI	There was no significant difference between groups in fatigue levels. Qigong/Tai Chi improved fatigue from the baseline to 1 month post radiotherapy and remained steady 1–3 months post radiotherapy. Light exercise had no effect on post-radiotherapy fatigue.	High
	Monga et al. [20]	During radiotherapy	$n = 21$ Exercise group (11) Control group (10)	Aerobic exercise	PFS	Significantly improved fatigue	High
	Piraux et al. [21]	During radiotherapy	$n = 72$ High-intensity interval training (24) Resistance training (24) Control group (24)	High-intensity interval training or resistance exercise	FACT-F	Both high-intensity interval training and resistance exercise significantly attenuated increases in fatigue compared to control group.	High
	Schumacher et al. [53]	During radiotherapy	$n = 115$ Exercise group (72) Control group (43)	6 months moderate- to high-intensity exercise programme, including resistance training and aerobic exercise	EORTC QLQ-C30	Significantly improved fatigue and relieved the severity of fatigue	High
	Segal et al. [22]	During radiotherapy	$n = 121$ Aerobic exercise group (40) Resistance exercise group (40) Usual care group (41)	Moderate- to high-intensity aerobic and resistance exercises	FACT-F	Both exercises relieved fatigue in the short term (after 3 months of exercise) but only resistance exercise produced longer-term (after 6 months of exercise) improvements on fatigue	High
	Truong et al. [54]	During and post radiotherapy	$n = 80$ Exercise intervention group (50) Control group (30)	Home-based walking exercise programme	BFI	Improved fatigue and controlled the severity of fatigue up to 6 months post radiotherapy	High
	Windsor et al. [50]	During radiotherapy	$n = 65$ Exercise group (32) Control group (33)	Home-based, moderate-intensity walking exercise	BFI	Intervention benefited in relieving the severity of fatigue	Moderate
Psychosocial intervention	Arefpour and Mahdavi [36]	During radiotherapy	$n = 30$ Intervention group (15) Control group (15)	Group logotherapy	CFS	Significantly improved cancer-induced fatigue	Moderate
	Kim et al. [38]	Pre- and during radiotherapy	$n = 152$ Intervention group = not reported Control group = not reported	Informational intervention: about what to expect during their treatments	5-point Likert scale question on severity of fatigue	Marginally significant improvement in fatigue levels	Moderate

Abbreviations: BFI, Brief Fatigue Inventory; CFS, Cancer Fatigue Scale; EORTC QLQ-C30, European organisation for research and treatment of cancer-quality of life questionnaire core; FACT-F, functional assessment of chronic illness therapy-fatigue; PFS_revised, Piper Fatigue Scale.

TABLE 2 | Summary of included studies on interventions to improve sexual function.

Intervention	Reference	Timing of intervention	Sample size	Intervention details	Outcome measurement	Key findings	Study quality
Exercise intervention	Ben-Josef et al. [24]	During radiotherapy	$n = 50$ Intervention (22) Control (28)	Eischens yoga	IIEF-5 and SHIM	Significant improvement in erectile function scores, but remained stable after week 4 of radiotherapy	High
	Hojan et al. [17]	During radiotherapy	$n = 54$ Intervention (27) Control (27)	8 weeks of moderate-intensity physical exercise	EORTC-QLQ-PR25	Sexual function significantly improved, but there was no significant difference in sexual activity between the intervention and control groups.	High
	Hojan et al. [18]	During and post radiotherapy	$n = 66$ Intervention (35) Usual care (31)	12 months of moderate- to high-intensity exercise programme	EORTC QLQ-PR25	Intervention benefits sexual function (maintained and prevented worsening of sexual function)	High
	Schumacher et al. [53]	During radiotherapy	$n = 115$ Intervention (72) Control (43)	6 months moderate- to high-intensity exercise programme	EORTC QLQ-PR25	No improvement in sexual function	High
Psychosocial intervention	Schofield et al. [39]	During and post radiotherapy	$n = 331$ Intervention (165) Usual care (166)	Nurse-led group consultations	EPIC-26	No effect on sexual function	High
Diet and nutrition intervention	Ahmad et al. [42]	During and post radiotherapy	$n = 42$ Intervention (20) Placebo group (22)	Consuming 200 mg of soy isoflavone for 6 months	Self-administered quality of life questionnaire at 3 and 6 months	Improved erectile function at 3 and 6 months. Overall ability to have erections (77% vs. 57%) at 6 months.	High
	Hejazi et al. [40]	During radiotherapy	$n = 40$ Intervention (20) Placebo (20)	Consuming curcumin capsules	EORTC QLQ-PR25	No group differences (no improvement in sexual activity)	High
Multidisciplinary intervention	Dieperink et al. [55]	Post radiotherapy	$n = 153$ Intervention (76) Usual care (77)	Multidisciplinary rehabilitation (nursing counselling and physical therapy)	EPIC-26	No difference in sexual function between intervention and usual care group	High
	Dieperink et al. [56]	Post radiotherapy	$n = 143$ Intervention (72) Usual care (71)	Multidisciplinary rehabilitation (psychosocial support and physical activity)	EPIC-26	No impact on sexual function in 3 years follow-up	High

Abbreviations: EPIC-26, Expanded Prostate Cancer Index Composite Short-Form; IIEF-5, International Index of Erectile Function Questionnaire; QLQ-PR25, European Organisation for Research and Treatment of Cancer prostate-specific module; SHIM, sexual health inventory for men.

3.3.3 | Urinary Function

Table 3 summarises studies assessing interventions to improve urinary function. We identified six exercise intervention studies, including five RCTs [17, 18, 24, 49, 53] and one quasiexperimental study [57]. One RCT was assessed as moderate quality [49], while all other studies were high quality. Kegel exercises (pelvic floor exercises) [57] were reported to significantly reduce urinary incontinence, while yoga [24] showed potential benefits, although the results lacked statistical significance. Several aerobic and resistance training intervention trials [17, 18, 49, 53] demonstrated no effect on the urinary function.

Two psychosocial interventions (both RCTs), which examine the impact on urinary symptoms, were identified: one assessing a nurse-led group consultation intervention [39] and another assessing an informational intervention [38]. Neither intervention demonstrated a significant reduction in urinary problems. Four dietary intervention studies were identified (three high-quality RCTs [29, 40, 42] and one moderate-quality quasiexperimental study [28]). Interventions included soy isoflavone [42], cranberry extract [28, 29] and curcumin capsules [40]. While each of the studies [28, 29, 40, 42] suggested potential benefits in improving urinary function and relieving symptoms, the evidence was generally inconclusive due to the lack of multiple studies relating to similar dietary interventions and three of the trials were small pilot studies with small samples [29, 40, 42].

Four multidisciplinary intervention studies were identified, including three RCTs [55, 56, 58] and one quasiexperimental [51]. The interventions comprised multidisciplinary rehabilitation combining nurse counselling sessions and physical therapy sessions [55, 56] and a symptom-management intervention involving self-management skills, group support, education and pelvic floor exercises [51, 58]. While the symptom-management intervention showed significant improvement in relieving urinary tract symptoms, the study quality was low [51]. Multidisciplinary rehabilitation demonstrated significant improvement in relieving urinary irritative symptoms in the short term [55] but no long-term benefits [56]. Faithfull et al. [58] reported a trend towards improved urinary voiding and continence in the short term (at 3 months) in relation to their symptom-management intervention. However, there was no long-term effect on urinary symptoms nor any effect on the overall urinary function.

3.3.4 | Bowel Function

A summary of studies to improve bowel function are provided in Table 4. Five exercise intervention studies were identified: four RCTs [17, 18, 49, 53] and one quasiexperimental study [57]. All the studies were high quality except one RCT assessed as moderate quality [49]. Two studies reported significant improvements in bowel function [18] and rectal toxicity [49] with aerobic and resistance exercises. However, two other studies [17, 53] found no benefit from moderate- to high-intensity aerobic and resistance exercises. Additionally, Urvaylioglu et al. [57] found no significant difference in faecal incontinence between patients who performed Kegel exercises and controls.

Seven studies (all RCTs) investigated dietary and nutritional interventions [30, 31, 40–44]. Two studies [30, 31] were conducted by the same authors and involved the same population group and similar dietary intervention, differed solely in the timing of outcome measurement. Three of the trials were small pilot studies [40–42]. Results suggest that soy isoflavone consumption [42] and synbiotic powder intake [30, 31] significantly improved bowel function, while interventions involving soluble fibre and lactose replacement [41, 43, 44] had no clinically significant effect on bowel problems. One study [40] suggested that curcumin supplementation worsened bowel symptoms, although differences were not statistically significant.

Of the two RCTs that examined psychosocial interventions, one reported that an informational intervention was ineffective in reducing diarrhoeal problems [38], while the other reported that nurse-led group consultations had no effect on bowel function [39]. Two RCTs evaluating multidisciplinary rehabilitation interventions found no short-term or long-term improvement in bowel function [55, 56].

3.3.5 | Mental Wellbeing

Studies that assessed non-medical interventions and different dimensions of mental wellbeing such as overall emotional functioning, anxiety and depression level are summarised in Table 5. Seven RCTs [17–21, 24, 53] and one quasiexperimental study [52], all of high quality, evaluated the impact of exercise on emotional functioning. Moderate- to high-intensity aerobic and resistance exercises [17, 18] have been shown to significantly improve emotional functioning. Additionally, a dyadic resistance training programme [52] significantly reduced patient anxiety levels. While this programme [52] also showed a trend towards improved depression levels, the difference was not statistically significant. Aerobic and resistance exercises (moderate intensity [19] and moderate to high intensity [53]) tended to improve emotional functioning, but the effects were not significant. However, studies on aerobic exercise alone [20], yoga [24] and high-intensity interval training or resistance exercises [21] found no significant difference in emotional functioning compared to control groups. While aerobic exercise alone [20] and the dyadic resistance training programme [52] appeared to reduce depression, these findings were also not statistically significant. High-intensity interval training or resistance exercise intervention showed no improvement in depression [21].

Four psychosocial intervention studies to improve mental wellbeing, including two RCTs [38, 39] and two quasiexperimental studies [36, 37], were identified. Three of the four studies were assessed as being of moderate quality. The interventions investigated included information intervention [38], nurse-led group consultations [39], group logotherapy [36] and virtual reality education modules [37]. Group logotherapy demonstrated statistically significant improvements in anxiety, depression and psychological capital during radiotherapy [36], nurse-led group consultations [39] significantly reduced depressive symptoms and virtual reality education intervention [37] significantly reduced anxiety. However, informational intervention [38] did not show benefits in reducing mood issues and nurse-led group consultations [39] did not have a significant beneficial effect on generalised anxiety.

Four multidisciplinary interventions to improve mental wellbeing were identified: three high-quality RCTs [55, 56, 59] and one low-quality quasiexperimental study [51]. These interventions involved multidisciplinary rehabilitation combining

TABLE 3 | Summary of included studies on interventions to improve urinary function.

Intervention	Reference	Timing of intervention	Sample size	Intervention details	Outcome measurement	Key findings	Study quality
Exercise intervention	Ben-Josef et al. [24]	During radiotherapy	$n = 50$ Intervention group (22) Control group (28)	Eischens yoga	IPSS	Improved urinary function, but no significant difference with control group	High
	Hojan et al. [17]	During radiotherapy	$n = 54$ Exercise training group (27) Usual care group (27)	8 weeks of moderate-intensity physical exercise	EORTC QLQ-PR25	No improvement in urinary function	High
	Hojan et al. [18]	During and post radiotherapy	$n = 66$ Exercise group (35) Usual care group (31)	12 months of moderate- to high-intensity exercise programme	EORTC QLQ-PR25	Intervention did not benefit in improving urinary symptoms	High
	Kapur et al. [49]	During radiotherapy	$n = 65$ Exercise group (32) Control group (33)	Aerobic exercise: home-based, moderate-intensity, continuous walking	RTOG/EORTC	Slightly improved bladder function, but no significant difference in bladder toxicity scores between the two groups.	Moderate
	Schumacher et al. [53]	During radiotherapy	$n = 115$ Exercise group (72) Control group (43)	6 months moderate- to high-intensity exercise programme	EORTC QLQ-PR25	No effect on urinary function but relieved the severity of urinary symptoms	High
	Urvaylioglu et al. [57]	During radiotherapy	$n = 60$ Intervention group (30) Control group (30)	Kegal exercise (three times a day for 6 months)	CTCAE	Kegel exercises improved urinary incontinence. Incontinence scores increased in the control group but decreased over time in the experimental group.	High

(Continues)

TABLE 3 | (Continued)

Intervention	Reference	Timing of intervention	Sample size	Intervention details	Outcome measurement	Key findings	Study quality
Psychosocial intervention	Kim et al. [38]	Pre- and during radiotherapy	$n = 152$ Intervention group = not reported Control group = not reported	Informational intervention: about what to expect during their treatments	5-point Likert scale question on severity of urinary problem	No benefit of the intervention on urinary problems	Moderate
	Schofield et al. [39]	During and post radiotherapy	$n = 331$ Intervention group (165) Usual care (166)	Nurse-led group consultations	EPIC-26	No effect on urinary function	High
Diet and nutrition intervention	Ahmad et al. [42]	During and post radiotherapy	$n = 42$ Intervention group (20) Placebo group (22)	Consuming 200 mg of soy isoflavone for 6 months	Self-administered quality-of-life questionnaire at 3 and 6 months	Improved urinary incontinence, urgency at 3 and 6 months.	High
	Bonetta and Pirerro [28]	During radiotherapy	$n = 370$ Intervention group (184) Control group (186)	Cranberry extract therapy	Weekly assessing urinary symptoms and urine culture	Significantly improved urinary symptoms (dysuria, nocturia, urinary frequency, urgency) and lower urinary tract infections	High
	Hamilton et al. [29]	During and post radiotherapy	$n = 40$ Intervention group (20) Placebo (20)	Consuming cranberry capsule	EPIC	Reduced incidence and severity of cystitis (incidence 65% vs. 90% and severe cystitis 30% vs. 45% in the placebo and intervention group, respectively). Significantly reduced the incidence of pain/burning sensation, decreased pads/liners use	High
	Hejazi et al. [40]	During radiotherapy	$n = 40$ Curcumin group (20) Placebo group (20)	Consuming curcumin capsules	EORTC QLQ-PR25	Significantly relieved urinary symptoms	High

(Continues)

TABLE 3 | (Continued)

Intervention	Reference	Timing of intervention	Sample size	Intervention details	Outcome measurement	Key findings	Study quality
	Dieperink et al. [55]	Post radiotherapy	$n = 153$ Intervention group (76) Usual care (77)	Multidisciplinary rehabilitation (nursing counselling and physical therapy)	EPIC-26	Significantly improved urinary irritative symptoms	High
	Dieperink et al. [56]	Post radiotherapy (3 years follow-up)	$n = 143$ Multidisciplinary rehabilitation (72) Usual care (71)	Multidisciplinary rehabilitation (psychosocial support and physical activity)	EPIC-26	Significantly improved urinary irritation sum-score in patients with moderate-severe urinary problems at baseline, but there was no significant difference between groups in the overall long-term benefit.	High
Multidisciplinary intervention	Faithfull et al. [51]	Post radiotherapy	Pre–post-evaluation with 15 men	Self-management intervention: cognitive component (problem solving, coping strategies, information provision and emotional support) and behavioural component (symptoms monitoring and pelvic floor exercises)	IPSS	Significantly improved lower urinary tract symptoms	Low
	Faithfull et al. [58]	Post radiotherapy	$n = 63$ Intervention group (31) Usual care (32)	Symptom-management intervention: group support, education, pelvic floor muscle exercises	IPSS: urinary function. ICS: urinary voiding and incontinence.	Short-term (at 3 months) significant improvement in urinary voiding and continence but was not effective in a long term (beyond 3 months). No significant effect in the overall urinary function.	High

Abbreviations: CTCAE, common terminology criteria for adverse events; EORTC QLQ-PR25, European organisation for research and treatment of cancer-prostate specific module; EPIC, expanded prostate cancer index composite; EPIC-26, EPIC short-form; ICS, International Continence Society male short form; IPSS, International Prostate Symptom Score; RTOG/EORTC, radiation therapy oncology group/European organisation for research and treatment of cancer.

TABLE 4 | Summary of included studies on interventions to improve bowel function.

Intervention	Reference	Timing of intervention	Sample size	Intervention details	Outcome measurement	Key findings	Study quality
Exercise intervention	Hojan et al. [17]	During radiotherapy	$n = 54$ Exercise training group (27) Usual care group (27)	8 weeks of moderate-intensity physical exercise	EORTC QLQ-PR25	No improvement in bowel symptoms	High
	Hojan et al. [18]	During and post radiotherapy	$n = 66$ Exercise group (35) Usual care group (31)	12 months of moderate- to high-intensity exercise programme	EORTC QLQ-PR25	Significantly improved bowel function	High
	Kapur et al. [49]	During radiotherapy	$n = 65$ Exercise group (32) Control group (33)	Aerobic exercise: home-based, moderate-intensity, continuous walking	RTOG/EORTC scales	Less severe acute rectal toxicity in the exercise group with a statistically significant difference from control group	Moderate
	Schumacher et al. [53]	During radiotherapy	$n = 115$ Exercise group (72) Control group (43)	6 months moderate- to high-intensity exercise programme	EORTC QLQ-PR25	No improvement in bowel function	High
	Urvaylioglu et al. [57]	During radiotherapy	$n = 60$ Intervention group (30) Control group (30)	Kegal exercise	CTCAE	Faecal incontinence did not develop in any of the patients. No group difference.	High

(Continues)

TABLE 4 | (Continued)

Intervention	Reference	Timing of intervention	Sample size	Intervention details	Outcome measurement	Key findings	Study quality
Diet and nutrition intervention	Ahmad et al. [42]	During and post radiotherapy	$n = 42$ Intervention group (20) Placebo group (22)	Consuming 200 mg of soy isoflavone for 6 months	Self-administered quality-of-life questionnaire at 3 and 6 months	Less rectal cramping, pain and diarrhoea issues at 6 months post-radiotherapy	High
	Forslund et al. [41]	During and post radiotherapy	$n = 180$ Nutrition intervention group (92) Standard care (88)	Increase oral soluble fibre intake and reduce lactose intake	EORTC QLQ-C30 scales: diarrhoea and constipation. QLQ-PR25: bloated abdomen. GISEQ: blood in stools and flatulence	Effect of dietary fibre and lactose on bowel symptoms is small and inconclusive. Improved symptoms of blood in stools and flatulence in the acute phase (2 months post-radiotherapy). Improved symptoms of bloated abdomen during the late phase (7–24 months post-radiotherapy).	High
	Hejazi et al. [40]	During radiotherapy	$n = 40$ Curcumin group (20) Placebo group (20)	Consuming curcumin capsules	EORTC QLQ-PR25	Worsened bowel symptoms, but not statistically significant	High
	Nascimento et al. [30]	During radiotherapy	$n = 20$ Synbiotic group (10) Placebo group (10)	Oral intake of synbiotic powder	EORTC QLQ-PRT23	Reduced proctitis symptoms on the 2^{nd} and 3^{rd} weeks of radiotherapy. Outcome measured 1^{st}–4^{th} week of radiotherapy.	High
	Nascimento et al. [31]	During radiotherapy	$n = 20$ Synbiotic group (10) Placebo group (10)	Oral intake of synbiotic powder	EORTC QLQ-PRT23	Reduced the intensity of proctitis symptoms after the 5^{th}, 6^{th} and 7^{th} weeks of treatment, especially in 5^{th} and 6^{th} weeks.	High
	Pettersson et al. [43]	During and post radiotherapy	$n = 113$ Intervention group (55) Standard care (58)	Increase oral soluble fibre intake and reduce lactose intake	EORTC QLQ-C30 and QLQ-PR25	No improvement in the acute gastrointestinal side effects. Intervention lowered percentage of patients with bowel symptoms and bloated abdomen, but not statistically significant.	High
	Pettersson et al. [44]	During and post radiotherapy	$n = 102$ Intervention group (52) Standard care group (50)	Increase oral soluble fibre intake and reduce lactose intake	GISEQ, EORTC QLQ-C30 and QLQ-PR25	No effect of dietary intervention (compared to usual diet) on long-term gastrointestinal symptoms	High

(Continues)

TABLE 4 | (Continued)

Intervention	Reference	Timing of intervention	Sample size	Intervention details	Outcome measurement	Key findings	Study quality
Psychosocial intervention	Kim et al. [38]	Pre- and during radiotherapy	$n = 152$ Intervention group = not reported Control group = not reported	Informational intervention: about what to expect during their treatments	5-point Likert scale question on severity of diarrhoea	No effect on diarrhoeal problems	Moderate
	Schofield et al. [39]	During and post radiotherapy	$n = 331$ Intervention group (165) Usual care (166)	Nurse-led group consultations	EPIC-26	No effect on bowel function	High
Multidisciplinary intervention	Dieperink et al. [55]	Post radiotherapy	$n = 153$ Intervention group (76) Usual care (77)	Multidisciplinary rehabilitation (nursing counselling and physical therapy)	EPIC-26	No difference in bowel function between intervention and usual care groups	High
	Dieperink et al. [56]	Post radiotherapy	$n = 143$ Multidisciplinary rehabilitation (72) Usual care (71)	Multidisciplinary rehabilitation (psychosocial support and physical activity)	EPIC-26	No impact on bowel function in 3 years follow-up. Only slight benefit for patients with moderate-severe bowel problems at baseline.	High

Abbreviations: CTCAE, common terminology criteria for adverse events; EORTC QLQ-C30, EORTC quality of life questionnaire core; EORTC QLQ-PR25, European organisation for research and treatment of cancer-prostate specific module; EORTC QLQ-PRT23, EORTC QLQ for proctitis module 23 items; EPIC-26, expanded prostate cancer index composite short-form; GISEQ, Gastrointestinal Side Effects Questionnaire; RTOG/EORTC, radiation therapy oncology group/European organisation for research and treatment of cancer.

TABLE 5 | Summary of included studies on interventions to improve mental wellbeing.

Intervention	Reference	Timing of intervention	Sample size	Intervention details	Outcome measurement	Key findings	Study quality
Exercise intervention	Ben-Josef et al. [24]	During radiotherapy	$n = 50$ Intervention group (22) Control group (28)	Eischens yoga	FACT-G	Slightly improved emotional wellbeing, but not statistically significant	High
	Hojan et al. [17]	During radiotherapy	$n = 54$ Exercise training group (27) Usual care group (27)	8 weeks of moderate-intensity physical exercise	EORTC QLQ-C30	Emotional functioning significantly improved from baseline, but no significant difference was found between intervention and control groups	High
	Hojan et al. [18]	During and post radiotherapy	$n = 66$ Exercise group (35) Usual care group (31)	12 months of moderate- to high-intensity exercise	EORTC QLQ-C30	Significantly improved emotional function	High
	Hojan and Milecki [19]	During radiotherapy	$n = 72$ Exercise training group (36) Usual care group (36)	8 weeks of moderate-intensity supervised physical exercise	FACT-G	Small improvement in emotional functioning, not statistically significant	High
	Monga et al. [20]	During radiotherapy	$n = 21$ Exercise group (11) Control group (10)	Aerobic exercise	BDI: depression FACT-G: emotional wellbeing	Improved depression but at a non-significant level. No improvement in emotional functioning.	High
	Piraux et al. [21]	During radiotherapy	$n = 72$ High-intensity interval training (24) Resistance group (24) Control group (24)	High-intensity interval training or resistance exercise	CES-D: depression FACT-G: wellbeing	No improvement in depression symptom and wellbeing	High
	Schumacher et al. [53]	During radiotherapy	$n = 115$ Exercise group (72) Control group (43)	6 months moderate- to high-intensity exercise programme	EORTC QLQ-C30	Small improvement in emotional functioning, not significant	High
	Winters-Stone et al. [52]	During radiotherapy	$n = 16$ (8 couples) Patient (8) Spouse (8)	Progressive dyadic resistance training programme	CES-D: depression The symptom checklist-90 anxiety scale: anxiety	Significantly improved patient's anxiety level. Gradually improved patient's depression level, but not statistically significant.	High

(Continues)

TABLE 5 | (Continued)

Intervention	Reference	Timing of intervention	Sample size	Intervention details	Outcome measurement	Key findings	Study quality
Psychosocial intervention	Arefpour and Mahdavi [36]	During radiotherapy	$n = 30$ Intervention group (15) Control group (15)	Group logotherapy	BAI: anxiety BDI: depression Psychological capital questionnaire	Significantly improved anxiety, depression, and psychological capital	Moderate
	Kim et al. [38]	Pre- and during radiotherapy	$n = 152$ Intervention group = not reported Control group = not reported	Informational intervention: about what to expect during their treatments	POMS	No group difference in mood issues/negative affect	Moderate
	Marquess et al. [37]	Pre-radiotherapy	Only intervention group (22) with pre/post-test measures	Virtual reality education module	Four-point Likert scale questionnaire (not validated)	Significantly increased comprehension and reduced anxiety levels	Moderate
	Schofield et al. [39]	During and post radiotherapy	$n = 331$ Intervention group (165) Usual care (166)	Nurse-led group consultations	HDAS-D: depression HDAS-A: anxiety	Group consultations significantly reduced depressive symptoms but did not have a significant beneficial effect on generalised anxiety.	High
Multidisciplinary intervention	Dieperink et al. [55]	Post radiotherapy	$n = 153$ Intervention group (76) Usual care (77)	Multidisciplinary rehabilitation (nursing counselling and physical therapy)	EPIC-26	No difference in wellbeing 22 weeks post intervention	High
	Dieperink et al. [59]	Post radiotherapy	$n = 161$ Multidisciplinary rehabilitation (79) Standard care (82)	Multidisciplinary rehabilitation (nursing counselling and physical therapy)	Mini-MAC	Improved cognitive avoidance 3 years post-radiotherapy and fighting spirit in short term (within 6 months). No significant effect on anxious preoccupation	High
	Dieperink et al. [56]	Post radiotherapy	$n = 143$ Multidisciplinary rehabilitation (72) Usual care (71)	Multidisciplinary rehabilitation (psychosocial support and physical activity)	SF-12: mental domain	Small improvement in mental health in 3 years follow up, only minimal benefit and not statistically significant	High
	Faithfull et al. [51]	Post radiotherapy	Pre-post evaluation with 15 men.	Self-management intervention: cognitive component (problem solving, coping strategies, information provision and emotional support) and behavioural component (symptoms monitoring and pelvic floor exercises)	EORTC QLQ C30: emotional functioning scale	Decreased emotional distress, but not statistically significant	Low

Abbreviations: BAI, Beck Anxiety Inventory; BDI, Beck Depression Inventory; CES-D, Centre for Epidemiologic Studies Depression Scale 20-item; EORTC QLQ-C30, European organisation for research and treatment of cancer-quality of life questionnaire core; EPIC-26, expanded prostate cancer index composite short-form; FACT-G, functional assessment of chronic illness therapy-general; HDAS, Hospital Anxiety and Depression Scale; Mini-MAC, Mini-Mental Adjustment to Cancer Scale; POMS, profile of mood states; SF-12, Medical Outcome Study Short-Form 12.

nursing counselling and physical therapy sessions [55, 56, 59] as well as an intervention incorporating self-management and pelvic floor exercises [51]. The study by Faithfull et al. [51] reported that symptom-management intervention led to a decrease in emotional distress, although this effect was not statistically significant. Multidisciplinary rehabilitation did not show any improvement in emotional function in either the short [55] or long term [56]. Dieperink et al. [59] reported that multidisciplinary rehabilitation may alleviate mental adjustment styles, such as 'fighting spirit' immediately post-intervention and 'cognitive avoidance' after 3 years, but had no significant effect on anxious preoccupation.

4 | Discussion

To the best of our knowledge, this systematic review is the first comprehensive review of published literature to identify and evaluate various non-medical interventions aimed at improving functional outcomes among men treated with radiotherapy for prostate cancer. It provides a synthesis of RCTs and quasiexperimental studies published between 1990 and 2024. Our synthesis of the evidence suggests that exercise interventions, particularly those involving aerobic and/or resistance exercise, reduce fatigue. Additionally, multidisciplinary rehabilitation, comprising nurse-led consultations and pelvic floor exercises recommended by physical therapists, may also improve urinary function, specifically by alleviating urinary irritative symptoms. Inconsistent findings prevented definitive conclusions about the effect of exercise on other functional outcomes. Furthermore, the evidence regarding the impact of dietary and psychosocial interventions on various functional outcomes is insufficient to draw firm conclusions or make specific recommendations.

Multiple studies [17–22, 24, 50, 53, 54] consistently suggest that exercise interventions can have a positive effect on fatigue. This result aligns with findings from a meta-analysis of RCTs showing that exercise and physical activity significantly reduced fatigue related to any type of cancer [23]. Given the strength and consistency of this evidence, we recommend that prostate cancer patients consider engaging in aerobic and/or resistance exercise to improve radiotherapy-related fatigue.

Evidence regarding the effects of exercise on sexual function in men undergoing radiotherapy for prostate cancer remains mixed. Two RCTs by the same authors [17, 18] showed positive associations between aerobic and resistance exercises and sexual function. However, a pooled analysis of two RCTs by Schumacher et al. [53] found that a 6-month programme of physical activity did not improve sexual function. These inconsistencies reflect substantial heterogeneity across studies in terms of exercise modality, intensity, frequency and duration, which likely influences the extent of physiological adaptation achieved. Differences in the baseline sexual function and the use of concurrent treatments with radiotherapy such as androgen deprivation therapy—known to adversely affect sexual function—may have further limited opportunities for measurable improvement in some cohorts. In addition, variation in the outcome measurement tools used to assess sexual function and differences in the timing of assessment relative to radiotherapy may have influenced study findings. From a mechanistic perspective, exercise may improve sexual function through improvements in cardiovascular fitness and endothelial function, enhanced blood flow, favourable hormonal regulation and improved psychological wellbeing, all of which are associated with erectile and sexual functions [11, 23]. However, it is possible that the exercise intensity or intervention duration in some studies was insufficient to elicit these physiological adaptations.

In addition, while one study reported that Kegel exercise reduced urinary incontinence [57], most included studies found no significant effect of exercise on urinary issues [18, 24, 49, 53]. Similarly, the evidence for exercise interventions in relation to addressing bowel [17, 18, 49, 53] and mental wellbeing outcomes [17–21, 52, 53] is weak due to inconsistent findings. Further research is needed to investigate whether different types and durations of physical activity can improve urinary, bowel and mental wellbeing.

Certain psychosocial interventions appeared to be helpful in improving mental wellbeing for men with prostate cancer [36, 37]. However, the small number of papers, low numbers of participants and moderate quality of the studies weaken the strength of evidence for the general effectiveness of such interventions. The findings from Schofield et al. [39], showing that nurse-led consultations may improve patient's depression symptoms, are promising due to the high-quality RCT design and large sample size. However, as this is the only paper to explore the association between nurse-led consultations and mental wellbeing, it is difficult to draw definitive conclusions. Overall, the effectiveness of psychosocial interventions to improve mental wellbeing remains uncertain, and more rigorous research is required.

Similarly, the evidence regarding dietary and nutritional interventions for improving urinary function is inconclusive. Both Bonetta and Di Pirerro [28] and Hamilton et al. [29] reported that cranberry extract/cranberry capsules could potentially reduce urinary tract infections, reduce the severity of cystitis and alleviate pain and burning sensations. However, the former study employed a non-randomised design, while the latter, although a randomised study, was a small pilot study limited by the small sample size. Therefore, further RCTs with large sample sizes are necessary to confirm the potential benefits of cranberry consumption on urinary function. Similarly, oral intake of synbiotic powder [30, 31] appeared to have a positive effect, reducing the intensity of proctitis between the second and seventh weeks of radiotherapy. Nonetheless, due to the small sample sizes with only two studies by the same author on the same population, these findings remain inconclusive, underscoring the need for additional research with larger participant numbers.

Multidisciplinary rehabilitation, combining psychosocial and exercise interventions such as nurse consultations and pelvic floor exercises recommended by physical therapists, showed promise in improving urinary function, particularly by reducing irritative symptoms in the short term [55]. However, multidisciplinary rehabilitation may not yield long-term benefit although men with moderate-to-severe urinary at baseline did show some improvement [55, 56]. This suggests that ongoing consultations and/or continued exercise may be necessary to sustain improvements in urinary function. A symptom-management intervention consisting of peer support, education and pelvic floor muscle exercise also demonstrated positive short-term effects on the urinary function [58]. However, as there was no significant effect on the overall urinary function or long-term benefit for urinary symptoms, drawing definitive conclusions is limited.

5 | Implications of the Study

Consistent evidence supports the use of aerobic and resistance exercises to improve fatigue and multidisciplinary rehabilitation interventions to improve urinary function. However, evidence for other non-medical interventions to improve functional outcomes following radiotherapy for prostate cancer is weak. Many studies suffer from small sample sizes, and some from low to moderate quality, or nonrandomised designs. Additionally, the limited number of studies assessing specific interventions and outcomes, as well as inconsistencies in findings, further undermines the quality of evidence. As a result, clinicians, nurses and allied health professionals are hampered in advising patients on non-medical interventions to optimise functional outcomes after radiotherapy. More high-quality RCTs with larger sample sizes are needed to provide stronger evidence to guide the survivorship care of prostate cancer patients.

6 | Strengths and Limitations of the Study

The strengths of this systematic review include its examination of multiple functional outcomes—fatigue, mental health, sexual, urinary and bowel functions—which are common side effects of patients undergoing radiotherapy for prostate cancer. This allows for the identification of interventions that can simultaneously address multiple treatment side effects. Additionally, JBI critical appraisal tools were applied to rate the quality and reliability of the included studies. Furthermore, highlighting the range of interventions applied to different functional outcomes offers a framework for researchers to further investigate and address the evidence gaps.

However, this review also has some limitations. Restricting to English-only published articles may have excluded potentially relevant studies. Additionally, most of the studies only included men who received EBRT and drawing conclusions in relation to the effectiveness of interventions for men receiving brachytherapy is not possible. Furthermore, few studies conducted interventions before radiation initiation or compared outcomes with respect to the timing of the intervention. Therefore, it was not possible to draw conclusions regarding whether the timing of interventions plays a role in influencing their effectiveness with respect to improving functional outcomes. Although the scope of this review was on non-medical interventions, there are other medical interventions, such as endorectal balloons and hydrogel spacers, that may benefit prostate cancer patients receiving radiotherapy by reducing the likelihood of side effects. These medical interventions were not included in this study.

7 | Conclusion

This systematic review summarised evidence on the effectiveness of different non-medical interventions for improving physical functioning among men who received radiotherapy for prostate cancer. The results suggest that aerobic and resistance exercises may alleviate fatigue. Additionally, multidisciplinary rehabilitation (counselling and physiotherapy guidance) showed promise in improving urinary function, particularly urinary irritative symptoms. The evidence from the current review supports recommending exercise and multidisciplinary rehabilitation interventions to prostate cancer patients to improve radiotherapy-related fatigue and urinary problems, respectively. Because of substantial heterogeneity across studies in the intervention type, duration, timing and outcome measures, a meta-analysis was not feasible. As a result, the conclusions regarding efficacy should be interpreted with caution. The inconsistent findings, small sample sizes and methodological variability further constrain the ability to draw definitive recommendations. Further high-quality RCTs with large sample sizes are needed to assess the effectiveness of exercise interventions on sexual function (which appears promising), as well as psychosocial interventions for mental wellbeing and dietary interventions for bowel problems, to provide more varied options for patients' aftercare.

Author Contributions

Ben Hung, Tenaw Tiruye and Kerri Beckmann conceived the research. Ben Hung, Tenaw Tiruye, Stamati Morias and Kerri Beckmann contributed to the study design. Ben Hung undertook searching, screening, data extraction/synthesis and risk of bias assessment. Tenaw Tiruye and Kerri Beckmann contributed to screening, data extraction/synthesis and risk of bias assessment. Stamati Morias contributed to data extraction/synthesis and interpreted the findings. Ben Hung and Tenaw Tiruye drafted the manuscript. Stamati Morias and Kerri Beckmann critically revised the manuscript for intellectual content.

Acknowledgements

The authors would like to thank UniSA librarians who helped us for searching.

Funding

Tenaw Tiruye and Kerri Beckmann are supported through the Cancer Council SA's Research Fellowship. Open access publishing facilitated by Adelaide University, as part of the Wiley—Adelaide University agreement via the Council of Australasian University Librarians.

Disclosure

All authors have read and approved the final manuscript. The funders had no role in the design or conduct of the study; collection, management, analyses and interpretation of data; writing of the manuscript or decision to submit for publication. The protocol for this review has been published previously on Open Science Framework (https://osf.io/uehzr).

Ethics Statement

Ethics approval was not required for the study.

Conflicts of Interest

The authors declare no conflicts of interest.

References

1. Cancer Council SA, "Prostate Cancer," (2022), https://www.cancersa.org.au/cancer-a-z/prostate-cancer/the-prostate.

2. Cancer Australia, *Prostate Cancer in Australia Statistics* (Australian Government, 2024), https://www.canceraustralia.gov.au/cancer-types/prostate-cancer/statistics.

3. Australian Institute of Health and Welfare, *Cancer Data in Australia* (Australian Government, 2024), https://www.aihw.gov.au/reports/cancer/cancer-data-in-australia/contents/overview.

4. Cancer Australia, *National Cancer Control Indicators (NCCI)* (2022), https://ncci.canceraustralia.gov.au/outcomes/relative-survival-rate.

5. U. Lehto, H. Tenhola, K. Taari, and A. Aromaa, "Patients' Perceptions of the Negative Effects Following Different Prostate Cancer Treatments and the Impact on Psychological Well-Being: A Nationwide Survey,"

British Journal of Cancer 116, no. 7 (2017): 864–873, https://doi.org/10.1038/bjc.2017.30.

6. T. Tiruye, M. O'Callaghan, K. Moretti, et al., "Patient-Reported Functional Outcome Measures and Treatment Choice for Prostate Cancer," *BMC Urology* 22, no. 1 (2022): 169, https://doi.org/10.1186/s12894-022-01117-1.

7. T. Tiruye, M. O'Callaghan, K. Ettridge, et al., "Clinical and Functional Outcomes for Risk-Appropriate Treatments for Prostate Cancer," *BJUI Compass* 5, no. 1 (2024): 109–120, https://doi.org/10.1002/bco2.288.

8. F. C. Hamdy, J. L. Donovan, J. A. Lane, et al., "10-Year Outcomes After Monitoring, Surgery, or Radiotherapy for Localized Prostate Cancer," *New England Journal of Medicine* 375, no. 15 (2016): 1415–1424, https://doi.org/10.1056/nejmoa1606220.

9. T. Soliman, H. Shaher, A. Mohey, W. El-Shaer, and A. Sebaey, "Gonadotoxic Effect of Tramadol Administration: A Prospective Controlled Study," *Arab Journal of Urology* 20, no. 1 (2022): 54–60, https://doi.org/10.1080/2090598x.2021.2002634.

10. W. Kinnaird, M. G. Kirby, A. Mitra, R. Davda, V. Jenkins, and H. Payne, "The Management of Sexual Dysfunction Resulting From Radiotherapy and Androgen Deprivation Therapy to Treat Prostate Cancer: A Comparison of Uro-Oncology Practice According to Disease Stage," *International Journal of Clinical Practice* 75, no. 4 (2021): e13873, https://doi.org/10.1111/ijcp.13873.

11. X. Xiong, B. Zeng, S. Zhang, et al., "Which Type of Exercise During Radiation Therapy is Optimal to Improve Fatigue and Quality of Life in Men With Prostate Cancer? A Bayesian Network Analysis," *European Urology Open Science* 43 (2022): 74–86, https://doi.org/10.1016/j.euros.2022.07.008.

12. T. H. Almigbal, K. M. Almutairi, J. B. Fu, et al., "Assessment of Psychological Distress Among Cancer Patients Undergoing Radiotherapy in Saudi Arabia," *Psychology Research and Behavior Management* 12 (2019): 691–700, https://doi.org/10.2147/prbm.s209896.

13. C. F. Sharpley, D. R. H. Christie, and V. Bitsika, "Depression and Prostate Cancer: Implications for Urologists and Oncologists," *Nature Reviews Urology* 17, no. 10 (2020): 571–585, https://doi.org/10.1038/s41585-020-0354-4.

14. L. R. Feng, A. Espina, and L. N. Saligan, "Association of Fatigue Intensification With Cognitive Impairment During Radiation Therapy for Prostate Cancer," *Oncology* 94, no. 6 (2018): 363–372, https://doi.org/10.1159/000487081.

15. C. J. D. Wallis, A. L. Mahar, R. Choo, et al., "Second Malignancies After Radiotherapy for Prostate Cancer: Systematic Review and Meta-Analysis," *BMJ* 352 (2016): i851, https://doi.org/10.1136/bmj.i851.

16. T. Tiruye, R. David, M. O'Callaghan, et al., "Risk of Secondary Malignancy Following Radiation Therapy for Prostate Cancer," *Scientific Reports* 13, no. 1 (2023): 20083, https://doi.org/10.1038/s41598-023-45856-z.

17. K. Hojan, E. Kwiatkowska-Borowczyk, E. Leporowska, et al., "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," *European Journal of Physical and Rehabilitation Medicine* 52, no. 4 (2016): 489–501.

18. K. Hojan, E. Kwiatkowska-Borowczyk, E. Leporowska, and P. Milecki, "Inflammation, Cardiometabolic Markers, and Functional Changes in Men With Prostate Cancer: A Randomized Controlled Trial of a 12 Month Exercise Program," *Polish Archives of Internal Medicine* 127, no. 1 (2017): 25–35, https://doi.org/10.20452/pamw.3888.

19. K. Hojan and P. Milecki, "Does Regular Physical Exercises During Radiotherapy Influence Fatigue and Physical Endurance in High-Risk Prostate Cancer Patients?" *Rehabilitacja Medyczna* 23, no. 4 (2019): 21–27.

20. U. Monga, S. L. Garber, J. Thornby, et al., "Exercise Prevents Fatigue and Improves Quality of Life in Prostate Cancer Patients Undergoing Radiotherapy," *Archives of Physical Medicine and Rehabilitation* 88, no. 11 (2007): 1416–1422, https://doi.org/10.1016/j.apmr.2007.08.110.

21. E. Piraux, G. Caty, L. Renard, et al., "Effects of High-Intensity Interval Training Compared With Resistance Training in Prostate Cancer Patients Undergoing Radiotherapy: A Randomized Controlled Trial," *Prostate Cancer and Prostatic Diseases* 24, no. 1 (2021): 156–165, https://doi.org/10.1038/s41391-020-0259-6.

22. R. J. Segal, R. D. Reid, K. S. Courneya, et al., "Randomized Controlled Trial of Resistance or Aerobic Exercise in Men Receiving Radiation Therapy for Prostate Cancer," *Journal of Clinical Oncology* 27, no. 3 (2009): 344–351, https://doi.org/10.1200/jco.2007.15.4963.

23. L. Berríos-Contreras, R. Cuevas-Cid, L. A. Lorca, and I. L. Ribeiro, "Effectiveness of Resistance Training on Fatigue in Patients Undergoing Cancer Treatment: A Meta-Analysis of Randomized Clinical Trials," *International Journal of Breast Cancer* 2022 (2022): 9032534–17, https://doi.org/10.1155/2022/9032534.

24. A. M. Ben-Josef, J. Chen, P. Wileyto, et al., "Effect of Eischens Yoga During Radiation Therapy on Prostate Cancer Patient Symptoms and Quality of Life: A Randomized Phase II Trial," *International Journal of Radiation Oncology, Biology, Physics* 98, no. 5 (2017): 1036–1044, https://doi.org/10.1016/j.ijrobp.2017.03.043.

25. J. L. McQuade, S. Prinsloo, D. Z. Chang, et al., "Qigong/Tai Chi for Sleep and Fatigue in Prostate Cancer Patients Undergoing Radiotherapy: A Randomized Controlled Trial," *Psycho-Oncology* 26, no. 11 (2017): 1936–1943, https://doi.org/10.1002/pon.4256.

26. G. Saltaouras, H. Lightowler, S. Coe, et al., "Diet and Nutrition in Patients Who Have Received Pelvic Radiotherapy: A Mixed-Methods Study to Explore Dietary Habits, Nutritional Awareness, and Experiences of Nutritional Care," *Nutrition* 89 (2021): 111309, https://doi.org/10.1016/j.nut.2021.111309.

27. L. Söderström, M. Forslund, B. Johansson, A. Ottenblad, and A. Rosenblad, "Associations Between Dietary Advice on Modified Fibre and Lactose Intakes and Nutrient Intakes in Men With Prostate Cancer Undergoing Radiotherapy," *Upsala Journal of Medical Sciences* 127, no. 1 (2022): e8261, https://doi.org/10.48101/ujms.v127.8261.

28. A. Bonetta and F. Di Pierro, "Enteric-Coated, Highly Standardized Cranberry Extract Reduces Risk of UTIs and Urinary Symptoms During Radiotherapy for Prostate Carcinoma," *Cancer Management and Research* 4, no. 1 (2012): 281–286.

29. K. Hamilton, N. C. Bennett, G. Purdie, and P. M. Herst, "Standardized Cranberry Capsules for Radiation Cystitis in Prostate Cancer Patients in New Zealand: A Randomized Double Blinded, Placebo Controlled Pilot Study," *Supportive Care in Cancer* 23, no. 1 (2015): 95–102, https://doi.org/10.1007/s00520-014-2335-8.

30. M. Nascimento, J. E. Aguilar-Nascimento, C. Caporossi, H. M. Castro-Barcellos, and R. T. Motta, "Efficacy of Synbiotics to Reduce Acute Radiation Proctitis Symptoms and Improve Quality of Life: A Randomized, Double-Blind, Placebo-Controlled Pilot Trial," *International Journal of Radiation Oncology, Biology, Physics* 90, no. 2 (2014): 289–295, https://doi.org/10.1016/j.ijrobp.2014.05.049.

31. M. Nascimento, C. Caporossi, A. J. Eduardo, C. H. Michelon, M. R. Teixeira, and S. Reis Lima, "Efficacy of Synbiotics to Reduce Symptoms and Rectal Inflammatory Response in Acute Radiation Proctitis: A Randomized, Double-Blind, Placebo-Controlled Pilot Trial," *Nutrition and Cancer* 72, no. 4 (2020): 602–609, https://doi.org/10.1080/01635581.2019.1647254.

32. L. Dreismann, A. Goretzki, V. Ginger, and T. Zimmermann, "What If...I Asked Cancer Patients About Psychological Distress? Barriers in Psycho-Oncological Screening From the Perspective of Nurses-A

Qualitative Analysis," *Frontiers in Psychiatry* 12 (2022): 786691, https://doi.org/10.3389/fpsyt.2021.786691.

33. S. K. Chambers, S. Occhipinti, A. Stiller, et al., "Five-Year Outcomes from a Randomised Controlled Trial of a Couples-Based Intervention for Men With Localised Prostate Cancer," *Psycho-Oncology* 28, no. 4 (2019): 775–783, https://doi.org/10.1002/pon.5019.

34. American Cancer Society, *Psychosocial Support Options for People With Cancer* (American Cancer Society, 2023).

35. C. Breidenbach, R. Roth, L. Ansmann, et al., "Use of Psycho-Oncological Services by Prostate Cancer Patients: A Multilevel Analysis," *Cancer Medicine* 9, no. 11 (2020): 3680–3690, https://doi.org/10.1002/cam4.2999.

36. A. M. Arefpour and H. Mahdavi, "Effects of Group Logotherapy on Mood and Function of Locally Advanced Prostate Cancer Patients," *Counselling and Psychotherapy Research* 22, no. 4 (2022): 868–875, https://doi.org/10.1002/capr.12509.

37. M. Marquess, S. P. Johnston, N. L. Williams, et al., "A Pilot Study to Determine if the Use of a Virtual Reality Education Module Reduces Anxiety and Increases Comprehension in Patients Receiving Radiation Therapy," *Journal of Radiation Oncology* 6, no. 3 (2017): 317–322, https://doi.org/10.1007/s13566-017-0298-3.

38. Y. Kim, J. A. Roscoe, and G. R. Morrow, "The Effects of Information and Negative Affect on Severity of Side Effects From Radiation Therapy for Prostate Cancer," *Supportive Care in Cancer* 10, no. 5 (2002): 416–421, https://doi.org/10.1007/s00520-002-0359-y.

39. P. Schofield, K. Gough, K. Lotfi-Jam, et al., "Nurse-Led Group Consultation Intervention Reduces Depressive Symptoms in Men With Localised Prostate Cancer: A Cluster Randomised Controlled Trial," *BMC Cancer* 16, no. 1 (2016): 637, https://doi.org/10.1186/s12885-016-2687-1.

40. J. Hejazi, R. Rastmanesh, F. A. Taleban, S. H. Molana, and G. Ehtejab, "A Pilot Clinical Trial of Radioprotective Effects of Curcumin Supplementation in Patients With Prostate Cancer," *Journal of Cancer Sciences and Therapy* 5, no. 10 (2013): 320–324.

41. M. Forslund, A. Ottenblad, C. Ginman, S. Johansson, P. Nygren, and B. Johansson, "Effects of a Nutrition Intervention on Acute and Late Bowel Symptoms and Health-Related Quality of Life Up to 24 Months Post Radiotherapy in Patients With Prostate Cancer: A Multicentre Randomised Controlled Trial," *Supportive Care in Cancer* 28, no. 7 (2020): 3331–3342, https://doi.org/10.1007/s00520-019-05182-5.

42. I. U. Ahmad, J. D. Forman, F. H. Sarkar, et al., "Soy Isoflavones in Conjunction With Radiation Therapy in Patients With Prostate Cancer," *Nutrition and Cancer* 62, no. 7 (2010): 996–1000, https://doi.org/10.1080/01635581.2010.509839.

43. A. Pettersson, B. Johansson, C. Persson, A. Berglund, and I. Turesson, "Effects of a Dietary Intervention on Acute Gastrointestinal Side Effects and Other Aspects of Health-Related Quality of Life: A Randomized Controlled Trial in Prostate Cancer Patients Undergoing Radiotherapy," *Radiotherapy & Oncology* 103, no. 3 (2012): 333–340, https://doi.org/10.1016/j.radonc.2012.04.006.

44. A. Pettersson, P. Nygren, C. Persson, A. Berglund, I. Turesson, and B. Johansson, "Effects of a Dietary Intervention on Gastrointestinal Symptoms After Prostate Cancer Radiotherapy: Long-Term Results From a Randomized Controlled Trial," *Radiotherapy & Oncology* 113, no. 2 (2014): 240–247, https://doi.org/10.1016/j.radonc.2014.11.025.

45. M. J. Page, J. E. McKenzie, P. M. Bossuyt, et al., "The PRISMA 2020 Statement: An Updated Guideline for Reporting Systematic Reviews," *BMJ* 372 (2021): 71, https://doi.org/10.1136/bmj.n71.

46. T. H. Barker, J. C. Stone, K. Sears, et al., "The Revised JBI Critical Appraisal Tool for the Assessment of Risk of Bias for Randomized Controlled Trials," *JBI Evidence Synthesis* 21, no. 3 (2023): 494–506, https://doi.org/10.11124/jbies-22-00430.

47. T. H. Barker, N. Habibi, E. Aromataris, et al., "The Revised JBI Critical Appraisal Tool for the Assessment of Risk of Bias Quasi-Experimental Studies," *JBI Evidence Synthesis* 22, no. 3 (2024): 378–388, https://doi.org/10.11124/jbies-23-00268.

48. S. Kachabian, S. Seyedmajidi, B. Tahani, and M. M. Naghibi Sistani, "Effectiveness of Educational Strategies to Teach Evidence-Based Dentistry to Undergraduate Dental Students: A Systematic Review," *Evidence-Based Dentistry* 25, no. 1 (2024): 53–54, https://doi.org/10.1038/s41432-023-00958-5.

49. G. Kapur, P. M. Windsor, and C. C. Mc, "The Effect of Aerobic Exercise on Treatment-Related Acute Toxicity in Men Receiving Radical External Beam Radiotherapy for Localised Prostate Cancer," *European Journal of Cancer Care* 19, no. 5 (2010): 643–647, https://doi.org/10.1111/j.1365-2354.2009.01083.x.

50. P. M. Windsor, K. F. Nicol, and J. Potter, "A Randomized, Controlled Trial of Aerobic Exercise for Treatment-Related Fatigue in Men Receiving Radical External Beam Radiotherapy for Localized Prostate Carcinoma," *Cancer* 101, no. 3 (2004): 550–557, https://doi.org/10.1002/cncr.20378.

51. S. Faithfull, J. Cockle-Hearne, and V. Khoo, "Self-Management After Prostate Cancer Treatment: Evaluating the Feasibility of Providing a Cognitive and Behavioural Programme for Lower Urinary Tract Symptoms," *BJU International* 107, no. 5 (2010): 783–790, https://doi.org/10.1111/j.1464-410x.2010.09588.x.

52. K. M. Winters-Stone, K. S. Lyons, T. M. Beer, M. B. Skiba, and A. Hung, "A Pilot Feasibility Study of Exercising Together© During Radiation Therapy for Prostate Cancer: A Dyadic Approach for Patients and Spouses," *Pilot and Feasibility Studies* 7, no. 1 (2021): 216, https://doi.org/10.1186/s40814-021-00952-7.

53. O. Schumacher, D. A. Galvao, D. R. Taaffe, et al., "Effect of Exercise Adjunct to Radiation and Androgen Deprivation Therapy on Patient-Reported Treatment Toxicity in Men With Prostate Cancer: A Secondary Analysis of 2 Randomized Controlled Trials," *Practical Radiation Oncology* 11, no. 3 (2021): 215–225, https://doi.org/10.1016/j.prro.2021.01.005.

54. P. T. Truong, C. A. Gaul, R. E. McDonald, et al., "Prospective Evaluation of a 12 Week Walking Exercise Program and Its Effect on Fatigue in Prostate Cancer Patients Undergoing Radical External Beam Radiotherapy," *American Journal of Clinical Oncology: Cancer Clinical Trials* 34, no. 4 (2011): 350–355, https://doi.org/10.1097/coc.0b013e3181e841ec.

55. K. B. Dieperink, C. Johansen, S. Hansen, et al., "The Effects of Multidisciplinary Rehabilitation: Repca-A Randomised Study Among Primary Prostate Cancer Patients," *British Journal of Cancer* 109, no. 12 (2013): 3005–3013, https://doi.org/10.1038/bjc.2013.679.

56. K. B. Dieperink, S. Hansen, L. Wagner, L. R. Minet, and O. Hansen, "Long-Term Follow-Up 3 Years After a Randomized Rehabilitation Study Among Radiated Prostate Cancer Survivors," *Journal of Cancer Survivorship: Research and Practice* 15, no. 5 (2021): 668–676, https://doi.org/10.1007/s11764-020-00958-9.

57. A. E. Urvaylioglu, S. Kutluturkan, and D. Kilic, "Effect of Kegel Exercises on the Prevention of Urinary and Fecal Incontinence in Patients With Prostate Cancer Undergoing Radiotherapy," *European Journal of Oncology Nursing: The Official Journal of European Oncology Nursing Society* 51 (2021): 101913, https://doi.org/10.1016/j.ejon.2021.101913.

58. S. Faithfull, J. Cockle-Hearne, A. Lemanska, S. Otter, and S. S. Skene, "Randomised Controlled Trial to Investigate the Effectiveness of the Symptom Management After Radiotherapy (SMaRT) Group Intervention

to Ameliorate Lower Urinary Tract Symptoms in Men Treated for Prostate Cancer," *Supportive Care in Cancer* 30, no. 4 (2022): 3165–3176, https://doi.org/10.1007/s00520-021-06749-x.

59. K. B. Dieperink, C. Johansen, S. Hansen, et al., "Male Coping Through a Long-Term Cancer Trajectory. Secondary Outcomes From a RTC Examining the Effect of a Multidisciplinary Rehabilitation Program (RePCa) Among Radiated Men With Prostate Cancer," *Acta Oncologica* 56, no. 2 (2017): 254–261, https://doi.org/10.1080/0284186x.2016.1267395.

Supporting Information

Additional supporting information can be found online in the Supporting Information section.

Supporting Information 1. Supporting Table 1: Search string (sample Medline via Ovid).

Supporting Information 2. Supporting Table 2: JBI critical appraisal checklist results for assessing the methodological quality of included studies.