

Review

PFME-based combined rehabilitation for post-prostatectomy urinary incontinence: a systematic review and meta-analysis

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Abstract: Background: Urinary incontinence (UI) is a common complication after radical prostatectomy and can affect daily functioning, social participation, emotional well-being, and quality of life. Pelvic floor muscle exercise (PFME) is a first-line conservative intervention, but the added value of combining PFME with other rehabilitation modalities remains uncertain. This review evaluated continence outcomes and explored reported quality-of-life and psychosocial outcomes. **Methods:** CNKI, WanFang, the Chinese Biomedical Literature Database, CENTRAL, Embase, Web of Science, and PubMed were searched for randomized controlled trials published from January 2000 to June 2025. Eligible studies compared a PFME-based combined intervention with PFME alone after radical prostatectomy. Continuous outcomes were synthesized using mean differences (MDs) or standardized mean differences (SMDs), and continence-recovery events were synthesized using risk ratios (RRs) based on the original studies' definitions. Leave-one-out analyses assessed robustness. Certainty was evaluated using GRADE; heterogeneous quality-of-life and psychosocial outcomes were summarized narratively. **Results:** Eleven studies contributed 839 participants to the relevant pairwise comparisons. Pooled estimates favored PFME plus acupuncture for 1-hour pad-test leakage (SMD = -1.65, 95% CI -2.00 to -1.30), PFME plus electrical stimulation for International Consultation on Incontinence Questionnaire-Urinary Incontinence-Short Form (ICIQ-UI SF) scores (SMD = -0.85, 95% CI -1.20 to -0.50), PFME plus biofeedback for continence recovery (RR = 1.49, 95% CI 1.24 to 1.79), and PFME plus vibratory therapy for 24-hour pad-test leakage (MD = -17.10 g, 95% CI -20.39 to -13.81). Certainty was low for the continuous outcomes and very low for continence recovery. Leave-one-out findings were stable except for vibratory therapy, for which removal of the dominant study rendered the estimate non-significant. Two studies reported heterogeneous quality-of-life or psychosocial outcomes; no dedicated psychological outcome could be pooled. **Conclusions:** Low certainty evidence suggests that selected adjuncts may improve specific continence outcomes when added to PFME. Because each adjunct was evaluated using a different outcome and no head-to-head evidence was available, the modalities cannot be ranked. The psychological effects of improved continence also remain uncertain. Larger multicenter trials should use standardized continence definitions, common follow-up points, and validated psychological and quality-of-life measures.

Keywords: meta-analysis; systematic review; pelvic floor muscle exercise; radical prostatectomy; urinary incontinence; quality of life; psycho-oncology; rehabilitation.

1. Introduction

Prostate cancer is the second most frequently diagnosed cancer in men worldwide and remains a major cause of cancer-related mortality [1,2]. Incidence varies substantially across regions [3], and the disease burden has also increased in China [4]. Radical prostatectomy is an established treatment for localized disease. In addition to its oncological objective, the procedure exposes patients to surgical trauma and blood loss, which may influence inflammatory and immunosuppressive pathways relevant to tumour progression [5]. Functional recovery therefore forms an important part of comprehensive survivorship care.

Urinary incontinence (UI) is a common sequela of radical prostatectomy (RP) and can persist during the period of otherwise successful oncological recovery [6]. Post-RP UI is multifactorial and may involve urethral sphincter deficiency, altered pelvic-floor support, or detrusor dysfunction. Although spontaneous improvement often occurs over time, leakage can disrupt daily activities, generate financial burden, restrict social participation, and contribute to embarrassment, anxiety, or depressive symptoms [7]. These consequences make continence rehabilitation relevant not only to urology and nursing but also to psycho-oncology.

Conservative rehabilitation includes Pelvic floor muscle exercise (PFME) alone or combined with biofeedback, electrical stimulation, vibratory therapy, acupuncture, or other physical approaches. PFME is widely used and has shown benefit in several studies [8-11]. The 2024 Chinese expert consensus on perioperative integrated rehabilitation after radical prostatectomy also identifies selected adjunctive therapies as potentially useful, while acknowledging limitations in the supporting evidence [12]. Existing trials use heterogeneous interventions, continence definitions, and follow-up points, making the additional benefit of each adjunct uncertain. The primary objective of this review was therefore to synthesize each PFME-based combination versus PFME alone for the outcome reported by comparable trials. A secondary, exploratory objective was to summarize reported quality-of-life and psychosocial outcomes and consider their implications for psycho-oncology.

2. Materials and methods

2.1. Eligibility criteria

Eligibility was defined using the the Population, Intervention, Comparison, Outcomes, and Study design (PICOS) framework. Population: men with UI after RP; studies enrolling patients with preoperative UI or another condition that could independently explain leakage were excluded. Intervention: PFME combined with acupuncture, electrical stimulation, biofeedback, vibratory therapy, or another adjunctive rehabilitation modality. Comparator: PFME alone. Outcomes: continuous leakage measured by a 1-hour or 24-hour pad test; continuous International Consultation on Incontinence Questionnaire-Urinary Incontinence Short Form (ICIQ-UI SF) scores; or a dichotomous continence-recovery event defined by the original trial. Quality-of-life and psychosocial measures were retained for exploratory narrative synthesis. Study design: randomized controlled trials. Reports were excluded when outcome data were not extractable, the full text was unavailable, or the publication was a conference abstract, thesis, or dissertation. No language restriction was applied.

2.2. Search strategy

Electronic searches were conducted in CENTRAL, Embase, Web of Science,

PubMed, CNKI, WanFang Data, and the Chinese Biomedical Literature Database from January 2000 to June 2025. EndNote X9 was used for record management. Controlled vocabulary and free-text terms represented prostate cancer or prostatic neoplasms, radical prostatectomy, postprostatectomy urinary incontinence, pelvic floor muscle exercise or training, relevant adjunctive rehabilitation modalities, and randomized trials. Standard contemporary terminology was used; archaic English terms for incontinence were removed from the reported strategy. Chinese-language equivalents were used in the Chinese databases.

2.3. Study selection and data extraction

Two reviewers (QY Gai and YY Hu) independently screened records, extracted data, and cross-checked the results. Extracted items included study and country, analytic sample size, intervention and comparator, baseline UI severity or within-study comparability, outcome definition and scale, assessment timing, and numerical outcome data. Disagreements were resolved by consensus or, when necessary, adjudication by a third reviewer (B). The original authors were contacted when essential information was missing or unclear. The complete list of extracted items is presented in **Table 1**.

2.4. Risk-of-bias assessment

Two reviewers (QY Gai and YY Hu) independently assessed risk of bias using the Cochrane Risk of Bias tool across random-sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, incomplete outcome data, selective reporting, and other bias. Each domain was judged as low, high, or unclear risk. Disagreements were resolved by consensus or adjudication by reviewer B. Because blinding participants and therapists is often infeasible for rehabilitation, performance bias was interpreted together with the objectivity of each outcome rather than treated as proof that every estimate was invalid.

2.5. Statistical analysis

Meta-analyses were performed in Review Manager 5.3. Pad-test leakage and ICIQ-UI SF scores were treated as continuous outcomes and summarized with MDs or SMDs and 95% confidence intervals (CIs). Only the study-defined event of achieving continence was treated as dichotomous and summarized with an RR; ICIQ-UI SF scores were not dichotomized. Statistical heterogeneity was quantified using I^2 [13]. A fixed-effect model was used when $p > 0.10$ and $I^2 < 50\%$; otherwise, a random-effects model was planned. Because each outcome included fewer than 10 studies, subgroup analysis, meta-regression, and funnel-plot assessment were not considered reliable. Leave-one-out sensitivity analysis was performed for every pooled outcome with at least two studies. The four adjunctive modalities were analyzed separately; no indirect or head-to-head comparison was attempted because outcome constructs and measurement scales differed.

2.6. Certainty of evidence assessment

Certainty was assessed separately for each pooled outcome using the GRADE framework. Randomized evidence began at high certainty and was considered for downgrading because of risk of bias, inconsistency, indirectness, imprecision, or publication bias. Judgments were based on the outcome-specific evidence rather than applied uniformly. No upgrading domain was used. Domain-level reasons and the resulting certainty ratings are reported in Section 3.7 and **Table 2**.

3. Results

3.1. Study selection

The searches identified 2,685 records. After 744 duplicates were removed, 1,941 unique records underwent title and abstract screening; 1,741 were excluded. Two hundred full-text reports were assessed, and 189 were excluded because of an ineligible design, population, intervention, comparator, or outcome, or because analyzable data were unavailable. Eleven studies were included in the qualitative and quantitative syntheses (**Figure 1**). The three Chinese databases contributed 236 initial records. No study was excluded solely because of language; one Chinese-language study met all eligibility criteria, whereas the remaining Chinese-database records were removed during deduplication or eligibility screening, most commonly because they were nonrandomized reports, lacked a PFME-only comparator, or did not provide extractable outcomes.

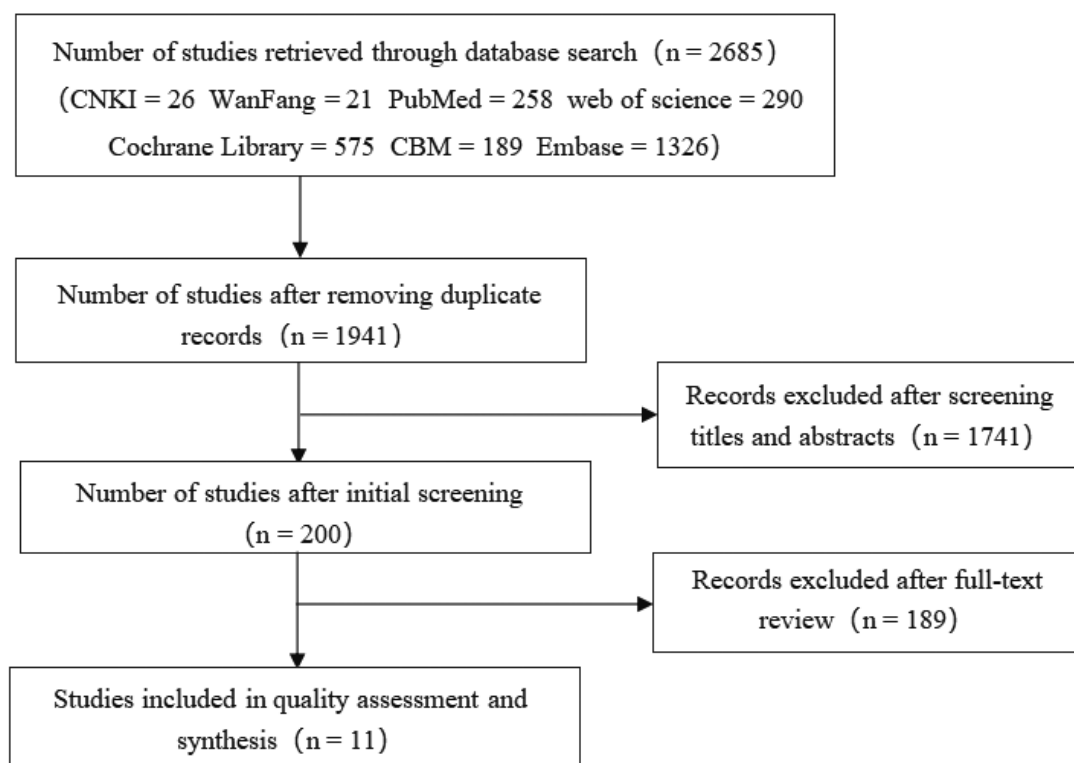


Figure 1. PRISMA flow diagram of study selection.

3.2. Study characteristics and baseline incontinence

Eleven studies, one published in Chinese and ten in English, contributed 839 participants to the relevant pairwise meta-analyses (418 in combined-intervention groups and 421 in PFME-only groups). Baseline UI could not be expressed on a common scale because studies differed in the timing and method of assessment. Where numerical baseline data were reported, groups were generally comparable within each study, although severity varied appreciably between studies. The adjunctive intervention was assigned by the study protocol rather than selected according to an individual participant's baseline severity; therefore, there was no evidence that baseline severity determined the choice of adjunct. Study-level final assessments ranged from 3 weeks to 6 months, with a median of approximately 8 weeks. The previously reported 1-week value was an early assessment within a study

that continued follow-up to 6 months, not the study's sole follow-up. Details are shown in **Table 1**.

Table 1. Study characteristics, baseline urinary incontinence, outcome definitions, and assessment timing

Study	Analytic n (T/C)	Comparison	Baseline UI / comparability	Meta-analysis outcome and definition	Assessment timing
Bernardes et al. 2022 [14]	32/31	PFME + systemic acupuncture vs PFME	1-h pad test: 48.67 ± 55.59 vs 62.69 ± 56.81 g; $p = 0.326$	1-h pad-test leakage (g), continuous	Baseline, 4 and 8 weeks
Bu et al. 2022 [15]	24/24	PFME + acupuncture vs PFME	1-h pad test: 15.37 ± 3.89 vs 15.23 ± 3.81 g; $p = 0.897$	1-h pad-test leakage (g), continuous	Before and after treatment
Azevedo et al. 2024 [16]	30/30	PFME + auricular acupuncture vs PFME	Post-RP UI; groups assessed at pre-test and reported as comparable	1-h pad-test leakage (g), continuous	Pre-test and after 8 weekly sessions
Pedriali et al. 2016 [17]	30/31	PFME + anal electrical stimulation vs PFME	UI assessed 4 weeks after RP; groups comparable at baseline	ICIQ-UI SF, 0-21; higher scores indicate greater severity/impact	Baseline and 10 weeks after training began
Tang et al. 2024 [18]	40/40	PFME + transcutaneous electrical stimulation vs PFME	Post-RP UI; baseline characteristics reported as comparable	ICIQ-UI SF, 0-21; continuous	After 8 weeks of treatment
Sanchez-Salas et al. 2024 [19]	39/40	PFME + biofeedback vs PFME	Urine leakage after RARP; randomized groups reported as comparable	Continence: no pad or ≤ 1 security pad/day	Primary assessment at 6 months
Allameh et al. 2021 [20]	19/19	PFME + biofeedback vs PFME	No preoperative UI; postoperative pad use assessed	Continence: 0 pads or 1 dry security pad/24 h	1, 3 and 6 months
Oh et al. 2020 [21]	40/42	PFME + extracorporeal biofeedback vs PFME	Groups balanced; first postoperative 24-h pad test: 71.0 ± 48.0 vs 120.8 ± 132.7 g	Continence: 0 g loss on a 24-h pad test	1, 2 and 3 months
Kim et al. 2021 [22]	41/42	PFME + visual biofeedback vs PFME	At 1 week: UI in 78.0% vs 85.7%; $p = 0.364$	Continence: zero pads/day	1 week and 1, 3 and 6 months
Heydenreich et al. 2020 [23]	93/91	PFME + oscillating-rod therapy vs PFME	24-h pad test: 242.9 ± 269.6 vs 237.6 ± 273.0 g	24-h pad-test leakage (g), continuous	Baseline and 3 weeks
Tantawy et al. 2019 [24]	30/31	PFME + whole-body vibration vs PFME	Mild stress UI; groups homogeneous at baseline	24-h pad-test leakage (g), continuous	Baseline, 4 weeks and 2 months

Note: T, combined-intervention group; C, PFME-only control group; ICIQ-UI SF, International Consultation on Incontinence Questionnaire-Urinary Incontinence Short Form; NR, not reported; RARP, robot-assisted radical prostatectomy. Analytic sample sizes correspond to the arms and participants contributing to the forest plots.

3.3. Risk of bias

All 11 studies were judged at high risk of performance bias because participant and therapist blinding was absent or inadequately described. Incomplete outcome data were generally judged at low risk because the data used in the analyses were reported and extractable. Reporting for random-sequence generation, allocation concealment, blinded outcome assessment, selective reporting, and other bias was insufficient in several studies and was therefore judged unclear. Taken together, these limitations raised substantial concerns about the internal validity of the pooled estimates; no nonstandard overall letter grade was assigned. Domain-level judgments are shown in **Figure 2**.

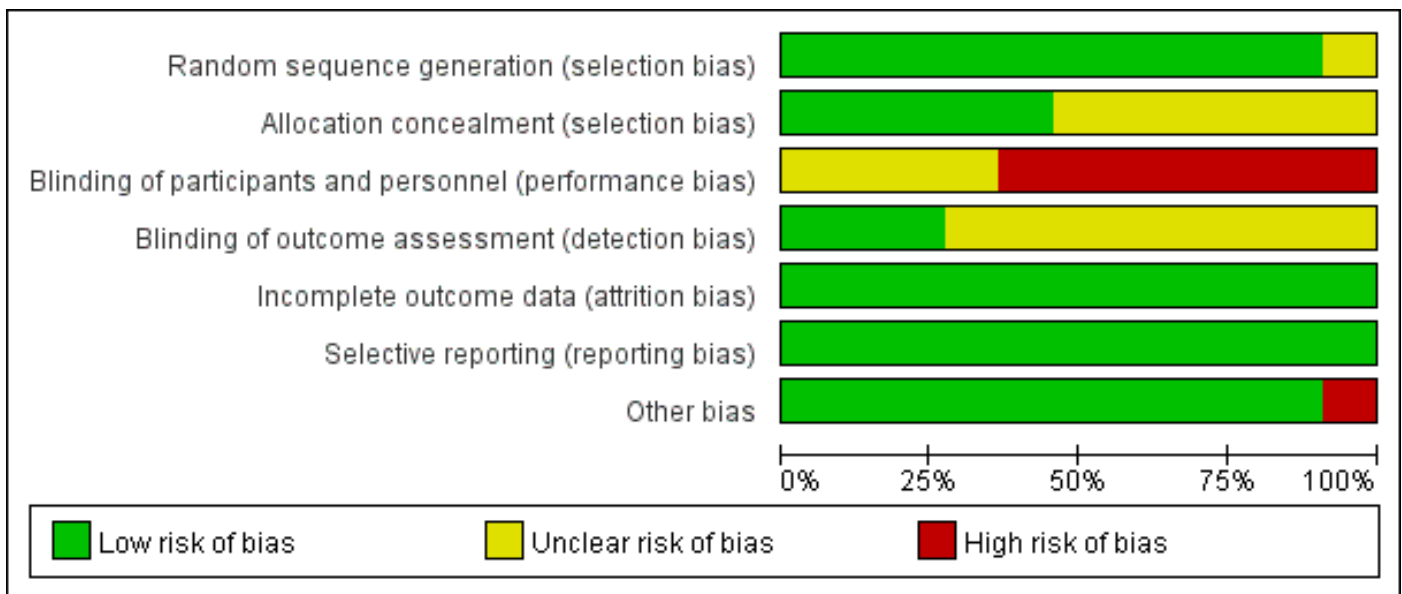


Figure 2. Risk-of-bias assessment of the included studies.

3.4. Meta-analysis results

3.4.1. PFME plus acupuncture: 1-hour pad-test leakage

Three studies [14-16] included 171 participants (86 combined intervention; 85 PFME alone). The pooled estimate favored PFME plus acupuncture for reducing 1-hour pad-test leakage (SMD = -1.65, 95% CI -2.00 to -1.30; $p < 0.00001$; $I^2 = 0\%$; **Figure 3**). Although statistically precise, the result was rated as low-certainty evidence because of risk-of-bias concerns and the small cumulative information size.

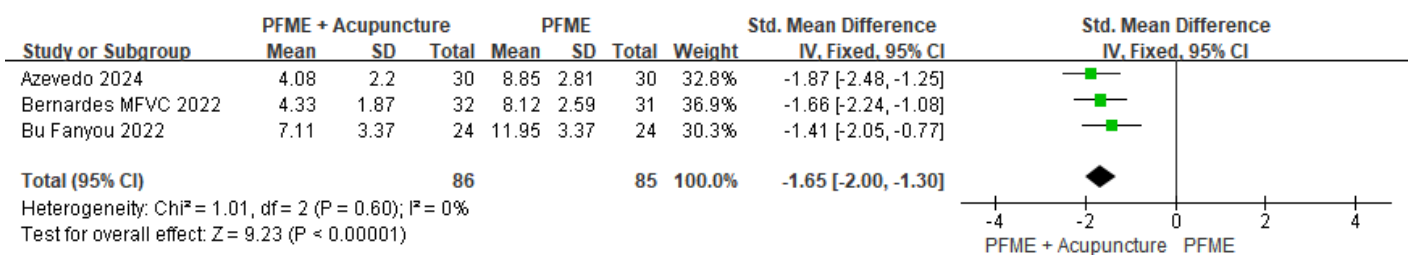


Figure 3. Standardized mean difference in 1-hour pad-test leakage after RP: PFME plus acupuncture versus PFME alone.

3.4.2. PFME plus electrical stimulation: ICIQ-UI SF score

Two studies [17,18] contributed 141 participants (70 combined intervention; 71 PFME alone). ICIQ-UI SF was analyzed as a continuous 0-21 score, with lower

scores indicating less severe symptoms and impact. The pooled SMD was -0.85 (95% CI -1.20 to -0.50 ; $p < 0.00001$; $I^2 = 0\%$; **Figure 4**), favoring the addition of electrical stimulation. This estimate was also judged low certainty.

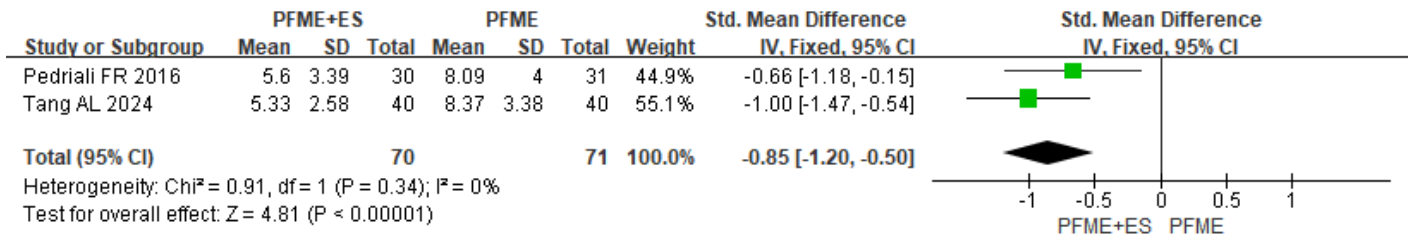


Figure 4. Standardized mean difference in ICIQ-UI SF scores after RP: PFME plus electrical stimulation versus PFME alone.

3.4.3. PFME plus biofeedback: continence-recovery rate

Four studies [19-22] included 282 participants (139 combined intervention; 143 PFME alone). Each study classified whether continence had been achieved using an explicit but study-specific definition (**Table 1**); no ICIQ-UI SF cutoff was used for this analysis. The pooled RR was 1.49 (95% CI 1.24 to 1.79; $p < 0.0001$; $I^2 = 27\%$; **Figure 5**), favoring PFME plus biofeedback. Certainty was very low because of risk of bias, imprecision, and indirectness arising from nonuniform continence definitions and assessment times.

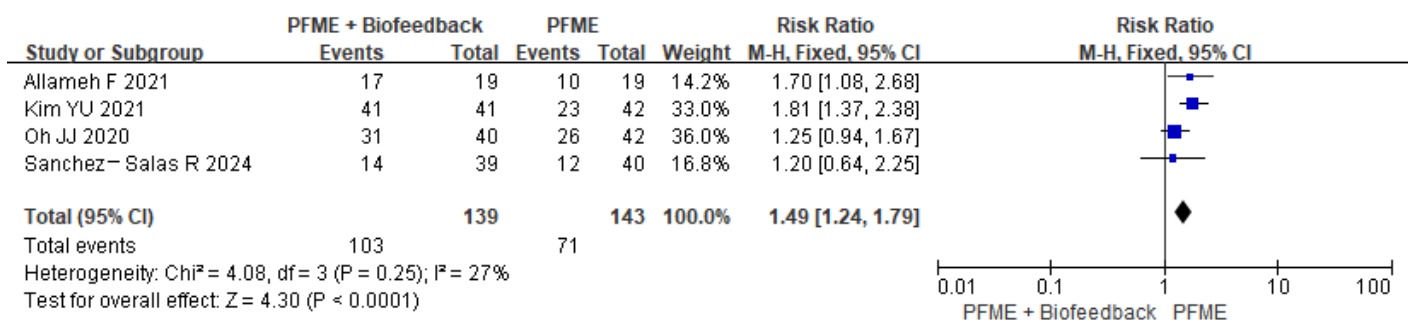


Figure 5. Risk ratio for study-defined urinary continence recovery after RP: PFME plus biofeedback versus PFME alone.

3.4.4. PFME plus vibratory therapy: 24-hour pad-test leakage

Two studies [23,24] contributed 245 participants (123 combined intervention; 122 PFME alone). The pooled estimate favored PFME plus vibratory therapy for reducing 24-hour pad-test leakage (MD = -17.10 g, 95% CI -20.39 to -13.81 ; $p < 0.00001$; $I^2 = 24\%$; **Figure 6**). The evidence was rated low certainty and was sensitive to removal of the dominant study.

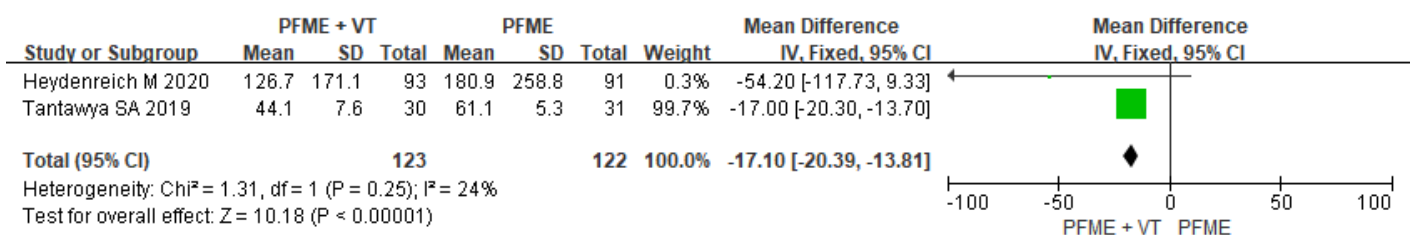


Figure 6. Mean difference in 24-hour pad-test leakage after RP: PFME plus vibratory therapy versus PFME alone.

These four estimates represent separate pairwise syntheses. Acupuncture, electrical stimulation, biofeedback, and vibratory therapy were linked to different outcomes and scales, so their effect estimates cannot be compared directly or used to rank the adjuncts. A network or indirect comparison was not undertaken.

3.5. Exploratory quality-of-life and psychosocial outcomes

The included trials did not provide a common dedicated psychological outcome suitable for meta-analysis. Azevedo et al. [16] reported a between-group difference in an incontinence-related quality-of-life severity domain at post-test ($p = 0.013$) and within-group improvements in the intervention arm for emotions ($p < 0.001$) and sleep/mood ($p = 0.008$); the latter within-group findings do not establish a comparative psychological effect. Heydenreich et al. [23] reported a greater improvement in Functional Assessment of Cancer Therapy-Prostate scores with oscillating-rod therapy than with the control intervention ($p = 0.017$).

ICIQ-UI SF captures the perceived interference of UI with everyday life but is not a dedicated measure of anxiety, depression, body image, relationship distress, or social isolation. Accordingly, the current evidence supports a possible quality-of-life signal but does not demonstrate that PFME-based combined rehabilitation improves psychological morbidity.

3.6. Publication bias and sensitivity analysis

Funnel plots were not constructed because each outcome included only two to four studies. Leave-one-out analyses showed that removing any single study did not alter the direction or statistical significance of the pooled acupuncture, electrical-stimulation, or biofeedback estimates. For vibratory therapy, removing Heydenreich et al. [23] left the Tantawy et al. [24] estimate statistically significant, whereas removing Tantawy et al. left the Heydenreich et al. estimate in the same direction but with a 95% CI crossing the null. The statistical significance of the vibratory-therapy result was therefore not robust to exclusion of the dominant study.

3.7. Certainty of evidence

Outcome-specific GRADE judgments are shown in **Table 2**. Evidence was downgraded for serious risk of bias across all outcomes and for serious imprecision because each synthesis contained few studies and a limited cumulative sample. Continence recovery was additionally downgraded for indirectness because trials used different event definitions and assessment times. Certainty was therefore low for the three continuous outcomes and very low for continence recovery.

Table 2. Outcome-specific GRADE assessment

Outcome (studies; n)	Risk of bias	Inconsistency	Indirectness	Imprecision	Publication bias	Certainty
1-h pad test (3; 171)	Serious ^a	Not serious $I^2 = 0\%$	Not serious	Serious ^b	Not detected ^c	Low ⊕⊕○○
ICIQ-UI SF (2; 141)	Serious ^a	Not serious $I^2 = 0\%$	Not serious	Serious ^b	Not detected ^c	Low ⊕⊕○○
Continence recovery (4; 282)	Serious ^a	Not serious $I^2 = 27\%$	Serious ^d	Serious ^b	Not detected ^c	Very low ⊕○○○

Continuation Table:

Outcome (studies; n)	Risk of bias	Inconsistency	Indirectness	Imprecision	Publication bias	Certainty
24-h pad test (2; 245)	Serious ^a	Not serious $I^2 = 24\%$	Not serious	Serious ^c	Not detected ^c	Low ⊕⊕○○

Note: ^a Downgraded for high performance-bias risk and unclear reporting in several other domains. ^b Downgraded because only two to four studies and limited cumulative information were available. ^c Funnel plots were not informative with fewer than 10 studies; no additional downgrade was made without direct evidence of publication bias. ^d Downgraded because continence definitions ranged from zero-pad/zero-leakage criteria to use of one security pad, and assessment times differed. ^e Downgraded because only two studies were available and the conclusion lost statistical significance when the dominant study was removed.

4. Discussion

This review found that pooled estimates favored the addition of acupuncture, electrical stimulation, biofeedback, or vibratory therapy to PFME for the specific outcome examined within each subgroup. PFME may improve rhabdosphincter tone and pelvic-floor coordination [25], while electrical stimulation and biofeedback may facilitate neuromuscular activation and correct contraction technique [18,22]. Acupuncture and vibratory therapy may influence neuromuscular or sensory pathways [16,23]. These mechanisms are plausible, but mechanistic plausibility does not overcome the low or very low certainty of the clinical evidence.

The results should not be interpreted as evidence that one adjunct is superior to another. Each modality was evaluated against PFME alone using a different construct: objective leakage over 1 or 24 hours, a patient-reported symptom-impact score, or study-defined continence recovery. The apparent magnitude of an SMD, MD, or RR across these analyses is not directly comparable. Clinically, PFME remains the foundational conservative intervention; an adjunct may be considered according to the patient's symptoms, preferences, access to trained professionals, and local resources, but the present evidence does not support a definitive recommendation for any single combination [26,27].

The psycho-oncological relevance of post-RP UI extends beyond the amount of leakage. Prospective evidence indicates that UI-related life impact, depression, and anxiety may change together during recovery [7], and depression and impaired work ability are strongly associated with poorer generic quality of life among men treated for post-prostatectomy incontinence [28]. In the present review, the limited narrative findings suggest possible improvement in selected quality-of-life domains, but no pooled estimate addressed anxiety, depression, embarrassment, relationship functioning, or social withdrawal. Continence services should therefore screen for distress and provide referral or psychological support when needed, rather than assuming that symptom improvement automatically resolves psychosocial burden.

Several limitations must be considered. First, only two to four studies contributed to each outcome, and risk-of-bias reporting was frequently inadequate. Second, baseline UI severity, timing of treatment initiation, PFME protocols, adjunctive interventions, continence definitions, and assessment times varied. Natural postoperative recovery may therefore have contributed to observed changes. Third, outcome heterogeneity prevented cross-modality comparison, and the vibratory-therapy result was not robust in leave-one-out analysis. Fourth, the screening log did not support a stage-specific database-level attrition analysis, although no language

restriction was applied and the reasons for excluding Chinese-database records were clarified. Fifth, the psychosocial synthesis was exploratory and included too few heterogeneous measures for meta-analysis. Future multicenter RCTs should report baseline leakage using standardized pad tests and ICIQ-UI SF, adopt a common definition of continence, assess common follow-up points, and include validated measures of depression, anxiety, cancer-related distress, social participation, and quality of life.

5. Conclusion

Low certainty evidence suggests that adding selected rehabilitation modalities to PFME may improve specific continence outcomes after RP. Because the adjuncts were evaluated with different outcomes and no head-to-head comparisons were available, they cannot be ranked and the pooled results should not be treated as definitive clinical recommendations. Evidence for psychological benefit is insufficient. Standardized, adequately powered trials that integrate continence, quality-of-life, and psychological outcomes are required.

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