ORIGINAL RESEARCH

Mediation analysis of adherence to pelvic floor muscle training and weekly self-monitoring on urinary symptoms in men with localized prostate cancer

A secondary analysis of the Prostate Cancer-Patient Empowerment Program (PC-PEP) randomized controlled trial

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ABSTRACT

INTRODUCTION: Men treated curatively for localized prostate cancer often experience urinary complications that impair quality of life. The Prostate Cancer-Patient Empowerment Program (PC-PEP) is a six-month, digital intervention integrating pelvic floor muscle training (PFMT), fitness, nutrition, and intimacy support. While early initiation of PC-PEP improves urinary outcomes, the influence of adherence remains unclear. This mediation analysis examined whether reported PFMT duration and engagement with self-monitoring mediate the association between timing of PC-PEP delivery (early vs. late) and urinary outcomes.

METHODS: In a randomized, crossover trial, 128 men with localized prostate cancer were assigned to receive PC-PEP immediately (early group, n=66) or after six months of standard care (late group, n=62). Urinary outcomes were assessed using the Expanded Prostate Cancer Index Composite (EPIC) and International Prostate Symptom Score (IPSS). Weekly compliance surveys tracked engagement. Mediation and moderated mediation analyses adjusted for age, comorbidity, treatment modality, and baseline urinary function.

RESULTS: Mean reported weekly PFMT duration did not differ between groups. The early group had higher compliance survey completion (98.8% vs. 64.1%, $p<0.001$) and higher post-intervention EPIC urinary incontinence scores (81.5 ± 21.9 vs. 68.2 ± 17.0, $p<0.001$), indicating better continence. Compliance survey completion mediated 41% of the association between early intervention and post-intervention EPIC urinary incontinence scores. No significant mediation was observed for IPSS or EPIC irritative/obstructive scores. Treatment modality did not moderate effects.

CONCLUSIONS: Early initiation of PC-PEP was associated with greater engagement in structured self-monitoring, which mediated improvements in urinary continence independent of reported PFMT duration. Integrating early patient activation and digital self-monitoring into post-treatment care may improve urinary continence outcomes and support scalable rehabilitation.

INTRODUCTION

Prostate cancer remains the most frequently diagnosed non-cutaneous malignancy among Canadian men, affecting approximately one in eight over their lifetime.[1] Advances in detection, most notably prostate-specific antigen (PSA) testing and prostate magnetic resonance imaging, have increased the diagnosis of clinically significant disease, leading to more men receiving curative-intent treatments such as radical prostatectomy or radiotherapy.[2] While these modalities achieve excellent oncologic control, both are associated with adverse effects that can significantly impair quality of life, particularly in the early post-treatment period. Urinary incontinence is one of the most distressing complications, often exerting a profound psychosocial impact and emerging as the symptom most strongly associated with treatment regret compared to sexual, bowel, and hormonal dysfunction.[3,4]

Urinary incontinence is more prevalent and severe following radical prostatectomy than after radiation therapy.[5] Pelvic floor muscle training (PFMT) is widely recommended as a non-invasive, evidence-based

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KEY MESSAGES

- Early initiation of the PC-PEP, a structured, home-based, digital intervention, significantly improved urinary continence outcomes among men undergoing curative-intent prostate cancer treatment.
- Adherence to program self-monitoring mediated 41% of the observed improvement in post-intervention urinary incontinence.
- Mean reported weekly duration of PFMT did not mediate improvements, suggesting that consistency and quality of participation are more important than total exercise time.
- Digital delivery of PFMT through structured, progressive video instruction provides a feasible, low-cost, and accessible alternative to in-person pelvic floor physiotherapy, particularly beneficial for men in rural or resource-limited regions.

intervention to improve continence following prostate surgery and, conditionally, preoperatively, despite limited data regarding its timing and optimal implementation.[6-10] Randomized trials have demonstrated that men engaging in structured PFMT regain continence earlier than those receiving usual care; however, heterogeneity in adherence, supervision, and timing has produced mixed results, leaving key implementation questions unresolved.[11,12]

To address these limitations, the Prostate Cancer-Patient Empowerment Program (PC-PEP) was developed as a comprehensive, home-based, digital intervention designed to support men undergoing local prostate cancer therapy.[13] The program integrates daily, progressively structured PFMT videos with aerobic and strength exercise, stress-reduction and mindfulness practices, dietary guidance, and social support, aiming to reduce psychological distress and enhance self-management. In a randomized controlled trial, PC-PEP demonstrated benefits beyond usual care, with secondary analyses identifying engagement-related mechanisms.[13,14]

A subsequent secondary analysis of the PC-PEP randomized trial demonstrated clinically meaningful improvements in urinary function when the program was delivered within six months of treatment, including reductions in urinary bother and irritative/obstructive symptoms sustained at 12 months post-treatment.[15] Despite these findings, the role of patient adherence, particularly engagement with PFMT components, has not been systematically examined as a potential mechanism underlying these improvements. Given evidence that structured, self-directed interventions can mitigate barriers such as low supervision, poor compliance, and limited access to pelvic floor specialists,[16,17] understanding adherence as a mediator of PFMT efficacy has both clinical and health-system relevance, particularly in rural populations with restricted healthcare access.[17,18]

This secondary analysis examined whether adherence to the PC-PEP program, as measured by weekly self-reported PFMT duration and completion of compliance surveys, mediates the association between intervention timing (early vs. delayed initiation) and urinary outcomes in men undergoing curative-intent prostate cancer treatment. It is hypothesized that greater adherence to the PFMT component of PC-PEP mediates improvements in urinary function, supporting early implementation of structured, technology-enabled PFMT as a standard adjunct to surgical and radiotherapeutic care. If confirmed, these findings would inform the integration of PFMT into standard prostate cancer care, either as postoperative rehabilitation or prehabilitation, and strengthen the case for scalable, online patient-empowerment programs that promote self-efficacy, equitable access, and efficient use of limited healthcare resources.

METHODS

Study design and participants

This secondary analysis used data from a single-center, prospective, crossover, randomized clinical trial, the Prostate Cancer-Patient Empowerment Program (PC-PEP). The full protocol and primary outcomes have been published previously.[13] Participants were recruited between December 2019 and January 2021 through urologic and radiation oncologists or by self-referral in response to advertisements displayed in oncology clinics across Nova Scotia.

Eligible participants were men aged 18 years or older with biopsy-confirmed prostate cancer who were scheduled to undergo curative treatment (radical prostatectomy or radiotherapy with or without hormone therapy) within six months of randomization. Participants were required to be deemed medically safe to engage in low to moderate physical activity, literate in English, able to travel to Halifax for in-person assessments at baseline, six, and 12 months, and to have daily access to the internet and email. Of 171 eligible individuals, 140 consented to participate and were randomized. Twelve participants were excluded (11 did not receive curative treatment within six months and one withdrew before baseline), leaving 128 participants who completed the trial. Participant flow followed the CONSORT 2010 guidelines (Figure 1).

Computer-generated, fixed-block randomization was used to ensure balance in baseline psychological distress, hormone therapy status, and treatment modality. Participants were allocated 1:1 to either the PC-PEP intervention or a standard-of-care waitlist control for the first six months. Allocation concealment was maintained by limiting access to the randomization code to the principal investigator; clinicians and study staff were blinded to group assignment. At six months, a crossover occurred: the waitlist control group received the PC-PEP intervention (late intervention), and the early intervention group retained access to program materials and live monthly online videoconferences. The study received approval from the Nova Scotia Health Research Ethics Board (File 1024822) and was registered at *ClinicalTrials.gov* (NCT03660085). All procedures adhered to CONSORT reporting guidelines.

Group exposure: Early vs. late intervention

Comprehensive details of the PC-PEP intervention and trial procedures have been published previously.[13] Briefly, PC-PEP is a six-month, home-based, digital program delivered via daily emails and weekly instructional content. For the present mediation analysis, the intervention component of interest was PFMT, delivered in a standardized, progressive format.

Pelvic floor muscle training

PFMT was delivered as part of the PC-PEP intervention using a standardized, progressive protocol described previously.[15] Participants received weekly instructional guidance supported by daily digital prompts. Adherence to PFMT was assessed using weekly compliance surveys and served as the behavioral exposure of interest in the mediation analyses.

Outcome measures

Post-intervention urinary function

Urinary function was assessed using the International Prostate Symptom Score (IPSS) and the Expanded Prostate Cancer Index Composite (EPIC) urinary incontinence and urinary irritative/obstructive domains.

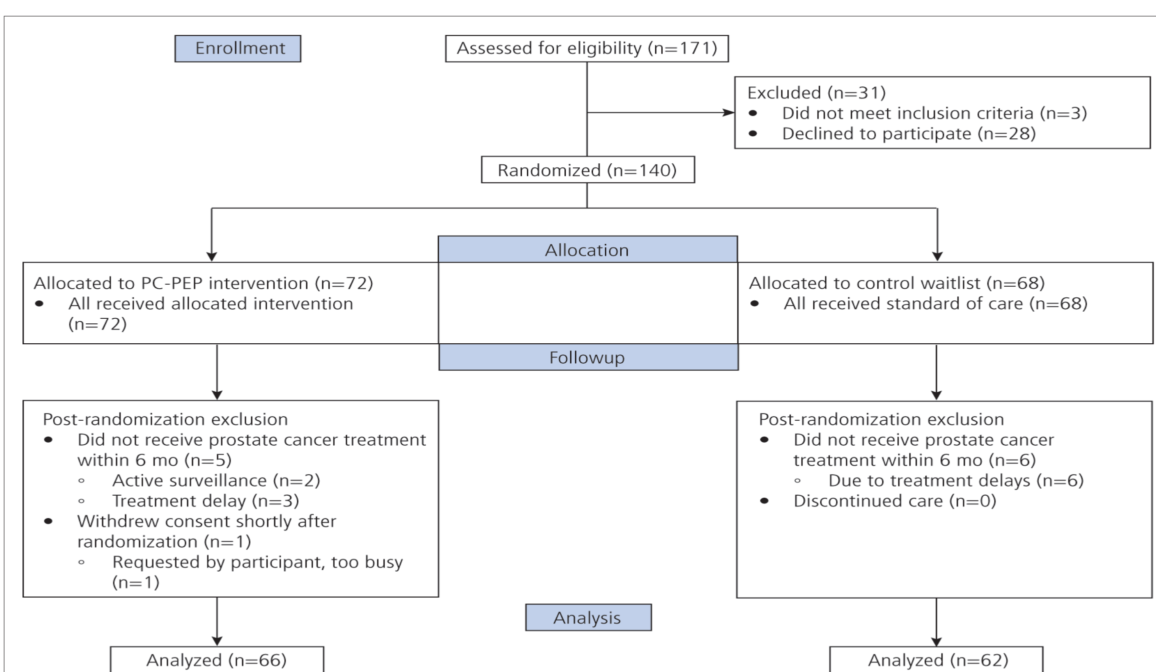

Figure 1. CONSORT 2010 flow diagram. CONSORT: Consolidated standards of reporting trials. PC-PEP: Prostate Cancer Patient Empowerment Program.

The IPSS is a validated seven-item measure assessing incomplete emptying, frequency, intermittency, urgency, weak stream, straining, and nocturia, with total scores ranging from 0–35. Higher scores indicate more severe symptoms.[19]

The EPIC is a validated questionnaire that evaluates urinary, bowel, sexual, and hormonal quality of life in men treated for localized prostate cancer. Domain scores range from 0–100, with higher values indicating better function.[20]

Mediator variables

PFMT adherence was evaluated using weekly self-reported compliance surveys administered during the 26-week intervention.[15] Participants recorded the number of prescribed PFMT sessions completed each day and the total daily duration of PFMT in minutes.

Two adherence variables were used in mediation analyses: mean weekly PFMT duration (average minutes per week) and compliance survey completion rate (percentage of completed weekly surveys multiplied by 100). These variables represented behavioral adherence mediators linking intervention timing (early vs. late delivery) to urinary outcomes. These adherence variables were selected a priori based on conceptual relevance to self-monitoring and PFMT behavior and on measurement validity for formal mediation analysis. Other engagement indicators were considered but not included because they did not provide standardized, behaviorally interpretable metrics suitable for mediation modeling. Optional text message reminders were available to all participants; however, text alert subscription was not modeled as a mediator due to its binary nature and close correlation with overall engagement.

Prognostic covariates

Covariates were selected a priori based on established predictors of urinary outcomes in the literature and prior PC-PEP analyses. They included patient age (years),[21] Charlson comorbidity index,[22] time between randomization and treatment initiation (days),[23] treatment modality (surgery or radiotherapy),[24] and baseline urinary function scores corresponding to each analysis (IPSS total, EPIC incontinence, or EPIC irritative/obstructive domain).[25]

Statistical analysis

All analyses were conducted using IBM SPSS Statistics, version 29.0.2.0.[26] Descriptive statistics summarized participant characteristics, urinary outcomes, survey completion, and mean PFMT duration. Differences between early and late intervention groups were assessed using independent-samples t tests for continuous variables and Chi-squared tests for categorical variables. A two-sided p-value less than 0.05 was considered statistically significant.

Mediation analyses were performed using PROCESS macro version 5.0 (Model 4)[27] to examine whether PFMT adherence (survey completion rate and mean weekly PFMT duration) mediated the association between timing of PC-PEP delivery (early vs. late)

Table 1. Sample characteristics and urinary symptom scores among localized prostate cancer patients receiving early vs. late PC-PEP intervention in Nova Scotia, Canada

Variable	Early intervention PC-PEP (n=66)	Late intervention PC-PEP (n=62)	p
Baseline characteristics			
Age, years	65.42 (6.84)	67.06 (7.23)	0.19
Charlson comorbidity index	0.36 (0.69)	0.39 (0.58)	0.8
Treatment modality			0.3
Radical prostatectomy	29 (43.9%)	33 (53.2%)	
Radiotherapy	37 (56.1%)	29 (46.8%)	
Time from randomization to treatment, days	64.41 (36.68)	70.32 (40.45)	0.4
Mean weekly PFMT, minutes	110.75 (61.22)	103.49 (72.41)	0.6
Compliance survey completion rate, %	98.83 (6.78)	64.08 (45.27)	<0.001
Baseline urologic outcomes			
IPSS total score	8.61 (6.37)	9.32 (5.93)	0.5
EPIC urinary incontinence	92.52 (14.20)	92.06 (14.29)	0.8
EPIC irritative/obstructive	89.58 (11.72)	88.21 (11.98)	0.5
Pre-intervention urologic outcomes[a]			
IPSS total score	8.61 (6.37)	11.93 (7.01)	0.006
EPIC urinary incontinence	92.52 (14.20)	62.06 (33.14)	<0.001
EPIC irritative/obstructive	89.58 (11.72)	83.40 (15.30)	0.011
Post-intervention urologic outcomes[b]			
IPSS total score	8.95 (5.69)	9.84 (6.21)	0.4
EPIC urinary incontinence	81.45 (21.89)	68.15 (17.04)	<0.001
EPIC irritative/obstructive	90.82 (10.20)	87.90 (13.34)	0.17

Values are mean (standard deviation) for continuous variables and n (%) for categorical variables. Sample sizes vary slightly across outcomes due to missing questionnaire data at specific time points. [a]Pre-intervention corresponds to baseline for the early-intervention group and 6 months for the late-intervention group. [b]Post-intervention corresponds to 6 months for the early-intervention group and 12 months for the late-intervention group. EPIC: Expanded Prostate Cancer Index Composite; IPSS: International Prostate Symptom Score; PFMT: pelvic floor muscle training.

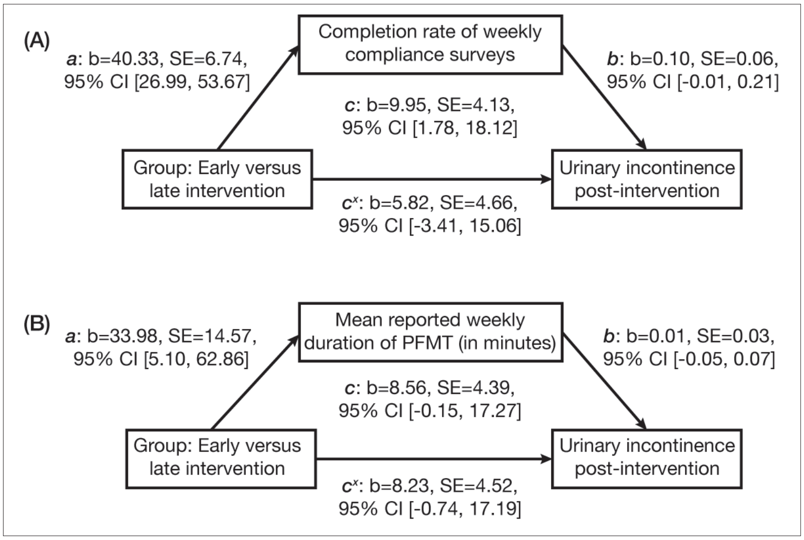

Figure 2. Mediation of early vs late intervention on post-intervention urinary incontinence by (A) completion rate of weekly compliance surveys (n=125) and (B) mean reported weekly duration of pelvic floor muscle training (PFMT) (n=114). Urinary incontinence was measured by the expanded prostate cancer index composition (EPIC) incontinence domain. Mediation analyses were adjusted for prognostic covariates: age, Charlson comorbidity index, treatment modality, time between randomization and treatment, and pre-intervention EPIC urinary incontinence scores. b: regression coefficient; CI: confidence interval; SE: standard error.

and post-intervention urinary outcomes, adjusting for covariates. The mediation model estimated four regression pathways: a) group assignment to the mediator; b) mediator to outcome controlling for group; c) direct effect of group on outcome controlling for mediator; and d) total effect of group on outcome. The indirect (mediated) effect was calculated as the product of paths (a) and (b). Statistical significance was determined using bias-corrected 95% bootstrap confidence intervals with 10 000 replicates.

For mediations that were statistically significant, moderated mediation analyses were conducted using PROCESS Model 7 to determine whether treatment modality (radical prostatectomy or radiotherapy) modified the mediation effect.

RESULTS

Sample characteristics

A total of 128 men participated in the randomized, crossover clinical trial, including 66 randomized to the early PC-PEP intervention and 62 to the standard-of-care, late intervention group. Baseline demographic and clinical characteristics were comparable between groups (Table 1). There were no statistically significant differences in age (mean 65.4 vs 67.1 years, p=0.19), Charlson comorbidity index (0.36 vs. 0.39, p=0.84), treatment modality (radical prostatectomy 43.9% vs. 53.2%, p=0.29), or baseline urinary function scores. Baseline IPSS and EPIC urinary domain scores did not differ significantly (p>0.05 for all comparisons), indicating balanced groups at trial initiation.

Urinary outcomes

Consistent with the crossover design, participants in the early intervention group initiated PC-PEP primarily in the pretreatment period, whereas participants in the late intervention group initiated the program following treatment completion, as detailed previously.[15] As expected, given the crossover design, between-group differences at the pre-intervention assessment reflect differences in treatment status (pretreatment vs. post treatment) and are not interpreted as intervention effects.

At the pre-intervention timepoint (baseline for the early group and six months for the late group), all urinary outcomes differed significantly between groups. Specifically, the late group exhibited worse urinary incontinence (EPIC incontinence 62.1±33.1 vs. 92.5±14.2, p<0.001), higher IPSS total scores (11.9±7.0 vs. 8.6±6.4, p=0.006), and greater urinary irritative/obstructive symptoms (83.4±15.3 vs. 89.6±11.7, p=0.011).

At the post-intervention assessment (six months for the early group and 12 months for the late group),

Table 2. Mediation of early vs. late intervention on post-intervention EPIC urinary incontinence

	Total			Direct			Indirect		% mediated
Mediator	Effect size (95% CI)	SE	p	Effect size (95% CI)	SE	p	Effect size (95% CI)	SE	
Survey completion rate	9.95 (1.78, 18.12)	4.13	0.017	5.82 (-3.41, 15.06)	4.66	0.2	4.12 (0.22, 9.17)	2.29	41.4%
Mean weekly PFMT	8.56 (-0.15, 17.27)	4.39	0.054	8.23 (-0.74, 17.19)	4.52	0.072	0.34 (-2.06, 2.47)	1.08	.

Mediation analyses were adjusted for prognostic covariates: age, Charlson comorbidity index, treatment modality, time between randomization and treatment, and pre-intervention EPIC urinary incontinence scores. CI: confidence interval; EPIC: Expanded Prostate Cancer Index Composite; PFMT: pelvic floor muscle training; SE: standard error.

only the EPIC urinary incontinence domain remained significantly different between groups (81.5±21.9 vs. 68.2±17.0, $p<0.001$), indicating greater continence improvement among early-intervention participants (Table 1).

Adherence measures

The mean reported weekly duration of PFMT was similar between early and late groups (110.8±61.2 vs. 103.5±72.4 minutes per week, $p=0.56$). In contrast, adherence to weekly compliance surveys — a marker of program engagement— was markedly higher in the early group (mean completion rate 98.8±6.8%) compared with the late group (64.1±45.3%, $p<0.001$). This finding demonstrates greater consistency and self-monitoring behavior when PC-PEP was initiated early, consistent with prior analyses of participant engagement and psychological activation within the program.[13,14]

Mediation analysis

Mediation analyses were performed to assess whether adherence variables (compliance survey completion rate and mean weekly PFMT duration) mediated the relationship between intervention timing and post-intervention urinary outcomes. For the EPIC urinary incontinence domain, compliance survey completion rate significantly mediated the association between early intervention and improved post-intervention scores, accounting for 41% of the total effect (indirect effect 4.12, 95% confidence interval [CI] 0.22, 9.17). The total effect of early vs. late intervention was significant ($\beta=9.95$, $p=0.017$), whereas the direct effect after adjusting for adherence was not ($\beta=5.82$, $p=0.214$), consistent with partial mediation, defined by a statistically significant indirect effect with attenuation of the direct effect (Figure 2, Table 2). Mean weekly PFMT duration did not significantly mediate the relationship (indirect effect 0.34, 95% CI -2.06, 2.47).

Mediation effects were not observed for the IPSS total score or the EPIC urinary irritative/obstructive domain (Supplementary Tables 1, 2; available at cuaj.ca). Treatment modality (radical prostatectomy vs. radiotherapy) did not significantly moderate the mediation pathway ($p>0.05$) (Table 3).

Together, these findings suggest that higher engagement, measured by consistent completion of self-monitoring surveys, was the primary behavioral mechanism linking early PC-PEP participation with improved urinary continence outcomes.

Table 3. Moderated mediation analysis for treatment modality, comparing radical prostatectomy and radiotherapy in the mediation of early vs late intervention on post-intervention EPIC urinary incontinence

Mediator	Effect size	SE	Lower 95% CI	Upper 95% CI
Completion rate of weekly compliance surveys	0.03	1.57	-2.71	3.97

Moderated mediation analysis was adjusted for prognostic covariates: age, Charlson comorbidity index, time between randomization and treatment, and pre-intervention EPIC urinary incontinence scores. EPIC urinary incontinence scores. CI: confidence interval; EPIC: Expanded Prostate Cancer Index Composite; SE: standard error.

DISCUSSION

This mediation analysis extends prior PC-PEP findings by identifying engagement with structured self-monitoring, rather than reported exercise duration, as a key pathway through which early program initiation is associated with improved urinary continence. In this secondary analysis of the PC-PEP randomized, crossover trial, participants in the early intervention group demonstrated greater engagement and consistency in monitoring their progress, reflected in significantly higher compliance survey completion rates. This engagement mediated 41% of the improvement in post-program urinary incontinence scores compared with the late group.

In contrast, mean reported weekly PFMT duration did not mediate this association. The attenuation of the direct effect after adjustment for compliance suggests that the timing of intervention exerts its influence primarily through engagement with structured self-monitoring behaviors. In contrast, mean reported weekly PFMT duration did not mediate this association, likely affected by the exclusion of 12 participants in the late group, who did not complete any compliance surveys and were therefore omitted from this analysis.

The divergence between PFMT duration and survey completion suggests that exercise quantity alone may not fully explain differences in urinary outcomes. Higher compliance survey completion may reflect greater consistency in self-monitoring and engagement with the program structure, rather than differences in total reported PFMT duration. Alternatively, compliance survey completion may capture a broader construct of patient engagement, including regular interaction with intervention components, such as exercise guidance, self-monitoring, and behavioral reinforcement, acting as a proxy for accountability and self-efficacy, both recognized drivers of health behavior change. Together, these findings suggest that early program initiation may support earlier and more consistent engagement with structured self-monitoring behaviors during recovery, thereby enhancing the effectiveness of rehabilitation efforts independent of total reported PFMT duration.

These results align with evidence from mobile health (mHealth) studies showing that digital prompts and cues, recognized behavior change techniques, are commonly embedded in PFMT applications and associated with greater adherence.[28] The underlying potential pathways can be understood through the Capability-Opportunity-Motivation-Behavior (COM-B) model, a widely used framework for designing and evaluating behavior-change interventions in healthcare.[29]

According to COM-B, a person must 1) have the *capability* (knowledge and skills); 2) the *opportunity* (environmental and social supports); and 3) the *motivation* (intention and reinforcement) to perform a behavior. In PC-PEP, daily emails and optional text reminders provide opportunity through structured cues, while weekly compliance surveys support capability and motivation by enabling self-monitoring and reinforcing progress. This alignment with COM-B principles helps explain how early activation, coupled with digital prompts and accountability, enhances adherence and ultimately continence recovery.

Accountability and structured self-monitoring have previously been shown to improve adherence and outcomes. In a randomized feasibility study, cancer patients who self-monitored physical activity using a smartphone app demonstrated greater increases in activity levels compared with those receiving standard care.[31] Similarly, higher self-efficacy (the belief in one's ability to manage challenges) has been associated with better adherence to PFMT and other rehabilitation programs.[14,18] These findings reinforce the importance of patient-centered care, emphasizing empowerment, active participation, and shared responsibility between patients and clinicians as determinants of recovery and well-being.

While the timing of PFMT initiation provides important clinical context, the present findings suggest that structured engagement and self-monitoring play a central role in continence recovery. Although PFMT is established for managing post-prostatectomy incontinence, the present findings suggest that early activation of self-monitoring, within the context of PFMT delivery, may confer greater benefit by establishing behavioral patterns that sustain adherence.[6,10-12] This interpretation aligns with a recent systematic review and meta-analysis concluding that prehabilitation PFMT improved urinary continence within three months of radical prostatectomy, although benefits diminished at longer followup.[30] Even short-term acceleration of recovery is clinically meaningful, as earlier restoration of continence has been associated with reduced psychological distress and treatment regret in men treated for prostate cancer.[3,13,15]

A key strength of PC-PEP is its accessibility and ability to sustain engagement. Its home-based design enables men to perform PFMT privately, rewatch instructional videos, and progress at their own pace. This flexibility may reduce stigma, increase confidence, and improve adherence compared with in-person physiotherapy, which can be logistically or psychologically challenging. Digital delivery also broadens access for men in rural and remote regions, where specialist physiotherapy services are scarce.[17,32]

PC-PEP has shown high safety, minimal attrition, and strong cost-effectiveness. A recent economic evaluation found that PC-PEP was a dominant strategy, saving approximately $660.89 CAD per participant over 12 months, with an additional $105.33 reduction possible by omitting non-essential components, such as heart rate variability monitoring.[33] Implementation within standard care could further reduce healthcare costs by limiting the need for repeated in-person physiotherapy sessions while maintaining clinical benefit.

Clinical relevance

Embedding low-effort, digital prompts and brief self-monitoring checkins within routine post-treatment care is a practical, scalable approach to improving PFMT adherence and continence outcomes — consistent with mHealth evidence that reminders and self-tracking enhance engagement.[28] Early activation appears especially important. Moreover, preoperative PFMT has been proposed to improve both sexual and mental health by expediting continence recovery and enhancing patient confidence,[34] supporting PC-PEP's early-activation design. These results emphasize the clinical importance of patient empowerment, accountability, and structured self-monitoring as integral components of modern prostate cancer rehabilitation.

Limitations

This single-site study may limit generalizability. As a secondary analysis, the trial was powered for its primary psychological outcome,[13] and the mediation models may be underpowered. Adherence and urinary outcomes were assessed using self-reported measures, introducing the potential for shared-method or reporting bias. Participants who were more engaged with the program may have been more likely to report both higher adherence and better urinary outcomes. Accordingly, the observed mediation should be interpreted as consistent with engagement-related mechanisms rather than as definitive evidence of causality. Importantly, the mediation effect was specific to urinary incontinence and was not observed for other urinary domains, which reduces the likelihood of a generalized positive reporting bias. Future trials should incorporate objective adherence indicators (e.g., app analytics, sensor-based exercise tracking) to further delineate causal pathways.

Future trials should prospectively include standardized mental health endpoints alongside urinary outcomes and examine whether adherence-enhancing components (digital prompts, self-monitoring) reduce anxiety, depression, and sexual-function burden.[33] Such designs will clarify whether the same adherence pathway mediates psychological recovery.

CONCLUSIONS

Early initiation of structured, digitally delivered rehabilitation was associated with greater engagement in self-monitoring, which mediated improvements in urinary continence among men receiving curative-intent prostate cancer treatment. Importantly, these benefits were independent of reported PFMT duration, underscoring the role of engagement, accountability, and structured self-monitoring rather than exercise quantity alone. These findings support the integration of early patient activation and self-monitoring frameworks into prostate cancer rehabilitation. Future multicenter trials incorporating objective engagement measures are needed to further clarify how digital self-monitoring pathways sustain functional recovery.

COMPETING INTERESTS: The authors have no relevant conflicts of interest to report.

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