Section: OBGN

Original Research Article

# THE ROLE OF HIP EXTERNAL ROTATOR STRENGTHENING IN IMPROVING PELVIC FLOOR FUNCTION IN POSTMENOPAUSAL WOMEN

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**ABSTRACT**

**Background:** Pelvic floor dysfunction is common in postmenopause, when oestrogen decline weakens pelvic tissues. Pelvic floor muscle training is first-line treatment, but data on strengthening neighbouring muscles, particularly the hip external rotators, is limited in postmenopausal women. The objective is to examine the effect of hip external rotator strengthening on pelvic floor function in postmenopausal women.

**Materials and Methods:** In this quasi-experimental study, 192 postmenopausal women were assigned to an intervention group (n = 96) or a control group (n = 96). The intervention group performed a 12 week hip external rotator strengthening program. Primary outcomes included incontinence severity (ICIQ-SF), and bladder base displacement and isometric hip external rotator strength. Secondary outcomes were pelvic floor symptoms (PFDI-20) and incontinence-related quality of life. The differences between the groups were analysed using ANCOVA after controlling for baseline values, age, BMI, parity, and years since menopause; and within-group differences were analysed using correlations.

**Results:** At baseline, groups were similar. At week 12, the intervention group showed greater improvement in ICIQ-SF (adjusted difference −3.6; 95% CI −4.5 to −2.7), bladder base displacement (4.4 mm; 3.8 to 5.0), hip strength (6.0 kg; 5.3 to 6.7) and PFDI-20 (−23.5; −26.8 to −20.2), all $p < 0.001$. There were significant correlations between hip strength increase and bladder base displacement (r = 0.62), ICIQ-SF (r = −0.58) and PFDI-20 (r = −0.54) and these were still significant after adjustment.

**Conclusion:** Hip external rotator strengthening was associated with better pelvic floor function and decreased symptoms in postmenopausal women. Randomised controlled trials with longer follow-up are needed to confirm these findings.

**Keywords:** hip external rotators; pelvic floor; postmenopause; urinary incontinence; strengthening

## INTRODUCTION

Pelvic Floor Dysfunction (PFD) includes urinary incontinence, pelvic organ prolapse, faecal incontinence and pelvic pain. This is a frequently occurring, yet underdiagnosed health issue in women globally.[1] A study of 1446 women found that urinary incontinence was reported by 55.8% of women, with the menopausal status being one of the factors found to have influenced the risk of developing urinary incontinence.[2] PFD can restrict physical activity, social participation and quality of life, and is likely to continue to be a growing burden as populations age.[3]

The menopause is an important time of vulnerability. In the late reproductive phase, a declining oestrogen causes the Genitourinary Syndrome of Menopause (GSM) that impacts 36% to nearly 90% of peri- and postmenopausal women.[4] Pelvic floor musculature, endopelvic fascia, urethra and bladder trigone have oestrogen receptors, which alters the structure of these tissues following their removal.[5] It is also reported that levator hiatus enlargement occurs in menopausal women with reduction in pelvic floor strength.[6] Combined, these alterations lead to a decline in urethral support, which makes it more likely for postmenopausal women to suffer from incontinence and symptoms associated with it.

Pelvic floor muscle training (PFMT) is the suggested first-line conventional treatment. In a systematic review of RCTs in postmenopausal women, all included studies showed that PFMT benefit women in terms of strength, quality of life, and/or severity of incontinence.[7] More recently, a second meta-analysis also showed that PFMT was effective in this population to alleviate incontinence symptoms.[8] There are still significant restrictions, however. There is a lack of agreement on the best physiotherapy treatment to stress urinary incontinence following the menopause, in part because treatments vary widely.[9] Both training protocols vary in terms of frequency, intensity, duration and exercise type.[10] The present gaps indicate that PFMT might not be most appropriate for all postmenopausal women and the importance of exploring complementing approaches.

A technique for this is strengthening pelvic floor muscles. Obturator internus is situated adjacent to the pelvic floor and is connected to it by fascia, which could have an effect on the function of the pelvic floor. After controlling for hip flexor strength, hip abductor strength and handgrip strength, hip external rotator strength was independently associated with pelvic floor muscle function in nulliparous women.[11] The connection seems to be limited to muscle, however. In young healthy women, maximal effort isometric hip adductor and abductor contraction led to descent of the bladder base, indicating that not all hip contraction helps to support the pelvic floor.[12] Strengthening the hip external rotators definitely therefore facts focused study.

There are several limitations to the existing evidence when it comes to the hip–pelvic floor relationship. It mainly comes from young, healthy or nulliparous women or from cross sectional designs. There are some differences in postmenopausal women that can impact this relationship. They have been studied far less but do tend to have oestrogen related changes in tissue, a lowered muscle mass and frequently a longer history of pelvic floor strain. The evidence of how strengthening the hip external rotators is correlated with improvement in pelvic floor function in this population is limited. Therefore, this quasi-experimental study investigated the effects of strengthening the hip external rotators in postmenopausal women on pelvic floor function. We hypothesized that hip external rotator strength gains would be correlated with measurable improvements in the pelvic floor function.

## MATERIALS AND METHODS

This quasi-experimental, non-randomized controlled study, which was undertaken in the Physiotherapy Departments of Indus Hospital, Lahore, Rex Medical Center, Lahore and Physical Medicine and Rehabilitation Center, Lahore for a period of 18 months from January 2025 to June 2026. The study evaluated at 12 weeks of hip external rotator strengthening training in naturally postmenopausal women to assess how this affected urinary incontinence symptoms, pelvic floor function and hip external rotator strength.

Inclusion criteria were that naturally post menopausal women age 50-70 years who had amenorrhea for at least 12 months and could walk without assistance and understood Urdu/English and were able to sign informed consent were included while women with a history of hip surgery or pelvic floor surgery were excluded. Exclusion criteria were: women with neurogenic bladder, severe cognitive or psychiatric illness, inability to perform a voluntary pelvic floor muscle contraction (modified Oxford grade 0–1), pelvic organ prolapse ≥ stage III, severe orthopedic or neurological conditions that would interfere with walking, and women who had had pelvic floor or hip strengthening exercises within 6 months.Women were excluded if they had neurogenic bladder, chronic renal failure, were unable to perform a voluntary pelvic floor muscle contraction (modified Oxford grade 0–1), had pelvic organ prolapse ≥ stage III, had severe cognitive or psychiatric illness, had neurological or severe orthopedic conditions that would interfere with walking, or had had pelvic floor or hip strengthening exercises in the previous 6 months, or had severe stress urinary incontinence requiring surgery.

The sample size is calculated by Charan and Biswas for comparing two independent proportions as shown below.[13] Due to the lack of a direct report on the effect of strengthening the external rotators of the hip on the function of the pelvic floor muscles in postmenopausal women, assumed proportions were based on the prevalence of urinary incontinence at 12 weeks after the start of pelvic floor muscle training in postmenopausal women, as reported,[14] 61.0% in the control group and 36.2% in the intervention group. With $p_1 = 0.61$, $p_2 = 0.36$, 80% power and 5% significance level (two-sided), a sample size of 59 per group was needed. To adjust for a 20% attrition rate, 74 persons per group (148 across all groups) were needed. There were 105 participants per group (210 total), due to the calculated requirement and sufficient statistical power.

Demographic questionnaire was used for data collection; validated Urdu version of International Consultation on Incontinence Questionnaire - Short Form (ICIQ-SF) for urinary incontinence severity

and quality of life; validated Urdu version of Pelvic Floor Distress Inventory – Short Form (PFDI-20) for pelvic floor symptoms; transabdominal ultrasound for bladder base displacement during voluntary contraction of the pelvic floor; and a handheld dynamometer for isometric strength of the external rotators of the hip (seated, hip flexed 90°, maximum 3-second contraction, best of two trials). The main outcome was the ICIQ-SF total score at Wk 12, while secondary endpoints were PFDI-20, bladder base displacement and strength of hip external rotators.

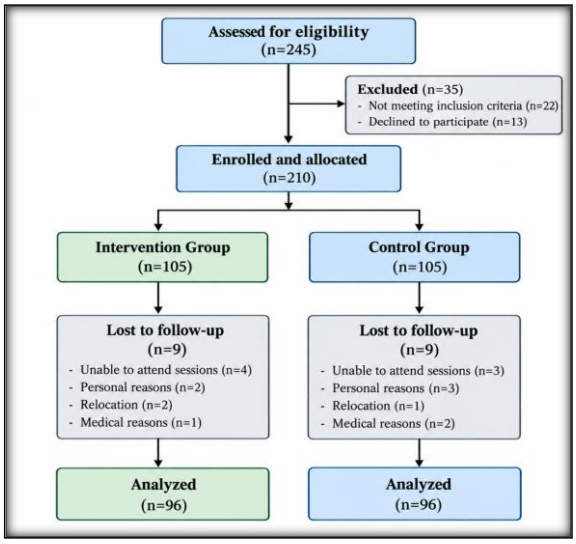
The allocation of participants was done in an alternate way. The intervention group performed hip external rotator strengthening 3 days/week for 12 weeks with the following exercises: warm up, sidelying hip ER, seated band hip ER, standing cable hip ER (3 sets × 10 reps), and cool down. When done with good form, 3 sets × 12 repetitions were considered to be resistance progressed. The control group was not given a structured program of hip strengthening, and was asked to maintain their usual activities. No specific instructions on exercise were provided and only a general information brochure on postmenopausal health was given. The outcome assessors were blind to group allocation while participants and treating physiotherapists were not. The study followed the Declaration of Helsinki and was approved by the Institutional Review Board of Physical Medicine & Rehabilitation Center, Lahore. Informed consent was sought from all participants and anonymization and secure storage of data were ensured.

Data were analysed with SPSS version 26.0 and significant at $p < 0.05$ (two-sided). Data were summarized as mean ± SD or median (IQR) for continuous variables and frequencies and percentages for categorical variables. Normality was tested for by using the Shapiro–Wilk test. For between-group comparisons at week 12, ANCOVA models adjusted for baseline data and prespecified confounding factors (age, BMI, parity, and years since menopause) were used, and adjusted mean differences and 95% CIs are reported. Paired t test or Wilcoxon signed-rank test were used for within-group changes. Partial eta-squared and Cohen's d were used to report effect size. Pearson or Spearman correlations were used to explore the relationships between changes in hip external rotator strength and the pelvic floor outcomes, while controlling for age, BMI and parity. Multiple imputation (20 datasets, missing at random assumption) was used for missing data, and an analysis per-protocol sensitivity analysis (≥80% attendance) was performed. Clinical relevance was evaluated based on the available MCIDs. Adherence and adverse events were noted and summarised.

## RESULTS

Participant Flow and Baseline Characteristics

A total of 210 postmenopausal women were enrolled, 105 in the intervention group (hip external rotator strengthening), and 105 in the control group. There were no differences between the intervention and control groups in terms of lost-to-follow-up (8.6% vs. 8.6% respectively), with 9 participants lost in both groups during the 12-week study period. The reasons for attrition were inability to attend scheduled sessions (n = 7), personal reasons (n = 5), relocation (n = 3), and medical reasons other than the study (n = 3). Per-protocol analysis was performed in 96 patients from each group (Figure 1). Unless otherwise noted, the results from the intention to treat analysis done with multiple imputations included all 210 participants.




Demographic characteristics, obstetric data and clinical parameters were statistically identical between groups at baseline ($p>0.05$ for all comparisons), thus providing good group comparability [Table 1]. The mean age was 58.4 ± 5.2 years in the intervention group and 58.9 ± 5.6 years in the control group ($p = 0.52$). Mean BMI was 27.3 ± 4.1 kg/m² and 27.6 ± 4.3 kg/m², respectively ($p = 0.61$). Mean duration since menopause was 8.2 ± 4.5 years and 8.5 ± 4.8 years, respectively ($p = 0.66$).

**Table 1: Baseline Characteristics of Participants (Mean ± SD or n (%))**

| Characteristic | Intervention Group (n=96) | Control Group (n=96) | p-value |
|---|---|---|---|
| Age (years) | 58.4 ± 5.2 | 58.9 ± 5.6 | 0.52 |
| BMI (kg/m²) | 27.3 ± 4.1 | 27.6 ± 4.3 | 0.61 |
| Age at menopause (years) | 49.8 ± 4.2 | 49.5 ± 4.5 | 0.63 |
| Years since menopause | 8.2 ± 4.5 | 8.5 ± 4.8 | 0.66 |
| Parity (n) | 3.2 ± 1.4 | 3.1 ± 1.3 | 0.59 |
| Vaginal deliveries (n) | 2.6 ± 1.2 | 2.5 ± 1.1 | 0.54 |
| ICIQ-SF score | 11.4 ± 3.8 | 11.6 ± 3.9 | 0.72 |
| PFDI-20 score | 68.4 ± 18.2 | 69.1 ± 18.7 | 0.79 |

| | | | |
|---|---|---|---|
| Bladder base displacement (mm) | 8.2 ± 2.8 | 8.4 ± 2.9 | 0.63 |
| Hip external rotator strength (kg) | 12.4 ± 3.2 | 12.6 ± 3.4 | 0.68 |

BMI: Body Mass Index; ICIQ-SF: International Consultation on Incontinence Questionnaire-Short Form; PFDI-20: Pelvic Floor Distress Inventory-Short Form.

**Primary Outcomes**

**Urinary Incontinence Severity (ICIQ-SF)**

At baseline, mean ICIQ-SF score was 11.4 ± 3.8 in the intervention group and 11.6 ± 3.9 in the control group (p = 0.72). At week 12, the intervention group demonstrated a significant reduction to 7.2 ± 3.1 (mean change: −4.2 ± 2.8; within-group p < 0.001; Cohen's d = 1.50), while the control group showed minimal change to 11.1 ± 3.7 (mean change: −0.5 ± 1.9; within-group p = 0.011; Cohen's d = 0.26). The between-group difference was statistically significant (mean difference: −3.7; 95% CI: −4.6 to −2.8; p < 0.001; Cohen's d = 1.18). There was a significant between-group difference at week 12 after adjusting for baseline ICIQ-SF scores and prespecified confounders (age, BMI, parity, years since menopause) (adjusted mean difference: −3.6; 95% CI: −4.5 to −2.7; F(1, 189) = 62.34; p < 0.001; $\eta^2$ = 0.25). The change observed was greater than the MCID of 2.5 points, which represents clinically meaningful improvement [Table 2].

Pelvic Floor Muscle Function (Bladder Base Displacement)

There was significant difference between the within-group mean change for the bladder base displacement of the intervention group (4.8 ± 2.1 mm) and the control group (0.3 ± 1.2 mm) at week 12 (p < 0.001; Cohen's d = 2.29). The between-group difference was statistically significant (mean difference: 4.5 mm; 95% CI: 3.9 to 5.1; p < 0.001; Cohen's d = 2.15). The difference between groups remained significant in an ANCOVA that adjusted for baseline values and prespecified confounders (adjusted mean difference: 4.4 mm; 95% CI: 3.8 to 5.0; p < 0.001; $\eta^2$ = 0.51) [Table 2].

**Hip External Rotator Strength**

There was a significant increase in isometric hip external rotator strength in the intervention group from 12.4 ± 3.2 kg to 18.7 ± 3.8 kg (mean change: 6.3 ± 2.5 kg; within group p < 0.001; Cohen's d = 2.52). There was no significant difference in the control group (mean change: 0.2 ± 1.1 kg; within-group p = 0.159; Cohen's d = 0.15). The between-group difference was statistically significant (mean difference: 6.1 kg; 95% CI: 5.4 to 6.8; p < 0.001; Cohen's d = 2.41). The between-group difference was significant (adjusted mean difference: 6.0 kg; 95% CI: 5.3 to 6.7; F(1, 189) = 247.32; p < 0.001; $\eta^2$ = 0.57) and confirmed by ANCOVA adjusting for baseline values and prespecified confounders [Table 2].

**Table 2: Primary Outcomes at Baseline and Week 12 (Per-Protocol Analysis)**

| Outcome Measure | Intervention Group (n = 96) | Control Group (n = 96) | Between-Group Difference (95% CI) | Between-Group p-value | Within-Group p (Intervention) | Within-Group p (Control) | Cohen's d |
|---|---|---|---|---|---|---|---|
| ICIQ-SF Score | | | | | | | |
| Baseline | 11.4 ± 3.8 | 11.6 ± 3.9 | — | 0.72 | — | — | — |
| Week 12 | 7.2 ± 3.1 | 11.1 ± 3.7 | — | — | — | — | — |
| Mean Change | −4.2 ± 2.8 | −0.5 ± 1.9 | −3.7 (−4.6 to −2.8) | <0.001* | <0.001* | 0.011* | 1.18 |
| Bladder Base Displacement (mm) | | | | | | | |
| Baseline | 8.2 ± 2.8 | 8.4 ± 2.9 | — | 0.63 | — | — | — |
| Week 12 | 13.0 ± 3.2 | 8.7 ± 2.8 | — | — | — | — | — |
| Mean Change | 4.8 ± 2.1 | 0.3 ± 1.2 | 4.5 (3.9 to 5.1) | <0.001* | <0.001* | 0.087 | 2.15 |
| Hip External Rotator Strength (kg) | | | | | | | |
| Baseline | 12.4 ± 3.2 | 12.6 ± 3.4 | — | 0.68 | — | — | — |
| Week 12 | 18.7 ± 3.8 | 12.8 ± 3.5 | — | — | — | — | — |
| Mean Change | 6.3 ± 2.5 | 0.2 ± 1.1 | 6.1 (5.4 to 6.8) | <0.001* | <0.001* | 0.159 | 2.41 |

*ICIQ-SF: International Consultation on Incontinence Questionnaire–Short Form; CI: Confidence Interval. Independent samples t-tests for between-group comparisons; paired t-tests for within-group comparisons; ANCOVA adjusted for baseline values and prespecified confounders (see text). Statistically significant at p < 0.05.

**Secondary Outcomes**

**Pelvic Floor Dysfunction Symptoms (PFDI-20)**

The PFDI-20 total score decreased significantly in the intervention group from 68.4 ± 18.2 to 42.1 ± 15.6 (mean change: −26.3 ± 12.4; within-group p < 0.001; Cohen's d = 2.13). The control group showed minimal change (mean change: −2.3 ± 8.1; within-group p = 0.007; Cohen's d = 0.28). The between-group difference was statistically significant (mean difference: −24.0; 95% CI: −27.2 to −20.8; p < 0.001;

Cohen's d = 2.10). The significant between-group difference was confirmed by ANCOVA with baseline value and prespecified confounders as covariates (adjusted mean difference: −23.5; 95% CI: −26.8 to −20.2; $F(1, 189) = 178.45$; $p < 0.001$; $\eta^2$ = 0.49). The change observed was above the MCID, which is 45 points [Table 3].

Subscale analysis revealed significant improvements in the intervention group across all three subscales: POPDI-6 (mean change: −8.2 ± 5.1; $p < 0.001$; Cohen's d = 1.61), CRADI-8 (mean change: −7.9 ± 4.8; $p < 0.001$; Cohen's d = 1.65), and UDI-6 (mean change: −10.2 ± 5.6; $p < 0.001$; Cohen's d = 1.82). All subscales showed statistically significant differences between groups ($p < 0.001$). None of the subscale changes surpassed the respective MCID value of each subscale [Table 3] (POPDI-6: 16.7; CRADI-8: 14.6; UDI-6: 16.7).

**Quality of Life (ICIQ-SF QoL Item)**

The ICIQ-SF QoL item improved significantly in the intervention group from 7.8 ± 2.4 to 4.9 ± 2.1 (mean change: −2.9 ± 1.8; within-group $p < 0.001$; Cohen's d = 1.61). The control group showed minimal change (mean change: −0.3 ± 1.2; within-group p = 0.016; Cohen's d = 0.25). The between-group difference was statistically significant (mean difference: −2.6; 95% CI: −3.1 to −2.1; $p < 0.001$; Cohen's d = 1.58). The overall significance of the difference between the groups remained after adjusting for baseline and prespecified (in the protocol) confounding values using ANCOVA (adjusted mean difference: −2.5; 95% CI: −3.0 to −2.0; $F(1, 189) = 98.76$; $p < 0.001$; $\eta^2$ = 0.34) [Table 3].

**Table 3: Secondary Outcomes at Baseline and Week 12 (Per-Protocol Analysis)**

| Outcome Measure | Intervention Group (n = 96) | Control Group (n = 96) | Between-Group Difference (95% CI) | Between-Group p-value | Within-Group p (Intervention) | Within-Group p (Control) | Cohen's d |
|---|---|---|---|---|---|---|---|
| PFDI-20 Total Score | | | | | | | |
| Baseline | 68.4 ± 18.2 | 69.1 ± 18.7 | — | 0.79 | — | — | — |
| Week 12 | 42.1 ± 15.6 | 66.8 ± 17.9 | — | — | — | — | — |
| Mean Change | −26.3 ± 12.4 | −2.3 ± 8.1 | −24.0 (−27.2 to −20.8) | <0.001* | <0.001* | 0.007* | 2.10 |
| POPDI-6 Score | | | | | | | |
| Baseline | 22.4 ± 7.8 | 22.8 ± 8.1 | — | 0.73 | — | — | — |
| Week 12 | 14.2 ± 6.2 | 22.1 ± 7.9 | — | — | — | — | — |
| Mean Change | −8.2 ± 5.1 | −0.7 ± 3.2 | −7.5 (−8.8 to −6.2) | <0.001* | <0.001* | 0.032* | 1.53 |
| CRADI-8 Score | | | | | | | |
| Baseline | 21.6 ± 7.2 | 21.9 ± 7.5 | — | 0.78 | — | — | — |
| Week 12 | 13.7 ± 5.8 | 21.4 ± 7.3 | — | — | — | — | — |
| Mean Change | −7.9 ± 4.8 | −0.5 ± 2.9 | −7.4 (−8.6 to −6.2) | <0.001* | <0.001* | 0.089 | 1.51 |
| UDI-6 Score | | | | | | | |
| Baseline | 24.4 ± 8.1 | 24.4 ± 8.3 | — | 0.98 | — | — | — |
| Week 12 | 14.2 ± 6.4 | 23.3 ± 8.0 | — | — | — | — | — |
| Mean Change | −10.2 ± 5.6 | −1.1 ± 3.4 | −9.1 (−10.5 to −7.7) | <0.001* | <0.001* | 0.042* | 1.63 |
| ICIQ-SF QoL Item | | | | | | | |
| Baseline | 7.8 ± 2.4 | 7.9 ± 2.5 | — | 0.78 | — | — | — |
| Week 12 | 4.9 ± 2.1 | 7.6 ± 2.4 | — | — | — | — | — |
| Mean Change | −2.9 ± 1.8 | −0.3 ± 1.2 | −2.6 (−3.1 to −2.1) | <0.001* | <0.001* | 0.016* | 1.58 |

*PFDI-20: Pelvic Floor Distress Inventory–Short Form; POPDI-6: Pelvic Organ Prolapse Distress Inventory; CRADI-8: Colorectal-Anal Distress Inventory; UDI-6: Urinary Distress Inventory; ICIQ-SF QoL: International Consultation on Incontinence Questionnaire–Short Form Quality of Life Item; CI: Confidence Interval. Independent samples t-tests for between-group comparisons; paired t-tests for within-group comparisons; ANCOVA adjusted for baseline values and prespecified confounders (see text). Statistically significant at $p < 0.05$.

**Correlation Analysis:** Within the intervention group (n = 96), relationships between the changes in hip external rotator strength (Δ hip ER strength) and changes in pelvic floor function outcomes were explored using Pearson correlation analysis. Scores were converted to change scores (week 12 – baseline). The normality of change scores were confirmed with the Shapiro-Wilk test, with all variables having a p-value greater than 0.05.

There was a significant positive correlation between the improvement in hip external rotator strength and the improvement in bladder base displacement (r =

0.62; 95% CI: 0.48 to 0.73; p < 0.001), suggesting higher gains in hip external rotator strength were correlated with higher gains in bladder base displacement. Increased hip external rotator strength was associated with decreased urinary incontinence severity and pelvic floor dysfunction symptoms (Table 4, r = −0.58; 95% CI: −0.70 to −0.43; p < 0.001; and r = −0.54; 95% CI: −0.67 to −0.38; p < 0.001, respectively).

**Table 4: Pearson Correlation Between Change in Hip External Rotator Strength and Changes in Pelvic Floor Outcomes (Intervention Group, n = 96)**

| Variable 1 | Variable 2 | r | 95% CI | p-value | Interpretation |
|---|---|---|---|---|---|
| Δ Hip ER strength (kg) | Δ Bladder base displacement (mm) | 0.62 | 0.48 to 0.73 | <0.001* | Strong positive |
| Δ Hip ER strength (kg) | Δ ICIQ-SF score | −0.58 | −0.70 to −0.43 | <0.001* | Strong negative |
| Δ Hip ER strength (kg) | Δ PFDI-20 total score | −0.54 | −0.67 to −0.38 | <0.001* | Strong negative |
| Δ Hip ER strength (kg) | Δ POPDI-6 score | −0.46 | −0.61 to −0.29 | <0.001* | Moderate negative |
| Δ Hip ER strength (kg) | Δ CRADI-8 score | −0.43 | −0.58 to −0.25 | <0.001* | Moderate negative |
| Δ Hip ER strength (kg) | Δ UDI-6 score | −0.51 | −0.65 to −0.34 | <0.001* | Strong negative |
| Δ Hip ER strength (kg) | Δ ICIQ-SF QoL item | −0.49 | −0.63 to −0.32 | <0.001* | Moderate negative |

*Δ = change score (week 12 − baseline); ER = external rotator; ICIQ-SF = International Consultation on Incontinence Questionnaire–Short Form; PFDI-20 = Pelvic Floor Distress Inventory–Short Form; POPDI-6 = Pelvic Organ Prolapse Distress Inventory; CRADI-8 = Colorectal-Anal Distress Inventory; UDI-6 = Urinary Distress Inventory; QoL = quality of life; CI = confidence interval. Statistically significant at p < 0.05.

## DISCUSSION

This quasi-experimental study demonstrated that 12 weeks of strengthening the hip external rotators in postmenopausal women associated with greater decrease in incontinence severity than in controls (ICIQ-SF difference −3.6 points). The intervention group also showed increased bladder base displacement and decreased PFDI-20 scores. Hip strength gains showed a correlation with improvements in pelvic floor outcomes (r = 0.62, bladder base displacement) that did not change after covariate adjustment of hip strength gains for age, BMI and parity.

These results are consistent with previous studies. In nulliparous women, hip external rotator strength was found to be an independent predictor of pelvic floor muscle function, irrespective of hip flexor, abductor and handgrip strength.[11] It has been reported that same association was true for postmenopausal women and that it seemed to be evident on change, not just for cross-sectional data. In a randomized study by Zhang et al, postpartum women with stress incontinence had higher efficacy rate with the addition of hip training to the standard rehabilitation than those who received standard rehabilitation alone (94.4% vs. 74.6%).[15] The proposed mechanism is the anatomical adhesion of the obturator internus and the pelvic floor, and the continuity of the fascia. This was a proposed explanation, as present study did not measure muscle activation.

In yhealthy women, maximal-effort isometric hip adduction and abduction were associated with downward displacement of the bladder base, with greater displacement witnessed in relation to hip muscle strength.[12] Whether this increased bladder displacement is a sign of increased bladder function, depends on when and how it is measured. The optimal exercise target also remains undetermined, as modified lumbo-pelvic exercise has also been investigated in the treatment of mild stress incontinence in middle aged women.[16]

The postmenopausal context is also relevant to these findings. The pelvic floor musculature contains oestrogen receptors and oestrogen depletion affects urogenital tissue.[6] It has been reported that the levator hiatus widens after menopause leading to reduced strength of the pelvic floor muscles, and prevalence of incontinence is increased after menopause.[2] Sarcopenia and pelvic floor disorders also share common risk factors, such as physical inactivity and menopausal hormonal changes.[16] In this age group, strengthening a large proximal muscle group could therefore be of broader benefit than strengthening the pelvic floor alone. The present study did not measure or record genitourinary syndrome of menopause status or use of vaginal oestrogen, which might affect the results.

The clinical relevance must be carefully interpreted. The ICIQ-SF between-group difference of −3.7 exceeds reported minimal important differences of about 1.5 to 1.9 points.[17,18] Within-group change of −4.2 is close to the clinically important difference noted following conservative treatment (approximately 4.0–4.6).[18] The PFDI-20 change is negative with a score of −26.3 which is greater than the minimal important change of 20.83 reported after PFMT. However, none of the subscale changes were at the respective thresholds and the smallest detectable change (55.6) in the PFDI-20 is significantly higher than our group mean.[19] Thresholds also vary by population, anchor and method,[20] so these comparisons are indicative only.

PFMT has been consistently supported by reviews in postmenopausal incontinence,[7,8,10] but no consensus was found on how to optimize PFM use and training protocols showed large variability.[9,10] Effect sizes above d = 2 for pelvic floor outcomes are unusually large for a conservative intervention and should be treated cautiously. Since there was no comparison arm of PFMT, it is not possible to determine if hip strengthening is an alternative or an addition to PFMT.

There are some limitations of causal inference. Baseline characteristics were balanced, but there was a risk of selection bias, given non-random allocation. The primary result was subjective, thus expectancy effects are possible. Improvements in controls are slight but significant which could be a Hawthorne effect or regression to the mean. However, the effects of the per-protocol analysis might be inflated and the correlations were only computed within the intervention group and not actually representing the mediation of the change in the pelvic floor by hip strength. Follow up was not done beyond 12 weeks, so there was no indication of the long-term effects of the treatment.

In summary, hip external rotator strengthening was correlated with the outcome of the pelvic floor in post-menopausal women as indicated in the literature. Randomised, blinded trials with PFMT comparators, objective muscle measurement and longer follow-up are required before PFMT can be recommended for use in practice.

## CONCLUSION

In postmenopausal women, 12 weeks of hip external rotator strengthening was linked to a decrease in severity of incontinence, improvement in bladder base displacement, and a decrease in pelvic floor symptom scores as compared to controls. There was an association between increased hip strength and increased outcomes of pelvic floor. Based on these results, it is hypothesized that strengthening exercises for hip external rotators could be a helpful intervention in addition to a pelvic floor muscle training intervention; however, these are preliminary results due to the non-randomised design, short follow-up period, and absence of a pelvic floor muscle training comparison group. Further longer term, randomized, blinded trials are required before widespread clinical adoption.

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