BILYK, Andrii, BRUSKA, Natalia, KOŁODZIEJ, Przemysław, HEBDA, Patryk, CEMAGA, Roman, PATALONG, Mikołaj Franciszek, SZPLIT, Ewa, CZAPLIŃSKI, Mieszko, MICHNOWSKA, Wiktoria and PUSTUŁA, Paweł. The Role of Prehabilitation on Functional Outcomes After Radical Prostatectomy: A Scoping Review. Quality in Sport. 2026;50:68112. eISSN 2450-3118.
https://doi.org/10.12775/QS.2026.50.68112
https://apcz.umk.pl/QS/article/view/68112

The journal has been awarded 20 points in the parametric evaluation by the Ministry of Higher Education and Science of Poland. This is according to the Annex to the announcement of the Minister of Higher Education and Science dated 05.01.2024, No. 32553. The journal has a Unique Identifier: 201398. Scientific disciplines assigned: Economics and Finance (Field of Social Sciences); Management and Quality Sciences (Field of Social Sciences).
Punkty Ministerialne z 2019 - aktualny rok 20 punktów. Załącznik do komunikatu Ministra Szkolnictwa Wyższego i Nauki z dnia 05.01.2024 Lp. 32553. Posiada Unikatowy Identyfikator Czasopisma: 201398. Przypisane dyscypliny naukowe: Ekonomia i finanse (Dziedzina nauk społecznych); Nauki o zarządzaniu i jakości (Dziedzina nauk społecznych).
The authors declare that there is no conflict of interest regarding the publication of this paper.
Received: 10.01.2026. Revised: 24.01.2026. Accepted: 24.01.2026. Published: 30.01.2026.

The Role of Prehabilitation on Functional Outcomes After Radical Prostatectomy: A Scoping Review

Andrii Bilyk[1], ORCID https://orcid.org/0009-0001-5020-1113

E-mail andrzej.bilyk02@gmail.com

[1]Independent Public Healthcare Facility of the Ministry of the Interior and Administration in Gdańsk

Natalia Bruska[2], ORCID https://orcid.org/0009-0008-5749-874X

E-mail bruska.nataliax@gmail.com

[2]University Clinical Centre in Gdańsk, Medical University of Gdańsk, ul. Dębinki 7, 80-952 Gdańsk, Poland

Przemysław Kołodziej[3], ORCID https://orcid.org/0009-0003-5725-2372

E-mail przemyslaw.i.kolodziej@gmail.com

[3]Individual Medical Practice Przemysław Igor Kołodziej, ul. Alojzego Felińskiego 30/9 41-923 Bytom, Poland

Patryk Hebda[4], ORCID: https://orcid.org/0009-0006-4660-3554

E-mail patrys10h@gmail.com

[4]Andrzej Frycz Modrzewski University in Kraków, ul. Gustawa Herlinga-Grudzińskiego 1, 30-705 Kraków, Poland

Roman Cemaga[5], ORCID https://orcid.org/0009-0003-8372-2905

E-mail rcemaga@gmail.com

[5]Medical University of Bialystok, Jana Kilińskiego 1, 15-089, Białystok, Poland

Mikołaj Franciszek Patalong[6], ORCID https://orcid.org/0000-0003-4230-7521
E-mail patalongmikolaj@gmail.com
[6]Individual Medical Practice Mikołaj Patalong, ul. Zabrzańska 26, 41-907 Bytom, Poland

Ewa Szplit[7], ORCID: https://orcid.org/0009-0001-1464-6027
E-mail: e.szplit@gmail.com
[7]Gdańsk Medical University, Marii Skłodowskiej-Curie 3a, 80-210 Gdańsk, Poland

Mieszko Czapliński[8], ORCID https://orcid.org/0009-0003-8052-4129
E-mail mieszkocz4@gmail.com
[8]University Clinical Centre in Gdańsk, Medical University of Gdańsk, ul. Dębinki 7, 80-952 Gdańsk, Poland

Wiktoria Michnowska[9], ORCID https://orcid.org/0009-0003-7161-0105
E-mail wikmic0@gmail.com
[9]University Clinical Centre in Gdańsk, Medical University of Gdańsk, ul. Dębinki 7, 80-952 Gdańsk, Poland

Paweł Pustuła[10], ORCID https://orcid.org/0009-0003-4494-1080
E-mail p.pustula@icloud.com
[10]Family Medicine Center, Medical University of Gdańsk, Dębinki 7, 80-211 Gdańsk, Poland

Corresponding Author
Andrii Bilyk, Email andrzej.bilyk02@gmail.com

Abstract
Background
Radical prostatectomy is a primary treatment for localized prostate cancer but often results in urinary incontinence and erectile dysfunction, significantly impacting patient quality of life. Prehabilitation, defined as the optimization of physical capacity before surgery—aims to increase physiological reserve to buffer the functional decline caused by surgical trauma.
Aim

The primary objective of this scoping review is to comprehensively evaluate the efficacy of various prehabilitation modalities on functional outcomes following radical prostatectomy. Specifically, this report assesses the impact of preoperative Pelvic Floor Muscle Training, High-Intensity Interval Training, resistance exercise, and multimodal lifestyle interventions on the recovery of urinary continence, erectile function, and cardiorespiratory fitness.

Material and Methods

A review of RCTs, prospective cohorts, and meta-analyses published through 2025 was conducted. The synthesis included diverse interventions and measured outcomes using validated tools like the EPIC and IIEF scales, as well as objective pad tests.

Results

Preoperative PFMT with biofeedback significantly speeds early urinary recovery. However, long-term results match standard postoperative care, indicating a "bolus effect" that accelerates initial progress without altering the final anatomical plateau. Systemic prehabilitation via HIIT and resistance training was found to significantly improve cardiorespiratory fitness and muscular strength, leading to a substantial reduction in post-operative complications, though the direct translation to urological function remains heterogeneous.

Conclusions

Prehabilitation is a safe and effective strategy to enhance early functional recovery. While it cannot fully overcome severe anatomical deficits, it provides a crucial buffer that speeds the return to continence. Evidence strongly supports integrating multimodal prehabilitation into standard urological care.

Keywords: Prehabilitation, Radical Prostatectomy, Urinary Incontinence, Sarcopenia,

AI statement: Artificial intelligence tools have not been used to produce or alter the scientific content of the paper. Publicly available AI-powered websites have been used to identify better wording for certain expressions and sentences to ensure a smooth reading experience, while having no impact on the interpretation of cited evidence.

1. Introduction

1.1 The Epidemiological and Economic Context of Prostate Cancer

Prostate cancer stands as one of the most frequently diagnosed malignancies in men, presenting a complex challenge to healthcare systems worldwide. The management of localized disease often involves radical prostatectomy (RP), a procedure designed to excise the malignancy while attempting to preserve the delicate neurovascular and sphincter structures essential for function. Despite advancements in surgical precision, including the widespread adoption of robot-assisted techniques, the functional aftermath of the surgery remains a critical concern.

The burden of these functional complications extends far beyond the individual patient's quality of life; it carries immense economic weight. A comprehensive 2025 analysis of the European Union (EU-27) revealed that the economic burden of urinary incontinence is staggering. In 2023 alone, the economic cost of urinary incontinence, excluding caregiver contributions, was estimated at approximately €69.1 billion. When informal caregiver costs were incorporated, this figure rose to €80.0 billion. This translates to an average annual per-patient cost of €1,470, a figure that underscores the financial toxicity associated with post-prostatectomy incontinence. Furthermore, the environmental impact is non-negligible; the disposal of incontinence pads contributes significantly to the carbon footprint of healthcare, with estimates suggesting that effective management and recycling could reduce CO2 equivalent emissions by over 117 million kilograms annually. Without effective interventions to reduce the prevalence and duration of incontinence, these costs are projected to escalate to over €100 billion by 2030, driven by an aging population. [1]

1.2 Pathophysiology of Functional Decline

To understand the potential role of prehabilitation, one must appreciate the mechanisms of injury during radical prostatectomy. The procedure involves the removal of the prostate gland, which inherently disrupts the bladder neck and the urethral sphincter complex. The recovery of urinary continence relies on the compensation of the external rhabdosphincter and the healing of the vesicourethral anastomosis. [2]

Urinary Incontinence (UI): Post-prostatectomy incontinence is primarily stress urinary incontinence (SUI), caused by sphincter deficiency or dysfunction. The intricate network of pelvic floor muscles (PFM) must adapt to maintain closure pressure under intra-abdominal stress. Factors such as obesity increase this intra-abdominal pressure, thereby exacerbating the load on an already compromised sphincter mechanism. [3]

Erectile Dysfunction (ED): The cavernous nerves, responsible for erectile function, run adjacent to the prostate capsule. Even in nerve-sparing procedures, these nerves are subject to traction injury, thermal damage, or neuropraxia (temporary loss of function). This neural insult leads to a period of "erectile silence," during which the lack of nocturnal erections can result in cavernosal hypoxia, fibrosis, and permanent erectile dysfunction. [4] Additionally, the phenomenon of climacturia—urinary incontinence during orgasm—represents a distinct and often overlooked functional deficit that further complicates sexual recovery. [5]

The concept of "prehabilitation" is predicated on the physiological principle of reserve. Surgery acts as a major stressor that inevitably induces a decline in functional capacity—a "dip" in physical and physiological health immediately following the procedure. In patients with low baseline reserve, this dip can push them below the threshold of independence or organ function, leading to complications and prolonged recovery. [6]

Prehabilitation utilizes the waiting period between diagnosis and surgery—typically ranging from 4 to 8 weeks—as a therapeutic window. By engaging in targeted interventions during this time, patients can elevate their baseline functional capacity. This "bolus" of physiological reserve ensures that even after the surgical insult, the patient remains at a higher functional level than they would have otherwise, thereby facilitating a faster return to baseline. [6]

In the specific context of radical prostatectomy, prehabilitation is multimodal, targeting:

Neuromuscular Control: Enhancing the strength, endurance, and coordination of the pelvic floor muscles (PFMT) to prepare them for the increased load post-catheter removal. [7]

Cardiorespiratory Fitness: Utilizing High-Intensity Interval Training (HIIT) to improve peak oxygen consumption ($\dot{V}O_2$ peak), which is strongly correlated with surgical resilience and reduced complications. [6]

Metabolic Health: Addressing obesity through diet and exercise to optimize the surgical field and reduce post-operative physical stress on the repair sites. [3]

1.3 Objectives and Scope

This scoping review aims to provide a granular analysis of the existing evidence base for prehabilitation in radical prostatectomy. It will dissect the nuances of various interventions, comparing the efficacy of isolated PFMT versus biofeedback-assisted training, and evaluating the systemic benefits of aerobic conditioning. Crucially, it will also examine the interaction between these interventions and fixed patient characteristics—such as Membranous Urethral Length (MUL) and sarcopenia—to determine which patients stand to benefit most from prehabilitative efforts. By synthesizing data from RCTs, meta-analyses, and observational studies, this report seeks to inform clinical practice and guide the development of optimized care pathways for prostate cancer survivors.

2. Research Materials and Methods

2.1 Data Collection Strategy

The foundation of this scoping review is a curated selection of peer-reviewed literature, including high-impact journals in urology, oncology, and rehabilitation medicine. The data collection process prioritized studies with high methodological rigor, specifically focusing on Randomized Controlled Trials (RCTs) and systematic reviews with meta-analyses reported according to the PRISMA (Preferred Reporting Items for Scoping Reviews and Meta-Analyses) guidelines.

The literature search encompassed major biomedical databases including MEDLINE, and Scopus. The search strategy utilized keywords such as "prehabilitation," "radical prostatectomy," "pelvic floor muscle training," "high-intensity interval training," "urinary incontinence," and "erectile dysfunction." The selection includes articles published up to mid-2025, ensuring the inclusion of the latest evidence regarding telehealth interventions and robotic surgical outcomes.

2.2 Inclusion and Exclusion Criteria

To ensure the validity and relevance of the findings, strict inclusion criteria were applied:

Target Population: Adult males diagnosed with clinically localized prostate cancer scheduled for radical prostatectomy (open, laparoscopic, or robot-assisted).

Interventions: Preoperative interventions aimed at improving post-operative functional outcomes. This included:

- Pelvic Floor Muscle Training (PFMT) with or without biofeedback.
- Aerobic and resistance exercise programs, including HIIT.
- Multimodal lifestyle interventions (diet, weight loss, smoking cessation).
- Telehealth or home-based delivery models.

Comparators: Standard of care (typically no preoperative intervention), post-operative rehabilitation alone, or active control groups.

Outcomes: Primary outcomes of interest were urinary continence (measured by pad tests or validated questionnaires like ICIQ), erectile function (measured by IIEF-5), and physical fitness metrics ($\dot{V}O_2$ peak, anaerobic threshold). Secondary outcomes included quality of life (QoL), post-operative complications, and economic burden measures.

Studies were excluded if they focused solely on metastatic disease where functional recovery was not the primary goal, or if they lacked a clear preoperative intervention component.

2.3 Methodological Analysis of Included Studies

The review includes a detailed assessment of the methodology of the primary studies to gauge the strength of the evidence.

Scoping Reviews and Meta-Analyses: Large-scale reviews, such as the meta-analysis of HIIT comprising 12 studies and 832 patients [6], and the PFMT review including 1,365 patients [8], provide the highest level of evidence. These studies were evaluated for heterogeneity and publication bias.

Randomized Controlled Trials: Individual RCTs, such as the TelePrehabTrial [9] and the "Knack" maneuver trial [10], were analyzed for randomization techniques, allocation concealment, and attrition rates. For instance, the TelePrehabTrial reported a 74% recruitment rate and ≥80% adherence, indicating high feasibility. [9]

Observational and Cohort Studies: Prospective studies identifying predictors like Membranous Urethral Length (MUL) [11] and the impact of obesity [3] were included to provide context on prognostic factors that may confound intervention effects.

2.4 Statistical Data Extraction

Data extraction focused on quantitative metrics to allow for comparative analysis. Key statistical indicators extracted included:

Odds Ratios (OR) and Hazard Ratios (HR): Used to quantify the likelihood of continence recovery or complications.

Mean Differences (MD): Used to assess changes in continuous variables such as $\dot{V}O_2$ peak or muscle strength.

Confidence Intervals (CI) and P-values: Used to determine statistical significance.

Sample Sizes: Reported for all included studies to weigh the power of the evidence (e.g., small pilot studies vs. large multicenter trials).

3. Results

The results of this scoping review are categorized by the primary modality of prehabilitation: Pelvic Floor Muscle Training (PFMT), Systemic Exercise Interventions (HIIT/Resistance), and Multimodal Lifestyle Interventions. Additionally, a section is dedicated to the predictive factors that influence these outcomes, providing a nuanced understanding of patient selection.

3.1 Pelvic Floor Muscle Training (PFMT) and Biofeedback

Pelvic Floor Muscle Training (PFMT) is the most extensively studied component of prehabilitation for prostatectomy patients. The theoretical basis is that a stronger, more coordinated pelvic floor can better compensate for the loss of the internal urethral sphincter mechanism removed during surgery.

3.1.1 Efficacy on Urinary Continence Recovery

A robust scoping review and meta-analysis synthesized data from 12 randomized controlled trials involving 1,365 patients to compare preoperative pelvic floor muscle training (PFMT) against standard care. [8] The analysis revealed a clear, time-dependent efficacy for prehabilitation. Specifically, during early recovery at 3 months post-surgery, the prehabilitation group demonstrated a statistically significant improvement in urinary continence, with an Odds Ratio (OR) of 0.61 (95% CI: 0.37–0.98; p=0.04). This indicates that patients who engaged in preoperative training were significantly less likely to be incontinent during this initial phase. [8]

In the immediate post-operative period at 1 month, although a strong trend favored the intervention, the difference did not reach statistical significance (OR: 0.47; 95% CI: 0.22–1.02; p=0.06). This may be attributed to the acute impact of surgical trauma and catheterization, which can temporarily overwhelm muscle function regardless of preoperative strength. [8] Furthermore, the benefits of preoperative training appeared to diminish over the long term; at both 6 months (OR: 0.57; p=0.13) and 12 months (OR: 0.56; p=0.12), no significant differences in continence rates were observed between the groups. [8]

Ultimately, these findings suggest that preoperative PFMT acts as an accelerator of recovery rather than a modifier of the final functional outcome. By priming the neuromuscular system, patients are able to achieve continence sooner—effectively reducing the duration of the incontinence burden by several months—even though long-term results are more likely dictated by anatomical healing and surgical technique.

3.1.2 The Added Value of Biofeedback

Biofeedback involves the use of electronic monitoring to provide visual or auditory feedback regarding muscle activity, helping patients identify and isolate the correct pelvic muscles. A separate scoping review focusing on biofeedback analyzed 14 studies. [12]

This analysis found that preoperative biofeedback combined with PFMT was significantly superior to control groups (no intervention) at multiple time points: up to 3 months: OR = 0.51 ($p = 0.02$); 3 to 6 months: OR = 0.40 ($p = 0.008$) and 6 to 12 months: OR = 0.29 ($p = 0.02$).
Interestingly, when preoperative biofeedback was compared directly to postoperative biofeedback, no significant difference was found. This implies that while biofeedback is a highly effective tool for teaching muscle control, the specific timing (before vs. after surgery) may be less critical than the technology's ability to ensure correct muscle engagement. [13] However, initiating it preoperatively allows patients to master the technique without the pain or inhibition associated with a fresh surgical wound.

3.1.3 Functional Maneuvers: The "Knack"

Recent research has moved beyond static muscle contractions to functional integration. The "Knack" maneuver involves a voluntary contraction of the pelvic floor muscles immediately prior to an event that increases intra-abdominal pressure (e.g., coughing, sneezing, standing up).
A randomized controlled trial (n=66) compared three groups:
Group I: PFMT + Knack maneuver + Comprehensive Lifestyle Recommendations.
Group II: PFMT + Knack maneuver.
Group III: PFMT alone (Control). [10]
The results were striking. Group I demonstrated the greatest improvement across all primary and secondary outcomes, including subjective UI severity and quality of life ($p < 0.001$). [10] Furthermore, Group II (Knack + PFMT) was superior to PFMT alone regarding subjective severity. This confirms that prehabilitation is most effective when it is functional (teaching patients *how* to use the muscles in daily life via the Knack) and comprehensive (including lifestyle changes), rather than simply strength-based. [10]

3.1.4 Impact on Erectile Dysfunction (ED)

The impact of pelvic floor training on erectile function is less definitive than for continence. A randomized trial of 97 men compared a high-intensity preoperative PFMT program (6 sets/day, standing postures) to standard care (3 sets/day). [4]
The study found that while physiological measures of muscle function improved, the only clinically relevant difference in sexual outcomes was observed at 2 weeks post-surgery. At this early stage, the intervention group reported significantly less distress ("bother") related to sexual dysfunction. [4]

The authors noted that early PFMT led to a faster return to continence. Since incontinence is a major barrier to sexual activity (due to climacturia or embarrassment), the accelerated continence recovery facilitates an earlier start to penile rehabilitation programs (e.g., vacuum devices, PDE5 inhibitors), thereby indirectly supporting erectile recovery. [4] However, PFMT alone was not sufficient to prevent the physiological impact of neuropraxia on erectile tissue.

3.2 Systemic Exercise Interventions: HIIT and Resistance Training

Radical prostatectomy is a major physiological stressor. Systemic prehabilitation aims to enhance cardiorespiratory fitness (CRF) and muscular strength to buffer this stress.

3.2.1 High-Intensity Interval Training (HIIT)

HIIT involves repeated bouts of high-intensity exercise followed by rest, offering a time-efficient method to boost fitness in the short preoperative window. A comprehensive meta-analysis of 12 studies involving 832 patients undergoing major surgery (including urological procedures) provided compelling evidence for its efficacy. [6]

Table 1: Efficacy of Preoperative HIIT on Physiological and Clinical Outcomes [6]

Outcome Measure	Improvement / Effect Size	Statistical Significance	Interpretation
Peak Oxygen Consumption ($\dot{V}O_2$ peak)	+2.59 mL/kg/min (MD)	$P < 0.001$	Significant increase in aerobic capacity.
Post-operative Complications	Odds Ratio: 0.44	$P < 0.001$	56% reduction in the odds of complications.
Length of Stay (LOS)	-3.06 days (MD)	$P = 0.07$	Trend toward shorter hospitalization.
Quality of Life (Physical Component)	+4.74 points (SF-36)	$P = 0.06$	Trend toward improved physical well-being.

In a specific urological cancer trial (n=40), a HIIT program of less than 31 days duration significantly improved the Anaerobic Threshold ($\dot{V}O_2$ peak) by 2.26 ml/kg/min compared to controls. [13] Additionally, this intervention significantly reduced both systolic (-8.2 mmHg) and diastolic (-6.47 mmHg) blood pressure, optimizing the patient's cardiovascular status prior to anesthesia. [13] Another study of 63 patients confirmed these findings, showing a $\dot{V}O_2$ peak improvement of 2.73 ml/kg/min compared to standard care, alongside a reduction in complication rates (0.64 vs. 1.16 events per patient). [14]

3.2.2 Resistance Training and Prehab vs. Rehab

A critical question in the field is whether exercise should be performed before (Prehab) or after (Rehab) surgery. A randomized trial involving 41 men directly compared these two approaches using a 6-week multimodal program consisting of resistance and aerobic exercise. [15] The prehabilitation group demonstrated significant improvements in physical capacity prior to surgery, including gains in leg press strength (+17.2 kg) and chest press strength (+2.9 kg). While these patients experienced a functional decline following the operation, their higher preoperative baseline ensured they remained functionally capable throughout the recovery process. [15]

In contrast, the rehabilitation group did not initiate exercise until 6 weeks post-surgery. Although this group eventually showed improvement, they spent the immediate and most critical post-operative period in a significantly deconditioned state. The results indicate that prehabilitation effectively prevents the depth of functional decline; while the rehabilitation group eventually "caught up" by week 12, the prehabilitation group successfully avoided the nadir of physical frailty during the early recovery phase. [15]

3.2.3 Aerobic Training and Erectile Function

Unlike PFMT, systemic aerobic training alone does not appear to directly improve erectile recovery. An RCT of 50 men assessed nonlinear aerobic walking (55-100% $\dot{V}O_2$ peak) versus usual care. [16] At 6 months, the prevalence of ED decreased by 20% in the aerobic group and 24% in the control group ($p=0.406$), with no significant differences in erectile function subscales. This indicates that while aerobic exercise is vital for cardiovascular health (a long-term risk factor for ED), it does not acutely reverse the nerve damage associated with prostatectomy. [16]

3.3 Multimodal and Lifestyle Interventions

Prehabilitation offers a unique "teachable moment" to address lifestyle risk factors that exacerbate functional complications.

3.3.1 Weight Management

A pilot study involving 20 overweight men evaluated the feasibility and metabolic efficacy of a tailored weight management program initiated in the weeks leading up to radical prostatectomy. [17] The intervention proved highly feasible, with participants achieving a mean weight reduction of **5.55 kg**—the majority of which was a **3.88 kg loss in fat mass**—over an average prehabilitation period of 8.3 weeks. [17] Beyond weight loss, the intervention group demonstrated significant clinical enhancements in insulin sensitivity, C-peptide levels, and visceral adiposity compared to the control group. Notably, the weight loss achieved during the preoperative phase was maintained throughout the post-surgical recovery period, suggesting that prehabilitation acts as a catalyst for sustainable, long-term behavioral change rather than just a short-term physiological fix. [17] Ultimately, by addressing obesity—a known driver of incontinence via increased intra-abdominal pressure—preoperative weight management programs can effectively optimize a patient's metabolic profile and mechanical risk factors before they reach the operating table. [17]

3.3.2 Telehealth Delivery (TelePrehab)

To enhance accessibility and cost-efficiency, telehealth-delivered prehabilitation models have emerged as a viable alternative to traditional clinic-based care. The "TelePrehabTrial" involving 40 participants assessed the feasibility and safety of a home-based, app-guided program for patients awaiting surgery. [9] The study confirmed the model's viability, reporting high recruitment rates (74%) and strong participant adherence (≥80%), suggesting that digital platforms can successfully overcome geographical and financial barriers to pre-surgical optimization. Furthermore, no serious adverse events were reported throughout the trial, helping to dispel clinical concerns regarding the safety of unsupervised, home-based exercise in this specific patient population. [9] Preliminary data also showed improved erectile function scores in the intervention group compared to standard care, a benefit researchers attributed to the telehealth platform's ability to facilitate better compliance with daily pelvic floor and resistance exercise regimens through real-time tracking and reminders. [9] Ultimately, app-guided telehealth represents a safe, scalable, and effective strategy for delivering prehabilitation, as these digital tools can directly translate into improved functional recovery post-prostatectomy by increasing the "dose" of exercise through better daily compliance.

3.3.3 Resistance Exercise and Metabolic Health

A randomized controlled trial involving 40 men evaluated the efficacy of a 6-month, home-based progressive resistance exercise training (RET) program following robot-assisted radical prostatectomy. [18] Compared to those receiving standard care, participants in the RET group demonstrated significant improvements in aerobic capacity ($P<0.01$) and both upper- and lower-limb muscular strength ($P\leq0.01$). These physical gains were mirrored by superior metabolic outcomes, including greater overall weight loss ($P=0.04$) and a significant reduction in total body fat percentage ($P=0.02$). [18] Beyond physical metrics, the exercise group reported significantly higher health-related quality of life, with enhancements observed as early as 3 months post-surgery and sustained throughout the 6-month follow-up period ($P<0.01$). [18] Ultimately, home-based resistance training serves as a safe and potent intervention to counteract the physiological and metabolic decline often associated with major surgery. By optimizing body composition and physical strength, RET facilitates a more robust functional and psychological recovery than usual care alone. [18]

3.4 Prognostic Factors Influencing Prehabilitation Success

The success of any prehabilitation program is modulated by the patient's intrinsic anatomical and physiological characteristics. Understanding these predictors is essential for managing patient expectations and tailoring interventions.

3.4.1 Membranous Urethral Length (MUL)

Anatomical variations play a decisive role in post-surgical continence, with the membranous urethral length (MUL) serving as the critical segment responsible for sphincter control. A study of 158 patients identified preoperative MUL, as measured by MRI, as the single independent predictor of urinary incontinence at 12 months post-prostatectomy. [11] This research allows for clear risk stratification: patients with a MUL exceeding 15 mm face a low risk of incontinence at approximately 5%, whereas those with a MUL shorter than 10 mm face a high risk of approximately 25%. These findings were further validated by a comprehensive meta-analysis of 970 patients, which confirmed that every additional millimeter of urethral length significantly reduces the odds of incontinence (Pooled OR: 0.74, $p < 0.001$). [19] The clinical implication is significant, as patients with a short MUL may encounter an anatomical "ceiling" on their recovery that even aggressive prehabilitation cannot fully breach. Consequently, these individuals require a different counseling approach than those with more favorable anatomy, as their recovery trajectory is fundamentally influenced by these baseline structural limits.

3.4.2 Obesity and Physical Activity Interaction

An observational study involving 405 men highlighted a profound interaction between obesity and physical activity regarding long-term functional recovery. [3] At 58 weeks post-surgery, the data revealed that obese men faced a 31% incontinence rate compared to 18% in their non-obese counterparts. Crucially, however, the study identified a significant protective effect associated with exercise: physically active obese men demonstrated an incontinence rate of 25%, a figure nearly identical to the 24% rate observed in inactive non-obese men. These findings suggest that physical activity, particularly when delivered through prehabilitation, can effectively mitigate the functional penalty often imposed by obesity. Conversely, the "Obese and Inactive" subgroup experienced the poorest outcomes with a 59% incontinence rate, identifying this specific cohort as the highest clinical priority for intensive, multimodal prehabilitation interventions. [3]

3.4.3 Intraoperative Prognostic Factors

Surgical technique also dictates outcomes. A study of 192 patients found that intraoperative techniques such as urethral suspension to the pubic bone significantly improved continence rates at all follow-up intervals. [2] Similarly, posterior musculofascial plate reconstruction resulted in a 92% continence rate at 12 months compared to 54% in the non-reconstruction group. [2] This underscores that while prehabilitation optimizes the *patient*, the *procedure* remains a dominant variable.

3.4.4 Sarcopenia

Interestingly, general muscle wasting (sarcopenia) measured by the Skeletal Muscle Index (SMI) was not found to be a significant predictor of continence or erectile recovery in a study of 100 patients. [20] This suggests that pelvic-specific function and cardiovascular fitness are more relevant to recovery than total body muscle mass in this specific context.

4. Discussion

4.1 Synthesis of Findings: The "Bolus" Effect

The collective evidence from this review strongly supports the biological plausibility and clinical utility of prehabilitation, functioning primarily through a "bolus effect" that acutely increases physiological reserve before the catabolic stress of surgery. In the context of urinary continence, preoperative pelvic floor muscle training (PFMT) does not appear to alter the ultimate anatomical healing of the sphincter, which explains why differences often dissipate by the 12-month mark. Instead, it "primes" the neuromuscular connection, enabling patients to engage their remaining sphincter complex more effectively during the critical early post-operative phase and leading to significant functional benefits as early as 3 months. [8] Similarly, for systemic health, high-intensity interval training (HIIT) elevates the $\dot{V}O_2$peak, ensuring that the inevitable post-surgical decline does not drop the patient into a zone of frailty or heightened complication risk. [6]

4.2 Reconciling Early vs. Late Benefits

A recurring theme in the data is the discrepancy between early (3-month) and late (12-month) outcomes. Critics might argue that if long-term outcomes are identical, prehabilitation is unnecessary. However, this view ignores the patient experience. Reducing the duration of incontinence by 3 to 6 months represents a massive improvement in quality of life. It reduces the period of social isolation, depression, and significant financial expenditure on pads (estimated at hundreds of Euros). [1] Furthermore, early continence is a gateway to sexual rehabilitation. [4] Therefore, "accelerated recovery" is a valuable clinical endpoint in itself, even if the final destination is the same.

4.3 The Economic Imperative

The economic analysis of urinary incontinence in the EU provides a compelling argument for prehabilitation. [1] With an annual burden of €69 billion, even a modest reduction in the duration of incontinence (e.g., shifting recovery from 6 months to 3 months) could save billions in healthcare resources and patient expenses. The cost of a telehealth-based prehabilitation program [9] is negligible compared to the €1,470 annual per-patient cost of managing incontinence. [1] Thus, prehabilitation is not just a clinical intervention but a value-based healthcare strategy.

4.4 Climacturia and Sexual Health

While ED is the primary sexual concern, climacturia (incontinence during orgasm) is a significant source of distress. Review data indicates that PFMT can effectively treat this condition, with success rates up to 100% in some series. [5] This reinforces the need for comprehensive PFMT that addresses the full spectrum of pelvic floor function, including its role in sexual activity.

4.5 Safety and Feasibility

Concerns about the safety of high-intensity exercise in this population appear unfounded. The HIIT meta-analysis reported only one serious adverse event across nearly 800 patients. [6] Additionally, systematic reviews of cardiovascular screening in athletes suggest that rigorous screening (often required for prehab) does not cause significant psychological distress [21], supporting the implementation of thorough pre-exercise evaluations.

5. Limitations

Despite the promising evidence, several limitations in the current body of research must be acknowledged.

Heterogeneity of Protocols: There is no standardized "dose" for prehabilitation. PFMT protocols vary widely in the number of contractions (sets/day), patient positioning (standing vs. supine), and the inclusion of biofeedback. [7] Similarly, HIIT protocols differ in intensity targets and duration. [6] This makes it difficult to create a unified clinical guideline.

Anatomical Confounders: Many studies did not control for Membranous Urethral Length (MUL). As MUL is a potent independent predictor [11], imbalances in MUL between control and intervention groups could skew results. A "failed" prehabilitation trial might simply reflect a cohort with shorter urethras rather than an ineffective exercise.

Sample Sizes: While meta-analyses provided robust numbers, many individual mechanistic trials (e.g., the weight loss pilot [9], the HIIT urology trial [13]) had small sample sizes (n=20-40). These studies are powered for physiological endpoints but may miss rare adverse events or subtle clinical differences.

Self-Report Bias: Outcomes such as "subjective improvement" or "bother" scores are inherently subjective. While validated tools like EPIC are used, the placebo effect of receiving intensive attention during prehabilitation cannot be entirely discounted.

6. Conclusions

This exhaustive scoping review underscores the critical role of prehabilitation in the management of men undergoing radical prostatectomy. The evidence base supports the following conclusions:

Accelerated Functional Recovery: Preoperative Pelvic Floor Muscle Training (PFMT), particularly when combined with biofeedback and functional "Knack" maneuvers, significantly accelerates the return of urinary continence in the first 3 months post-surgery. While it may not alter the long-term anatomical plateau, the reduction in symptom duration is clinically and economically profound.

Systemic Resilience: High-Intensity Interval Training (HIIT) and resistance conditioning effectively boost cardiorespiratory fitness and muscular strength in the short preoperative window. This "physiological bolus" significantly reduces the risk of post-operative complications and prevents severe deconditioning.

Mitigation of Risk Factors: Obesity and physical inactivity are major modifiable risk factors for incontinence. Prehabilitation programs that integrate weight management and general activity can neutralize the excess risk associated with obesity.

Anatomical Determinism: The efficacy of functional training is bounded by anatomy. Membranous Urethral Length (MUL) remains the single strongest predictor of long-term continence. Prehabilitation maximizes the potential of the existing anatomy but cannot compensate for severe structural deficiencies.

Integration into Care: The feasibility of telehealth delivery and the high economic burden of untreated incontinence support the routine integration of multimodal prehabilitation into urological oncology care pathways.

Supplementary materials

Not applicable

Funding

The study received no funding and incurred no expenses unrelated to the publication costs for the author.

Author contributions

Andrii Bilyk - conceptualization, methodology, formal analysis, writing - review and editing, supervision

Natalia Bruska - resources, writing - rough preparation

Przemysław Kołodziej - investigation, resources, formal analysis

Roman Cemaga - investigation, formal analysis, project administration

Mikołaj Patalong - formal analysis, resources

Ewa Szplit - formal analysis, resources

Mieszko Czapliński - investigation, data curation

Patryk Hebda - resources, data curation

Wiktoria Michnowska - data curation, writing - review and editing

Paweł Pustuła - data curation, writing - rough preparation

All authors have read and agreed with the published version of the manuscript.

Informed consent statement

Not applicable.

Data availability statement

Not applicable.

Conflict of interest

The author declares no conflict of interest in relation to this study.

Declaration of Generative AI and AI-Assisted Technologies

During the preparation of this work, the author used ChatGPT (OpenAI) to improve grammar and language clarity. After using this tool, the author reviewed and edited the content as needed and takes full responsibility for the content of the publication

References:

1. Bishop, C., Rodriguez-Cairoli, F., Hagens, A., Bermudez, M. A., Kerrebroeck, P. V., & Collen, S. (2025). Prevalence, Socioeconomic, and Environmental Costs of Urinary Incontinence in the European Union. European urology, 88(2), 157–166. https://doi.org/10.1016/j.eururo.2025.05.025
2. Kajmakovic, B. M., Petrovic, M., Bulat, P. R., Bumbasirevic, U., Milojevic, B., Nikic, P., Janicic, A., Durutovic, O., Cegar, B., Hadzibegovic, A., Ratkovic, S., & Dzamic, Z. M. (2024). Impact of Intraoperative Prognostic Factors on Urinary Continence Recovery Following Open and Laparoscopic Radical Prostatectomy. Medicina, 60(11), 1824. https://doi.org/10.3390/medicina60111824
3. Wolin, K. Y., Luly, J., Sutcliffe, S., Andriole, G. L., & Kibel, A. S. (2010). Risk of urinary incontinence following prostatectomy: the role of physical activity and obesity. The Journal of urology, 183(2), 629–633. https://doi.org/10.1016/j.juro.2009.09.082
4. Milios, J. E., Ackland, T. R., & Green, D. J. (2020). Pelvic Floor Muscle Training and Erectile Dysfunction in Radical Prostatectomy: A Randomized Controlled Trial Investigating a Non-Invasive Addition to Penile Rehabilitation. Sexual medicine, 8(3),

414–421. https://doi.org/10.1016/j.esxm.2020.03.005

5. Kannady, C., & Clavell-Hernández, J. (2020). Orgasm-associated urinary incontinence (climacturia) following radical prostatectomy: a review of pathophysiology and current treatment options. Asian journal of andrology, 22(6), 549–554. https://doi.org/10.4103/aja.aja_145_19
6. Clifford, K., Woodfield, J. C., Tait, W., Campbell, H. A., & Baldi, J. C. (2023). Association of Preoperative High-Intensity Interval Training With Cardiorespiratory Fitness and Postoperative Outcomes Among Adults Undergoing Major Surgery: A Systematic Review and Meta-Analysis. JAMA network open, 6(6), e2320527. https://doi.org/10.1001/jamanetworkopen.2023.20527
7. Aguila-Gimeno, O., Jareño-Vicens, A., & Recasens, C. T. (2025). Pelvic floor rehabilitation before radical prostatectomy: a systematic review. BMC urology, 25(1), 224. https://doi.org/10.1186/s12894-025-01932-2
8. Zhou, L., Chen, Y., Yuan, X., Zeng, L., Zhu, J., & Zheng, J. (2023). Preoperative pelvic floor muscle exercise for continence after radical prostatectomy: a systematic review and meta-analysis. Frontiers in public health, 11, 1186067. https://doi.org/10.3389/fpubh.2023.1186067
9. Pedersen, M. B., Saxton, J. M., Villumsen, B. R., Birch, S., Nielsen, A. H., & Jensen, J. B. (2025). Home based prehabilitation in prostate cancer patients undergoing nerve sparing robot assisted radical prostatectomy - The TelePrehabTrial. European journal of oncology nursing : the official journal of European Oncology Nursing Society, 77, 102903. https://doi.org/10.1016/j.ejon.2025.102903
10. Gerlegiz, E. N. A., Akbayrak, T., Gürşen, C., Yazici, M. S., Bolat, N. M., Akdoğan, B., Nakip, G., & Özgül, S. (2025). Lifestyle recommendations and pelvic floor muscle training with Knack maneuver for post-prostatectomy urinary incontinence: a randomized controlled trial. Supportive care in cancer : official journal of the Multinational Association of Supportive Care in Cancer, 33(2), 132. https://doi.org/10.1007/s00520-025-09197-z
11. Fonseca, J., Moraes-Fontes, M. F., Sousa, I., Oliveira, F., Froes, G., Gaivão, A., Palmas, A., Rebola, J., Muresan, C., Santos, T., Dias, D., Varandas, M., Lopez-Beltran, A., Ribeiro, R., & Fraga, A. (2024). Membranous urethral length is the single independent predictor of urinary continence recovery at 12 months following Retzius-sparing robot-assisted radical prostatectomy. Journal of robotic surgery, 18(1), 230. https://doi.org/10.1007/s11701-024-01986-8

12. Brea-Gómez, B., Pazo-Palacios, R., Pérez-Gisbert, L., Valenza, M. C., & Torres-Sánchez, I. (2025). Pelvic Floor Muscle Training with Preoperative Biofeedback in Patients with Postprostatectomy Incontinence: A Systematic Review and Meta-analysis of Randomised Clinical Trials. European urology focus, 11(5), 767–781. https://doi.org/10.1016/j.euf.2025.04.004
13. Blackwell, J. E. M., Doleman, B., Boereboom, C. L., Morton, A., Williams, S., Atherton, P., Smith, K., Williams, J. P., Phillips, B. E., & Lund, J. N. (2020). High-intensity interval training produces a significant improvement in fitness in less than 31 days before surgery for urological cancer: a randomised control trial. Prostate cancer and prostatic diseases, 23(4), 696–704. https://doi.org/10.1038/s41391-020-0219-1
14. Woodfield, J. C., Clifford, K., Wilson, G. A., Munro, F., & Baldi, J. C. (2022). Short-term high-intensity interval training improves fitness before surgery: A randomized clinical trial. Scandinavian journal of medicine & science in sports, 32(5), 856–865. https://doi.org/10.1111/sms.14130
15. Singh, F., Newton, R. U., Taaffe, D. R., Lopez, P., Thavaseelan, J., Brown, M., Ooi, E., Nosaka, K., Hayne, D., & Galvão, D. A. (2023). Prehabilitative versus rehabilitative exercise in prostate cancer patients undergoing prostatectomy. Journal of cancer research and clinical oncology, 149(18), 16563–16573. https://doi.org/10.1007/s00432-023-05409-3
16. Jones, L. W., Hornsby, W. E., Freedland, S. J., Lane, A., West, M. J., Moul, J. W., Ferrandino, M. N., Allen, J. D., Kenjale, A. A., Thomas, S. M., Herndon, J. E., 2nd, Koontz, B. F., Chan, J. M., Khouri, M. G., Douglas, P. S., & Eves, N. D. (2014). Effects of nonlinear aerobic training on erectile dysfunction and cardiovascular function following radical prostatectomy for clinically localized prostate cancer. European urology, 65(5), 852–855. https://doi.org/10.1016/j.eururo.2013.11.009
17. Hamilton-Reeves, J. M., Johnson, C. N., Hand, L. K., Bechtel, M. D., Robertson, H. L., Michel, C., Metcalf, M., Chalise, P., Mahan, N. J., Mirza, M., Lee, E. K., Sullivan, D. K., Klemp, J. R., Befort, C. A., Parker, W. P., Gibbs, H. D., Demark-Wahnefried, W., & Thrasher, J. B. (2021). Feasibility of a Weight Management Program Tailored for Overweight Men with Localized Prostate Cancer - A Pilot Study. Nutrition and cancer, 73(11-12), 2671–2686. https://doi.org/10.1080/01635581.2020.1856890
18. Ashton, R. E., Aning, J. J., Tew, G. A., Robson, W. A., & Saxton, J. M. (2021). Supported progressive resistance exercise training to counter the adverse side effects of robot-assisted radical prostatectomy: a randomised controlled trial. Supportive care in cancer :

official journal of the Multinational Association of Supportive Care in Cancer, 29(8), 4595–4605. https://doi.org/10.1007/s00520-021-06002-5

19. Mac Curtain, B. M., Sugrue, D. D., Qian, W., O'Callaghan, M., & Davis, N. F. (2024). Membranous urethral length and urinary incontinence following robot-assisted radical prostatectomy: a systematic review and meta-analysis. BJU international, 133(6), 646–655. https://doi.org/10.1111/bju.16170
20. Angerer, M., Salomon, G., Beyersdorff, D., Fisch, M., Graefen, M., & Rosenbaum, C. M. (2021). Impact of Sarcopenia on Functional and Oncological Outcomes After Radical Prostatectomy. Frontiers in surgery, 7, 620714. https://doi.org/10.3389/fsurg.2020.620714
21. Hill, B., Grubic, N., Williamson, M., Phelan, D. M., Baggish, A. L., Dorian, P., Drezner, J. A., & Johri, A. M. (2023). Does cardiovascular preparticipation screening cause psychological distress in athletes? A systematic review. British journal of sports medicine, 57(3), 172–178. https://doi.org/10.1136/bjsports-2022-105918