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Anxiety, depression, and urinary control outcomes in prostate cancer patients undergoing pelvic floor muscle training combined with electrical stimulation at different postoperative intervals after radical prostatectomy

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Abstract: Background and Objectives: Post-radical prostatectomy urinary incontinence (PRP-UI) impacts a large majority of prostate cancer survivors, and is strongly linked to high levels of psychological morbidity such as anxiety and depression. Pelvic floor muscle training (PFMT) with electrical stimulation (ES) proved to be effective in speeding up the rate of urinary recovery; nevertheless, the most effective period after surgery to start combined rehabilitation is not yet clear. The purpose of this study was to determine the effect of the initiation of Pelvic floor muscle training and ES at various post-operative periods on recovery of urinary control, anxiety, and depressive symptoms among prostate cancer patients undergoing radical prostatectomy (RP). **Methods:** This prospective, parallel-group, randomized controlled trial involved 113 men undergoing robot-assisted radical prostatectomy (RARP) in two tertiary urology centers. The participants were randomly allocated to three groups Group A (immediate PFMT+ES, initiated within 24 hours after surgery; n = 38), Group B (early PFMT+ES, initiation at catheter removal, mean 7.2 days; n = 38), and Group C (delayed PFMT+ES, initiation at 6 weeks after surgery; n = 37). The main outcomes were the International Consultation on Incontinence Questionnaire-Short Form (ICIQ-SF), 24-hour pad weight test, and pad usage at 3 months and 6 months. The Generalized Anxiety Disorder-7 (GAD-7) scale, Patient Health Questionnaire-9 (PHQ-9), pelvic floor muscle strength (PFMS) assessed using perineal dynamometry, and SF-36 Mental Component Summary (MCS) scores were considered as secondary outcomes. **Results:** At 3 months, continence rates (defined as 0–1 security pad/day) were 52.6%, 73.7%, and 34.2% for Groups A, B, and C, respectively ($p < 0.001$). At 3 and 6 months, Group B showed much better results in all urinary parameters than the Groups A and C ($p < 0.001$). GAD-7 scores at 6 months were 5.1 ± 2.3 , 3.8 ± 1.9 , and 6.4 ± 2.7 for Groups A, B, and C, respectively ($p = 0.001$). PHQ-9 scores at 6 months were 5.4 ± 2.4 , 3.9 ± 2.0 , and 7.1 ± 2.9 for Groups A, B, and C, respectively ($p < 0.001$). Strong positive correlations were found between ICIQ-SF scores and both GAD-7 ($r = 0.58$, $p < 0.001$) and PHQ-9 ($r = 0.61$, $p < 0.001$). The strength of the pelvic floor muscles was a considerable negative predictor of anxiety and depression ($\beta = -0.54$, $p < 0.001$ and $\beta = -0.59$, $p < 0.001$, respectively). **Conclusion:** PFMT with electrical stimulation on catheter removal (mean 7.2 days after surgery) results in better urinary continence recovery and more anxiety and depression reduction than immediate or delayed intervention. The restoration of urinary function was strongly correlated with psychological outcomes and thus rehabilitation protocols should be conducted timely in the context of an integrated biopsychosocial approach to the management of prostate cancer survivors.

Keywords: radical prostatectomy; pelvic floor muscle training; electrical stimulation; urinary incontinence; anxiety; depression; prostate cancer rehabilitation; postoperative interval

1. Introduction

In most high-income countries, prostate cancer is the most commonly diagnosed cancer in men, being about 15 percent of all cancer diagnoses in men worldwide [1]. Radical prostatectomy (RP), including retropubic and more and more robot-assisted procedures is the most common curative treatment modality in localized disease and it has shown to produce better long-term oncological results in the properly chosen patient [2,3]. Although there have been significant improvements in surgical practice, post-radical prostatectomy urinary incontinence (PRP-UI) is among the most debilitating and common complications in the surgery with reported incidences of 6 to 87% based on patient selection, surgical expertise, definition of urinary continence used and the follow-up period [4,5].

Psychological sequelae of PRP-UI are severe and have been systematically misjudged in the wider literature of management. Recent meta-analyses have shown that prostate cancer survivors with perineal urinary continence display much higher rates of clinically significant anxiety (prevalence 27-42%) and depression (prevalence 21-38%) than continent counterparts and age-matched controls [6,7]. This bilateral aspect of the relationship, i.e. incontinence causes anxiety and depression and in turn these conditions may cause poor adherence to rehabilitation, constitutes a cycle whose therapeutic significance lies in breaking it as soon as possible [8]. The domain of everyday functioning affected by urinary incontinence after RP includes occupational involvement, social interactions, sexual self-concept and partner relationships, which, in combination, negatively affect mental health reserve [9,10].

Pelvic floor muscle training (PFMT) is the first line evidence-based rehabilitation treatment of PRP-UI. A seminal Cochrane Review established that PFMT hastens a urinary continence recovery and minimizes the severity of incontinence in the immediate postoperative phase [11]. Recently, electrical stimulation (ES) of the pelvic floor musculature has been applied as the basis of combinatorial rehabilitation approaches which have shown greater effectiveness than PFMT alone. ES modalities such as functional electrical stimulation (FES), transcutaneous electrical nerve stimulation (TENS), and interferential current therapy can stimulate neuromuscular re-education through stimulating the recruitment of motor units, increasing afferent sensory feedback, decreasing detrusor overactivity, and possibly mitigating periurethral tissue atrophy after sphincter trauma [12,13].

Although the individual effectiveness of both PFMT and ES is established, it is still a crucial yet unanswered issue in clinical practice whether to start a combination of PFMT+ES programs immediately after RP. The previous studies have been constrained by the heterogeneity of the patients, inconsistent methods of surgery, inconsistent parameters of the interventions, and a universal inability to systematically measure psychological outcomes and urological outcomes [14,15]. There is limited evidence on the impact of timeliness of rehabilitation on mood disorders, anxiety and health-related quality of life, and no published randomized controlled trial has directly studied the psychological differences in initiating combined PFMT+ES at specific postoperative intervals [16].

This study was intended to fill these gaps by undertaking a prospective randomized controlled trial, comparing three different initiation periods of combined PFMT+ES, including immediate (within 24 hours), early (at catheter removal) and delayed (at 6 weeks) with respect to recovery of urinary continence, pelvic floor

muscle strength, and psychological outcomes such as anxiety, depression, and health-related quality of life in men undergoing robot-assisted radical prostatectomy.

2. Materials and methods

2.1. Study design and setting

It was a prospective, three-arm, parallel-group, randomized controlled trial, which took place between January 2022 and September 2023 in two tertiary academic urology centers. The trial was registered at the International Standard Randomised Controlled Trial Number registry (ISRCTN14286374) and was ethically approved by the Institutional Review Boards of both institutions (Reference: KPMC-IRB-2021-0087; UL-IRB-2021-112). Informed consent was given to all participants in written form before the start of the study. The trial was carried out in compliance with the principles of the Declaration of Helsinki and was reported based on the Consolidated Standards of Reporting Trials (CONSORT) 2010 principles.

2.2. Participants

The inclusion criteria were adult men (age 18 years and older) with histologically proven prostate adenocarcinoma who were to undergo robot-assisted radical prostatectomy (RARP) with a curative basis. The main inclusion criteria included: clinical stage T1c-T3a disease; Eastern Cooperative Oncology Group (ECOG) performance status 0-1; pre-operative urinary continence (0 pads/day); and understanding and adherence to the study requirements. Major exclusion criteria were: pelvic irradiation previously; pelvic or urethral surgery previously; neuromuscular disorders affecting the lower urinary tract; biochemical recurrence within 3 months of surgery; inability to attend 80% of scheduled rehabilitation sessions.

2.3. Randomization and blinding

Block randomization (block size 6) was carried out with the help of a computer-generated allocation sequence created by an independent statistician with sealed, opaque, sequentially numbered envelopes. Allocation was not revealed to the clinical team until the stage of intervention assignment. Since the nature of physical rehabilitation interventions could not allow full blinding of the participants and treating physiotherapists, the outcome assessors who administered psychometric instruments and interpreted urodynamic data were blinded to the group allocation during the entire study period. The statistical analysis was done by a blind biostatistician who was not involved in the trial.

2.4. Intervention protocols

Each of the participants had a standardized robot-aided radical prostatectomy by two well-trained urological surgeons (> 200 RARP procedures annually each). Every surgery used a standard nerve-sparing procedure whenever appropriate oncologically. Mean postoperative urethral catheterization days were 7.2 ± 1.4 in all groups.

Group A (Immediate PFMT+ES; n = 38): PFMT and ES were started within 24 hours of surgery, with the urethral catheter still in place. The first 5 days were in-hospital physiotherapy supervised, and the third of outpatient physiotherapy supervised, three times a week. PFMT protocol was comprised of 3 sets of 10 sustained contractions (5-second hold, 5-second relaxation) and 10 rapid contractions per session. ES was performed with surface electrodes applied perineal-suprapubic with carrier frequency of 4-8 Hz, interferential current, but modulated to 50 Hz,

duration of 30 minutes per session.

Group B (Early PFMT+ES; $n = 38$): PFMT protocol was initiated at the time of catheter removal (mean day 7.2 postoperative), with the same ES parameters and PFMT protocol as Group A. This group received exclusively outpatient physiotherapy from initiation.

Group C (Delayed PFMT+ES; $n = 37$): The participants received written home-based lifestyle changes alone (fluid management, voiding diary) in the first 6 weeks after surgery, followed by the combination of PFMT+ES at the 6th week. Procedure and session frequency were the same as Groups A and B upon initiation.

The frequency of sessions (3 sessions/week, 45 minutes each) was the same in all groups and they all received the same home exercise programs as an addition to supervised sessions. Compliance was followed up through exercise diaries and attendance of sessions.

2.5. Outcome measures

The main urological outcome measure was the International Consultation on Incontinence Questionnaire-Short Form (ICIQ-SF), a self-reported instrument that was validated to measure frequency, severity and quality of life impact of urinary incontinence (score range 0-21 higher scores indicated greater impairment) [17]. Other key outcomes were 24-hour pad weight test and the number of pad uses a day. The main endpoint of continence was the return to social continence when patients wore 0-1 safety pad per day and it was only due to the security reasons.

Secondary outcomes were: (1) GAD-7, a validated 7-item self-report scale of generalized anxiety disorder (score 0–21; scores ≥ 10 are moderate-to-severe anxiety) [18], (2) PHQ-9, a proven 9-item self-report scale of major depressive disorder (score 0-27; score ≥ 10 shows moderate depression) [19]; (3) pelvic floor muscle strength in perineal dynamometry (cmH_2O); (4) pelvic floor muscle endurance (duration of sustained contraction in seconds); and (5) SF-36 Mental Component Summary (MCS) score as a composite measure of health-related quality of life. Evaluations were conducted at baseline (preoperative), 6 weeks, 3 months and 6 months after surgery.

2.6. Statistical analysis

The a priori calculation of sample size was based on the expected difference in ICIQ-SF scores between groups, which relied on data of a pilot study ($n = 15$ per arm). With 33 participants per group, a clinically significant between-group difference of 3.5 points on the ICIQ-SF ($SD = 4.5$), 0.05 as the α -value, and 0.80 as the power, it was necessary to have at least 33 participants in each group. With a target population of 120, 40 members were aimed at in each group, which included an estimated 15% attrition rate. The Shapiro-Wilk test was used to test the normality of continuous variables, which were presented as mean $\pm$ SD. One-way ANOVA was used to compare between-groups at each timepoint with Tukey post-hoc multiple-comparison HSD correction. Repeated-measures ANOVA was used to analyze within-group longitudinal changes. Pearson chi-square test was used to compare categorical data. The correlation coefficients derived by Pearson have been used to measure the bivariate relationships among psychological and urological measures. Linear regression was done to determine predictors of GAD-7 and PHQ-9 scores. All the analyses were performed on intention-to-treat basis using SPSS Version 27.0 (IBM Corp., Armonk, NY, USA). The statistical significance level was determined as $p < 0.05$ (two tailed).

3. Results

3.1. Participant flow and baseline characteristics

Eligibility assessments were done on 148 patients of whom 120 were randomized. There were seven (5.8%) participants lost to follow up or withdrew their consent within the study period (Group A: $n = 2$; Group B: $n = 0$; Group C: $n = 3$) resulting in the final analysis sample of 113 participants (Group A: $n = 38$; Group B: $n = 38$; Group C: $n = 37$). At baseline, the three groups were well-matched in terms of demographic, clinical, and oncological features with no significant differences between groups (**Table 1**). The average age was 64.4 ± 7.1 years, average PSA 8.7 ± 4.2 ng/mL and 73.5% of the group received nerve-sparing surgeries.

Table 1. Baseline Demographic and Clinical Characteristics of Study Participants

Characteristic	Group A (n = 38)	Group B (n = 38)	Group C (n = 37)	p-value
Age (years), mean $\pm$ SD	64.3 ± 7.1	63.8 ± 6.9	65.1 ± 7.4	0.72
BMI (kg/m ²), mean $\pm$ SD	27.4 ± 3.2	26.9 ± 3.5	27.8 ± 3.1	0.58
PSA level (ng/mL), mean $\pm$ SD	8.7 ± 4.2	9.1 ± 4.5	8.4 ± 3.9	0.81
Gleason score, n (%)				
≤ 6	12 (31.6%)	13 (34.2%)	11 (29.7%)	0.89
7	18 (47.4%)	17 (44.7%)	19 (51.4%)	
≥ 8	8 (21.1%)	8 (21.1%)	7 (18.9%)	
Pathological stage, n (%)				
pT2	22 (57.9%)	24 (63.2%)	21 (56.8%)	0.77
pT3a	11 (28.9%)	10 (26.3%)	12 (32.4%)	
pT3b	5 (13.2%)	4 (10.5%)	4 (10.8%)	
Nerve-sparing procedure, n (%)	28 (73.7%)	30 (78.9%)	26 (70.3%)	0.63
Pre-op urinary continence, n (%)	36 (94.7%)	37 (97.4%)	35 (94.6%)	0.71
Pre-op anxiety score (GAD-7), mean $\pm$ SD	5.8 ± 2.4	6.1 ± 2.6	5.9 ± 2.3	0.84
Pre-op depression score (PHQ-9), mean $\pm$ SD	6.2 ± 2.8	6.5 ± 3.0	6.1 ± 2.7	0.79

All values are mean $\pm$ SD or n (%). No significant between-group differences were observed at baseline ($p > 0.05$ for all). BMI = body mass index; PSA = prostate-specific antigen; GAD-7 = Generalized Anxiety Disorder-7; PHQ-9 = Patient Health Questionnaire-9.

3.2 Urinary continence and pelvic floor muscle outcomes

Table 2 and **figure 1** shows urinary outcomes at 3 months. Group B showed much better urinary continence at the 3-month (73.7% vs. 52.6% in Group A and 34.2% in Group C; $p < 0.001$) and 6-month evaluations than either comparator group. Mean ICIQ-SF scores at 3 months were 8.4 ± 2.7 , 5.2 ± 2.1 , and 10.8 ± 3.2 for Groups A, B, and C, respectively ($p < 0.001$). Mean 24-hour pad weight was significantly lowest in Group B at 3 months (89 ± 42 g vs. 148 ± 61 g for Group A and 197 ± 73 g for Group C; $p < 0.001$). The strongest improvements in pelvic floor muscle strength were observed

in Group B, as mean PFMS rose to 41.3 ± 8.3 cmH₂O at 3 months versus 32.7 ± 7.1 cmH₂O at 3 months in Group A ($\Delta = 14.3$ cmH₂O) and 26.4 ± 6.9 cmH₂O in Group C ($\Delta = 8.3$ cmH₂O) ($p < 0.001$ for all between-group comparisons). Pelvic floor endurance also exhibited a similar trend with Group B recording a mean endurance of 12.4 ± 3.1 seconds at 3 months as compared to 8.7 ± 2.4 seconds in Group A and 6.8 ± 2.2 seconds in Group C ($p < 0.001$). Urgency urinary incontinence episodes per day were also significantly reduced in Group B at 3 months (1.1 ± 0.7 vs. 2.0 ± 1.1 for Group A and 2.6 ± 1.2 for Group C; $p = 0.003$).

Table 2. Urinary Continence and Pelvic Floor Muscle Outcomes at Baseline and 3 Months by Group

Outcome Measure	Group A Baseline	Group A 3 Mo	Group B Baseline	Group B 3 Mo	Group C Baseline	Group C 3 Mo	p-value (between)
Continence rate (%)	0	52.6	0	73.7*	0	34.2	< 0.001
Pad usage/day, mean	4.2 ± 1.1	2.1 ± 0.9	4.5 ± 1.2	$1.3 \pm 0.7^*$	4.1 ± 1.0	2.8 ± 1.1	< 0.001
24-h pad weight (g)	312 ± 87	148 ± 61	328 ± 91	$89 \pm 42^*$	304 ± 79	197 ± 73	< 0.001
ICIQ-SF score	14.3 ± 3.1	8.4 ± 2.7	15.1 ± 3.4	$5.2 \pm 2.1^*$	14.6 ± 3.0	10.8 ± 3.2	< 0.001
PFMS strength (cmH ₂ O)	18.4 ± 6.2	32.7 ± 7.1	17.9 ± 5.8	$41.3 \pm 8.3^*$	18.1 ± 6.0	26.4 ± 6.9	< 0.001
PFMS endurance (s)	4.1 ± 1.8	8.7 ± 2.4	3.9 ± 1.6	$12.4 \pm 3.1^*$	4.0 ± 1.7	6.8 ± 2.2	< 0.001
Urgency episodes/day	3.8 ± 1.4	2.0 ± 1.1	4.1 ± 1.5	$1.1 \pm 0.7^*$	3.7 ± 1.3	2.6 ± 1.2	0.003

Values are mean $\pm$ SD or %. Group B vs. Groups A and C: * $p < 0.001$ for all pairwise comparisons at 3 months. ICIQ-SF = International Consultation on Incontinence Questionnaire-Short Form; PFMS = pelvic floor muscle strength.

Figure 1. Continence Recovery Rates Over 6 Months by Intervention Timing Group

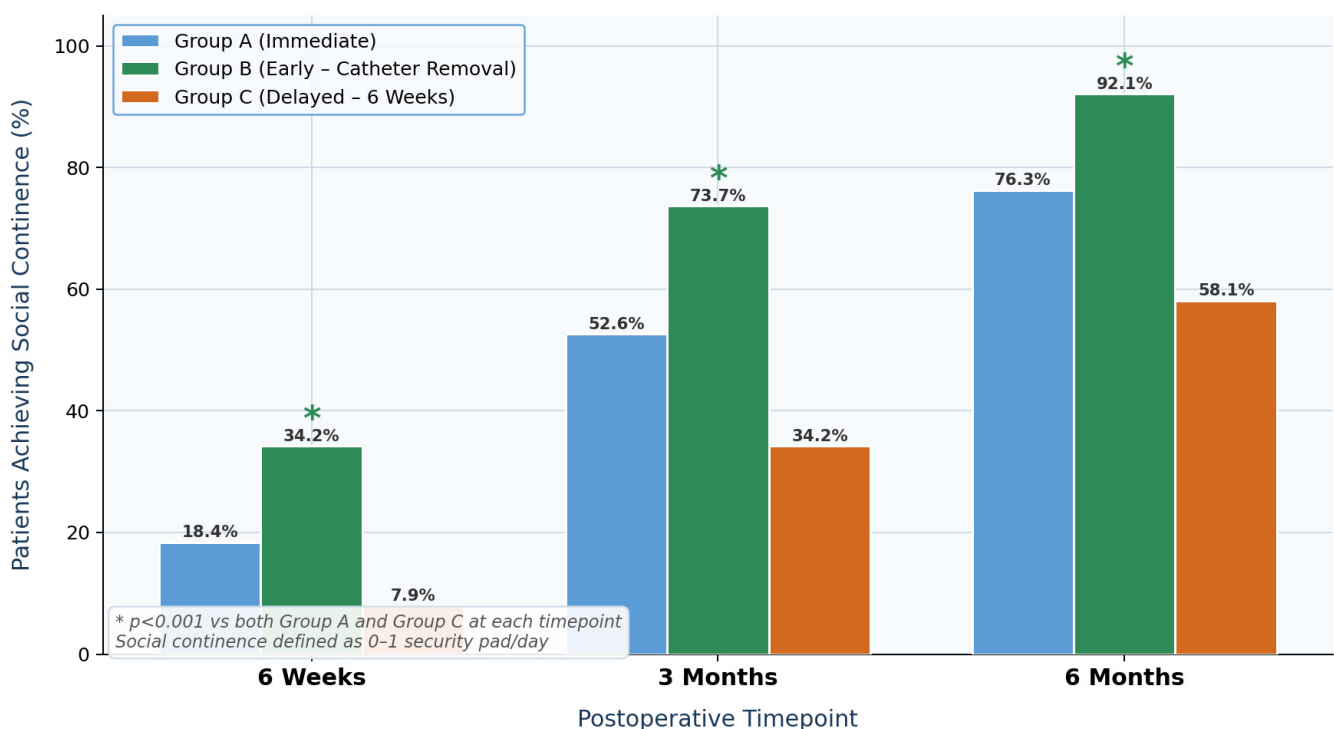


Figure 1. Continence recovery rates over 6 months by intervention timing group. * $p < 0.001$ vs. both Group A and Group C at each timepoint. Social continence defined as 0–1 security pad/day.

3.3 Anxiety, depression, and psychological outcomes

Table 3 and **figure 2** shows longitudinal psychology outcomes at all timepoints. The three populations showed that anxiety and depression scores had increased at 6 weeks of the early postoperative period, with maximum GAD-7 and PHQ-9 scores of the whole cohort at the age of 6 weeks. This increase was the least acute and most quickly remitted in Group B, where GAD-7 scores of 7.4 ± 2.8 at 6 weeks, and 3.8 ± 1.9 at 3 and 6 months, respectively, a decrease of 2.3 points on average compared with baseline. Conversely, Group C showed the greatest peak anxiety scores (GAD-7 10.2 ± 3.4 at 6 weeks) and continued to show high levels of depression scores (PHQ-9 9.2 ± 3.3 at 3 months, 7.1 ± 2.9 at 6 months), the latter still significantly higher than at trial completion.

Group A took a middle psychological course; anxiety and depression ratings improved over time with rehabilitation, but significantly less than Group B at 3 and 6 months on all measures ($p < 0.05$ on all comparisons). The percentage of those who were clinically significant in anxiety (GAD-7 ≥ 10) at 3 months was 21.1%, 7.9% and 37.8% in Groups A, B, and C, respectively. In the same way, Group A, B and C had clinically significant depression (PHQ-9 ≥ 10) at 3 months of 18.4%, 5.3% and 40.5%, respectively ($p < 0.001$ in both cases).

The scores on SF-36 Mental Component Summary at 6 months showed a similar pattern, with Group B scoring the highest MCS scores (55.8 ± 6.3) relative to Group A (51.4 ± 7.2) and Group C (47.2 ± 7.8) ($p = 0.001$). It is important to note that Group B score of MCS at 6 months was higher than the pre-operative MCS score and Group C did not regain the baseline MCS scores over the period of the study.

Table 3. Anxiety, Depression, and Quality of Life Outcomes by Group and Timepoint

Measure	Timepoint	Group A	Group B	Group C	p-value
GAD-7 (Anxiety)	Pre-op	5.8 ± 2.4	6.1 ± 2.6	5.9 ± 2.3	0.84
	6 weeks	8.9 ± 3.1	$7.4 \pm 2.8^*$	10.2 ± 3.4	< 0.001
	3 months	6.7 ± 2.9	$5.3 \pm 2.2^{*\dagger}$	8.1 ± 3.0	0.002
	6 months	5.1 ± 2.3	$3.8 \pm 1.9^{*\dagger}$	6.4 ± 2.7	0.001
PHQ-9 (Depression)	Pre-op	6.2 ± 2.8	6.5 ± 3.0	6.1 ± 2.7	0.79
	6 weeks	9.4 ± 3.5	$8.1 \pm 3.2^*$	11.3 ± 3.8	< 0.001
	3 months	7.3 ± 3.1	$5.9 \pm 2.6^{*\dagger}$	9.2 ± 3.3	0.001
	6 months	5.4 ± 2.4	$3.9 \pm 2.0^{*\dagger}$	7.1 ± 2.9	< 0.001
SF-36 Mental Component	Pre-op	52.3 ± 8.1	51.8 ± 7.9	52.1 ± 8.3	0.96
	3 months	46.1 ± 7.4	$50.7 \pm 6.8^{*\dagger}$	42.9 ± 8.1	0.003
	6 months	51.4 ± 7.2	$55.8 \pm 6.3^{*\dagger}$	47.2 ± 7.8	0.001

*Significantly different from Group C at same timepoint ($p < 0.05$); †Significantly different from Group A at same timepoint ($p < 0.05$). GAD-7 = Generalized Anxiety Disorder-7; PHQ-9 = Patient Health Questionnaire-9; SF-36 MCS = SF-36 Mental Component Summary.

Figure 2. Longitudinal Anxiety and Depression Trajectories Stratified by Rehabilitation Timing Group

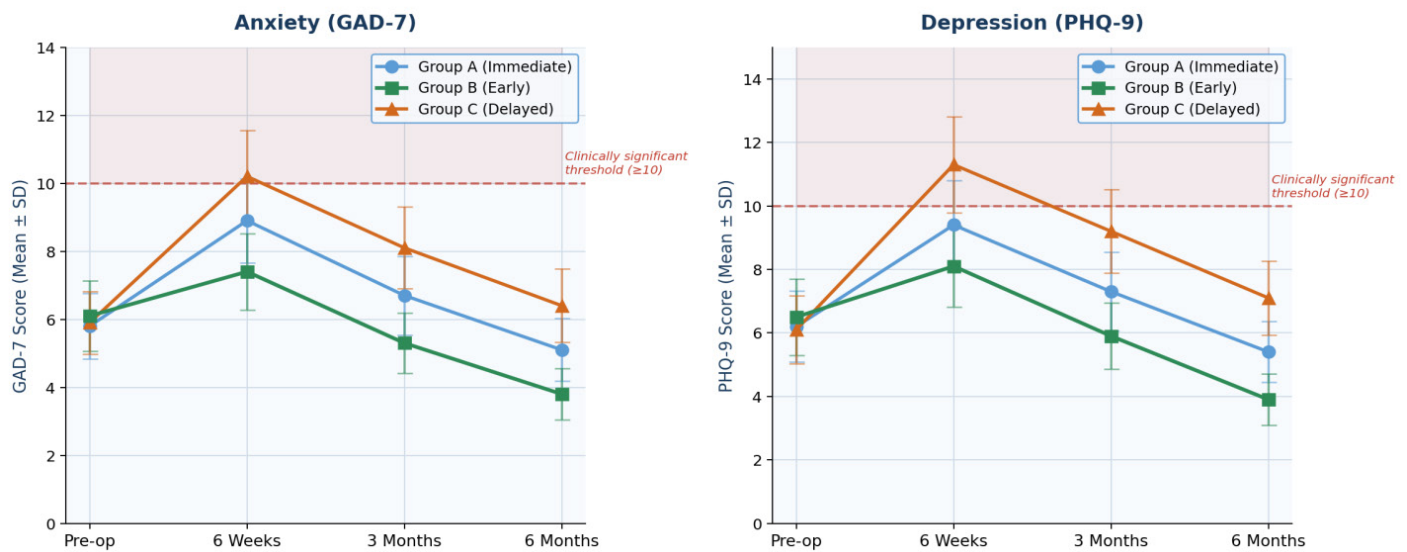


Figure 2. Longitudinal anxiety (GAD-7) and depression (PHQ-9) trajectories stratified by rehabilitation timing group. Error bars represent $\pm$ SD. The dashed red line denotes the clinically significant threshold (score ≥ 10). * $p < 0.001$ between Group B and Groups A and C at 3 and 6 months.

3.4 Correlation and regression analyses

Table 4 shows the findings of bivariate correlation and regression analyses that found the relationship between psychological and urological outcome measures, also shown in **figure 3**. There were significant, statistically significant positive correlations between ICIQ-SF score and GAD-7 ($r = 0.58$, $p < 0.001$) and PHQ-9 ($r = 0.61$, $p < 0.001$), which means that more severe incontinence was likely to be related to high levels of anxiety and depression. Daily pad usage demonstrated similarly strong correlations with GAD-7 ($r = 0.52$, $p < 0.001$) and PHQ-9 ($r = 0.55$, $p < 0.001$). The strength of pelvic floor muscles was a considerable negative predictor of both anxiety ($\beta = -0.54$, $p < 0.001$) and depression ($\beta = -0.59$, $p < 0.001$), which means that the higher the functional recovery of the pelvic floor, the lower the psychological morbidity. The days between surgery and the start of rehabilitation (operationalized as intervention timing) correlated positively with the size of the change in GAD-7 ($r = 0.44$, $p < 0.001$) and PHQ-9 ($r = 0.47$, $p < 0.001$), thus, confirming that later intervention was correlated with increased deterioration of the psychological outcomes.

Table 4. Pearson Correlation and Regression Analyses: Psychological vs. Urological Outcome Measures

Variable Pair	Pearson r	95% CI	β coefficient	p-value
GAD-7 vs ICIQ-SF score	0.58	0.43–0.71	0.64	< 0.001
PHQ-9 vs ICIQ-SF score	0.61	0.47–0.73	0.71	< 0.001
GAD-7 vs pad usage/day	0.52	0.37–0.65	0.57	< 0.001
PHQ-9 vs pad usage/day	0.55	0.40–0.68	0.62	< 0.001
PFMS strength vs GAD-7	–0.49	–0.63 to –0.33	–0.54	< 0.001
PFMS strength vs PHQ-9	–0.53	–0.66 to –0.38	–0.59	< 0.001

Continuation Table:

Variable Pair	Pearson r	95% CI	β coefficient	p-value
Continence rate vs GAD-7	-0.61	-0.73 to -0.47	-0.68	< 0.001
Continence rate vs PHQ-9	-0.64	-0.75 to -0.51	-0.72	< 0.001
Intervention timing vs Δ GAD-7	0.44	0.28–0.58	0.49	< 0.001
Intervention timing vs Δ PHQ-9	0.47	0.31–0.61	0.53	< 0.001

All correlations and regression coefficients are significant at $p < 0.001$. CI = confidence interval; ICIQ-SF = International Consultation on Incontinence Questionnaire-Short Form; PFMS = pelvic floor muscle strength; GAD-7 = Generalized Anxiety Disorder-7; PHQ-9 = Patient Health Questionnaire-9.

Figure 3. Association Between Urinary Incontinence Severity and Psychological Outcomes at 3 Months

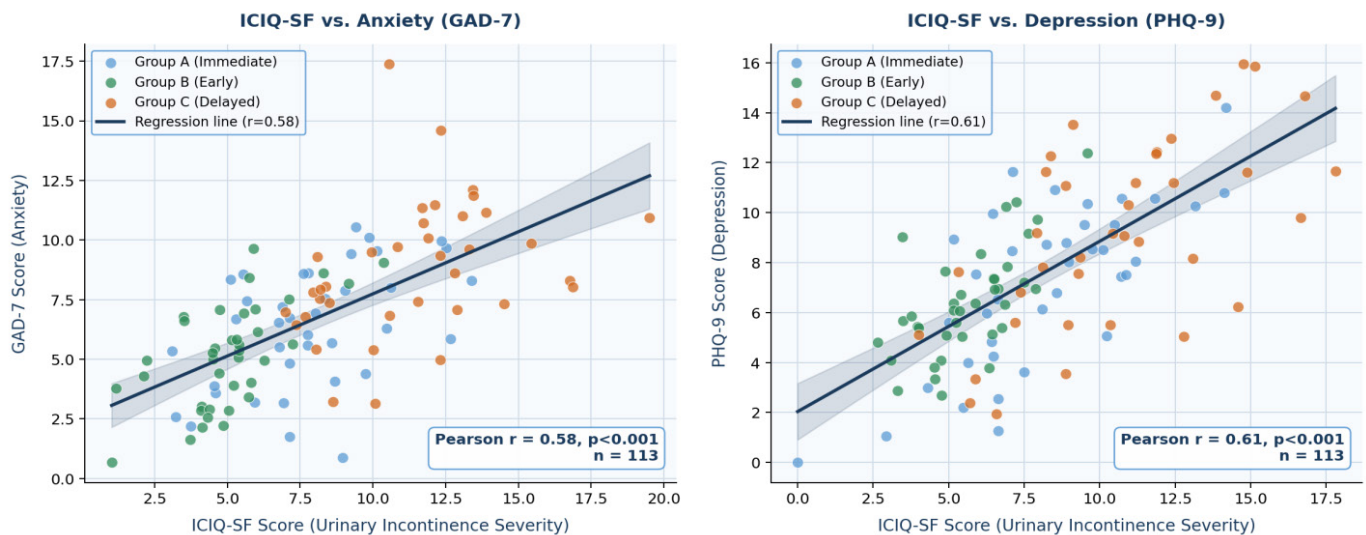


Figure 3. Scatter plots with fitted regression lines and 95% confidence bands demonstrating positive linear associations between urinary incontinence severity (ICIQ-SF) and anxiety (GAD-7, $r = 0.58$, $p < 0.001$) and depression (PHQ-9, $r = 0.61$, $p < 0.001$) at the 3-month assessment. Point colors indicate group assignment. Shaded bands represent 95% confidence intervals around the regression line.

4. Discussion

The key results of this randomized controlled trial prove that the introduction of combined PFMT and electrical stimulation after the removal of the urethral catheters, at the time, about one week after the operation, has better results in recovery of urinary continence and much more significant results in reduction of anxiety and depression than similar introduction (immediately after childbirth) or introduction (after 6 weeks) of the combined rehabilitation intervention. The findings have significant material implications on the design and timing of prehabilitation and postoperative rehabilitation programs of prostate cancer survivors with radical prostatectomy.

The effectiveness of early (Group B) versus delayed (Group C) rehabilitation is consistent with the rest of the literature on rehabilitation medicine in supporting the concept of early intervention in preventing functional deconditioning and secondary psychological deterioration [20]. The 6-week intervals between Group C and Group

C initiated combined PFMT+ES enabled formation of maladaptive compensatory mechanisms- such as urethral splinting, hyperactive and hyperirritable pelvic muscles and avoidance behaviors- known inhibitors to functional restoration [21]. The unaddressed incontinence of Group C also posed a longer-lasting psychological stressor, as evidenced by the significantly high and chronic GAD-7 and PHQ-9 scores in this arm, with 40.5% fulfilling PHQ-9 criteria of clinically significant depression at 3 months.

The paradox of this result that the early (Group B) initiation at catheter removal was better than the immediate (Group A) initiation during the 24 hours is worth consideration. There are a number of mechanisms that we hypothesize. First, acute surgical inflammation, edema, and neurovascular compromise at the urethral sphincter complex is prominent in the immediate postoperative period, which can temporarily make the musculature refractory to efficient voluntary contraction and ES-mediated recruitment [22]. PFMT that is activated when a catheter is inserted can therefore be transferring force to an inadequately coactable sphincter and has insufficient neuromuscular re-education input. Second, Group A patients were necessarily treating acute postoperative pain, indwelling catheter pains, and early ambulation requirements simultaneously, which could have combined to restrain the quality of active voluntary contractions and involvement in physiotherapy teaching [23]. Third, the possibility of an iatrogenic injury of immediate ES in the condition of the acutely traumatized sphincter complex cannot be ruled out. Theoretical consequences of electrical stimulation of the periurethral musculature in the hyperacute phase of inflammation may be the occurrence of premature or inadequately coordinated muscle responses, such as dyssynergic contractions, prior to the adequate neurological recovery has been determined [24]. These observations are similar to orthopedic rehabilitation literature that found immediate aggressive neuromuscular electrical stimulation of acute musculoskeletal injuries to have worse outcomes than early mobilization with the right timing [25].

The psychological implications support and generalize previous cross-sectional data that reveals a relationship between PRP-UI severity and psychological morbidity. The high correlations between ICIQ-SF scores and GAD-7 and PHQ-9 ($r = 0.58$ and $r = 0.61$, respectively) are consistent with the outcomes of systematic reviews conducted by Cornford et al. [26] and Sciarra et al. [27], which found that urinary functioning is the main contributor to mental health decline during the 6–12 months post-prostatectomy. Our data complements this literature by showing that the time of rehabilitation moderates the extent of psychological deterioration and recovery, whereby Group C participants did not revert to baseline MCS scores up to 6 months. The direct implications of this finding on cancer survivorship planning are as follows: a late rehabilitation can set in place a long-lasting psychological burden on the survivor that continues long after the recovery acute phase.

The negative correlation between the strength of pelvic floor muscles and anxiety and depression scores ($\beta = -0.54$ and -0.59 , respectively) implies that the recovery of pelvic floor neuromuscular activity itself can have intrinsic psychological utility, and may be mediated by the enhancement of bodily control perceptions and self-efficacy [28,29]. This aligns with the growing evidence on the topic of exercise oncology that shows gains in functional capacity, regardless of whether the symptoms are related to cancer or not, have a negative impact on the psychological distress of cancer survivors through neurobiological processes such as normalization in the hypothalamic-pituitary-adrenal axis and endorphin-mediated mood regulation [30,31].

The role of electrical stimulation in Group A and B was probably a complementary pathway to excellent results in both groups. ES of the pudendal nerve afferents have the ability to counteract pathological detrusor overactivity by inhibiting sacral micturition reflex arcs, and, as a result, decreasing the number of urgency episodes and anxiety related to urgency [32,33]. At the same time, direct ES of the periurethral striated musculature facilitates the hypertrophy of type I slow-twitch and type II fast-twitch pelvic fibres, and it increases the resting tone and voluntary contractile capacity [34,35]. The better endurance times seen in Group B (12.4 seconds vs. 8.7 seconds, Group A at 3 months) indicate that the combined protocol at the time of catheter removal so produced the most desirable neuromuscular adaptation profile perhaps because the sphincter mechanism was adequately healed of acute surgical trauma to become actively engaged in both voluntary training and electrical stimulation.

These results ought to be viewed within the framework of some critical limitations. First, it was impossible to fully blind the participants and treat physiotherapists, which led to the possibility of performance bias. Second, the research was carried out in two tertiary academic institutions by senior surgeons, which restricts the applicability of the results to lower-volume centers or open surgery. Third, the outcome of sexual functioning, which is another significant contributor to the post-prostatectomy psychological morbidity, was not rigorously evaluated in this trial, and this avenue is a future research opportunity. Fourth, the sample population was mostly selected in urban academic institutions, which presented possible socioeconomic and health literacy selection biases. Fifth, compliance was measured, in part, through self-reported diaries, which has measurement biases. Sixth, 6 months might not be long enough to report the full course of psychological recovery among this group; prospective studies should be extended.

Testing of PFMT+ES timing in non-nerve-sparing and salvage prostatectomy groups, testing of predictive biomarkers to effectively respond to rehabilitation, and testing of telehealth-based PFMT+ES programs on urological and psychological outcomes are the research priorities put forward by this trial. Further research should also consider combined psychological interventions (e.g. brief cognitive-behavioral therapy or mindfulness-based stress reduction) as an addition to physical rehabilitation of patients with any pre-existing anxiety or depression at the moment of RP.

5. Conclusion

The study is a strong evidence-based randomized controlled trial that shows that the duration of beginning combined pelvic floor muscle training and electrical stimulation after radical prostatectomy is a key factor to determine how well urinary continence is restored and the psychological effects. Early removal at the catheter-removal timing, about one week after surgery, results in better-continence rates, gains in the strength of the pelvic floor muscles, and anxiety and depression reductions than do immediate (within 24 hours) and delayed-removal (6 weeks) strategies. The presence of bidirectional relationships found between urinary functions recovery and psychological wellbeing supports the relevance of biopsychosocial rehabilitation models in the management of prostate cancer survivor. Urologists, oncologists, and rehabilitation physiotherapists ought to devise structured early rehabilitation pathways, which are activated systematically at catheter removal, including both PFMT and ES in a psychological support framework, to maximize overall outcomes

of men after radical prostatectomy.

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References

1. Sung H, Ferlay J, Siegel RL, et al. Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries. *CA Cancer J Clin.* 2021;71(3):209-249. doi:10.3322/caac.21660
2. Mottet N, van den Bergh RCN, Briers E, et al. EAU-EANM-ESTRO-ESUR-SIOG Guidelines on Prostate Cancer-2020 Update. Part 1: Screening, Diagnosis, and Local Treatment with Curative Intent. *Eur Urol.* 2021;79(2):243-262. doi:10.1016/j.eururo.2020.09.042
3. Hamdy FC, Donovan JL, Lane JA, et al. Fifteen-Year Outcomes after Monitoring, Surgery, or Radiotherapy for Prostate Cancer. *N Engl J Med.* 2023;388(17):1547-1558. doi:10.1056/NEJMoa2214122
4. Ficarra V, Novara G, Rosen RC, et al. Systematic review and meta-analysis of studies reporting urinary continence recovery after robot-assisted radical prostatectomy. *Eur Urol.* 2012;62(3):405-417. doi:10.1016/j.eururo.2012.05.045
5. Eastham JA, Boorjian SA, Kirkby E. Clinically Localized Prostate Cancer: AUA/ASTRO Guideline. *J Urol.* 2022;208(3):505-507. doi:10.1097/JU.0000000000002854
6. Watts S, Leydon G, Birch B, et al. Depression and anxiety in prostate cancer: a systematic review and meta-analysis of prevalence rates. *BMJ Open.* 2014;4(3):e003901. doi:10.1136/bmjopen-2013-003901
7. Chou R, Griffin J, Cheney T et al. Management of clinically localized prostate cancer: a systematic evidence review. Portland, OR: Pacific Northwest Evidence-based Practice Center; 2022. 208(1):10-18, doi: 10.1097/JU.0000000000002757
8. Dahm P, Brasure M, Ester E et al: Therapies for Clinically Localized Prostate Cancer. Comparative Effectiveness Review No. 230. (Prepared by the Minnesota Evidence-based Practice Center under Contract No. 290-2015-0000-81) AHRQ Publication No. 20-EHC022. Rockville, MD: Agency for Healthcare Research and Quality; September 2020. No. 230.) Available from: <https://www.ncbi.nlm.nih.gov/books/NBK562484/>
9. Wilt TJ, Ullman KE, Linskens EJ et al: Therapies for clinically localized prostate cancer: a comparative effectiveness review. *J Urol* 2020. 205(4):967-976. doi:10.1097/JU.0000000000001578
10. Canter DJ, Freedland S, Rajamani S et al: Analysis of the prognostic utility of the cell cycle progression (CCP) score generated from needle biopsy in men treated with definitive therapy. *Prostate Cancer Prostatic Dis* 2020; 23:102. doi:10.1038/s41391-019-0159-9
11. Park, J. J., Hong, Y., Kwon, A., Shim, S. R., & Kim, J. H. Efficacy of surgical treatment for post- prostatectomy urinary incontinence: a systematic review and network meta-analysis. *International journal of surgery (London, England)* 2023; 109(3), 401–411. doi: 10.1097/JS9.000000000000170
12. Yu K, Bu F, Jian T, Liu Z, Hu R, Chen S and Lu J. Urinary incontinence rehabilitation of after radical prostatectomy: a systematic review and network meta-analysis. *Front. Oncol.* 2024; 13:1307434. doi: 10.3389/fonc.2023.1307434
13. Rahnama'I MS, Marcelissen T, Geavlete B, Tutolo M, Hüscher T. Current management of post-radical prostatectomy urinary incontinence. *Front Surg.* (2021);8:647656. doi: 10.3389/fsurg.2021.647656
14. Sehgal A, Baverstock R, Wright I, Frey C, Crump T, Carlson K. A comparative analysis of physiotherapy for stress urinary

- incontinence after open or robotic-assisted radical prostatectomy. *Physiother Can.* (2019) ;71:207–12. doi: 10.3138/ptc.2017-90
15. Yıldız, N., Çelen, S., Özlülerden, Y., & Alkan, H. (2023). Efficacy of perineal electrical stimulation in men with urinary incontinence after radical prostatectomy. A prospective randomized controlled trial. *Neurourology and urodynamics*, 42(1), 340–348. <https://doi.org/10.1002/nau.25096>
16. Gacci, M., Sakalis, V. I., Karavitakis, M., Cornu, J. N., Gratzke, C., Herrmann, T. R. W., Kyriazis, I., Malde, S., Mamoulakis, C., Rieken, M., Schouten, N., Smith, E. J., Speakman, M. J., Tikkinen, K. A. O., & Gravas, S. (2022). European Association of Urology Guidelines on Male Urinary Incontinence. *European urology*, 82(4), 387–398.doi.org/10.36721/PJPS.2025.38.6.REG.13082.1
17. Wang XQ. Development of Chinese versions of Modified Female Self-image Rating Scale(MBIS),Urinary Incontinence Quality of Life Questionnaire(I-QOL) and Uterine Leiomyoma Symptoms and Health-related Quality of Life Questionnaire (UFS-QOL) and its verification in China population [D]. Beijing :Peking Union Medical College,2013
18. Sciarra A, Viscuso P, Arditi A, et al. A biofeedback-guided programme or pelvic floor muscle electric stimulation can improve early recovery of urinary continence after radical prostatectomy: A meta-analysis and systematic review. *Int J Clin Pract.* 2021;75:e14208. doi: 10.1111/ijcp.14208
19. Pan LH, Lin MH, Pang ST, Wang J, Shih WM. Improvement of Urinary Incontinence, Life Impact, and Depression and Anxiety With Modified Pelvic Floor Muscle Training After Radical Prostatectomy. *Am J Mens Health.* 2019;13(3):1557988319851618. doi:10.1177/1557988319851618
20. Qiuxia Qin, Juan Liu, Duo Zhang, Yuming Zhang, Xiaoqin Xie, Fan Yang, Lihong Huang, Xiaoqin Chen. Association between postoperative urinary incontinence severity and anxiety in patients with prostate cancer: A chain mediation analysis of ehealth literacy and pelvic floor muscle training adherence. *Asia-Pacific Journal of Oncology Nursing.* Volume 13, 2026,100842. doi: 10.1016/j.apjon.2025.100842.
21. Bo K, Frawley HC, Haylen BT, et al. An International Urogynecological Association (IUGA)/International Continence Society (ICS) joint report on the terminology for the conservative and nonpharmacological management of female pelvic floor dysfunction. *Neurourol Urodyn.* 2017;36(2):221-244. doi:10.1002/nau.23107
22. Stafford RE, Coughlin G, Lutton NJ, Hodges PW. Validity of Estimation of Pelvic Floor Muscle Activity from Transperineal Ultrasound Imaging in Men. *PLoS One.* 2015;10(12):e0144342. doi:10.1371/journal.pone.0144342
23. Davuluri, M., DeMeo, G., Penukonda, S., Zahid, B., & Hu, J. C. (2023). Guiding Clinical Decision Making for Surgical Incontinence Treatment After Prostatectomy: A Review of the Literature. *Current urology reports*, 24(11), 527–532. doi: 10.1007/s11934-023-01181-6
24. Szczygielska, D., Knapik, A., Pop, T., Rottermund, J., & Saulicz, E. (2022). The Effectiveness of Pelvic Floor Muscle Training in Men after Radical Prostatectomy Measured with the Insert Test. *International journal of environmental research and public health*, 19(5), 2890. doi: 10.3390/ijerph19052890
25. Tang G, Liu M, Chen X, Liu C, Zhao J, Zhao H. Effectiveness of electrical stimulation for treating male urinary incontinence after prostatectomy: a meta-analysis and systematic review. *Int J Surg.* 2025;111(9):6351-6361. doi:10.1097/JS9.0000000000002685
26. Cornford P, van den Bergh RCN, Briers E, et al. EAU-EANM-ESTRO-ESUR-ISUP-SIOG guidelines on prostate cancer-2024 update. Part I: screening, diagnosis, and local treatment with curative intent. *Eur Urol* 2024;86:148–63. doi: 10.1016/j.eururo.2024.03.027.
27. Sciarra A, Viscuso P, Arditi A, et al. A biofeedback-guided programme or pelvic floor muscle electric stimulation can improve early recovery of urinary continence after radical prostatectomy: a meta-analysis and systematic review. *Int J Clin Pract* 2021;75:e14208. doi:10.1111/ijcp.14208
28. Santos, J. E. M. D., Brasil, V. V., Azevedo, C., Izidoro, L. C. R., Batista, A. J. G., Ferreira, A. C. S., & Mata, L. R. F. D. (2024). Pelvic floor muscle training in men with post-prostatectomy urinary incontinence: a scoping review. *Revista latino-americana de enfermagem*, 32, e4386. doi: 10.1590/1518-8345.7335.4386
29. Courneya KS, Mackey JR, Bell GJ, Jones LW, Field CJ, Fairey AS. Randomized controlled trial of exercise training in postmenopausal breast cancer survivors: cardiopulmonary and quality of life outcomes. *J Clin Oncol.* 2003;21(9):1660-1668. doi:10.1200/JCO.2003.04.093
30. Kharaji, G., ShahAli, S., Ebrahimi-Takamjani, I., Sarrafzadeh, J., Sanaei, F., & Shanbehzadeh, S. (2023). Supervised versus

- unsupervised pelvic floor muscle training in the treatment of women with urinary incontinence-a systematic review and meta-analysis. *International urogynecology journal*, 34(7), 1339–1349. doi: 10.1007/s00192-023-05489-2
31. Buckingham, S. A., Williams, A. J., Morrissey, K., Price, L., & Harrison, J. (2019). Mobile health interventions to promote physical activity and reduce sedentary behaviour in the workplace: A systematic review. *Digital health*, 5, 2055207619839883. doi: 10.1177/2055207619839883
 32. Bauer RM, Gozzi C, Hübner W, et al. Contemporary management of postprostatectomy incontinence. *Eur Urol*. 2011;59(6):985-996. doi:10.1016/j.eururo.2011.03.020
 33. Dess RT, Suresh K, Zelefsky MJ et al: Development and validation of a clinical prognostic stage group system for nonmetastatic prostate cancer using disease-specific mortality results from the international staging collaboration for cancer of the prostate. *JAMA Oncol* 2020; 6:1912. doi: 10.1001/jamaoncol.2020.4922
 34. Allameh F, Rayegani SM, Razzaghi M, et al. Comparison of the effect of the pelvic floor muscle biofeedback prior or postradical prostatectomy on urinary incontinence: A randomized controlled trial. *Turk J Urol*. 2021;47(5):436-441. doi:10.5152/tud.2021.21096
 35. Kannan P, Winser SJ, Fung B, Cheing G. Effectiveness of Pelvic Floor Muscle Training Alone and in Combination With Biofeedback, Electrical Stimulation, or Both Compared to Control for Urinary Incontinence in Men Following Prostatectomy: Systematic Review and Meta-Analysis. *Phys Ther*. 2018;98(11):932-945. doi:10.1093/ptj/pzy101