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Pelvic Floor Muscle Training for Older Women with Urinary Incontinence

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Abstract

Purpose of Review To review and discuss the efficacy of pelvic floor muscle training (PFMT) for urinary incontinence (UI) in older women.

Recent Findings As opposed to UI in young and middle-aged women, UI in older women is often multifactorial. One randomized control trial (RCT) and secondary analyses from four RCTs suggest that healthy older women with UI benefit from PFMT as much as younger women. In older women with UI, 12 RCTs support PFMT as an effective treatment. Of interest, recent RCTs propose a more holistic approach to PFMT to address concurrent cognitive, gait, and balance deficits in older incontinent women.

Summary *What answers did you find*?: PFMT is an effective treatment for UI in older women and should be recommended as first-line treatment regardless of age. Further high-quality trials are needed to validate new PFMT holistic approaches on multifactorial aspects of UI in older women.

Keywords Urinary incontinence · Pelvic floor muscles · Pelvic floor muscle training · Pelvic floor physiotherapy · Aging women

Introduction

Urinary incontinence (UI) is one of the most prevalent conditions in older women and is defined as *any involuntary leakage of urine*, ranging from a few drops to the total loss of bladder control [1]. Up to 55% of older women suffer from UI and 20 to 25% of them regularly experience severe symptoms (> 10 episodes/week) [2]. Beyond its impact as a serious medical condition, UI also engenders shame and even depression, reduces social interactions, and physical activities. UI is also associated with sleep disturbance and an increased risk of falls, hip fractures, and nursing home admissions [2]. The majority of older women believe UI is a normal part of aging. Consequently, fewer than half of women afflicted report the condition to their healthcare provider [3].

Pelvic floor muscles (PFM) play an important role in maintaining urinary continence [4, 5]. Pelvic floor muscle training (PFMT) refers to the regular supervised practice of repetitive PFM contractions in order to train PFM [6]. The aim is to improve (1) resting tone, structural support, muscle strength, and volume and (2) coordination so that PFM may more effectively react to sudden increases in intra-abdominal pressure (e.g., coughing) [6, 7••]. The latest Cochrane review on PFMT in women with UI indicates that intensive supervised PFMT can cure or improve stress, mixed, and urgency UI in the short and medium-term [7••]. The Society of Obstetricians and Gynaecologists of Canada, the Canadian Urological Association, the 5th International Consultation on Incontinence [8], and the National Health Service have released national or international clinical practice guidelines for UI in which they are recommending PFMT as first-line treatment for UI in women.

However, PFMT is often perceived by patients and clinicians as less effective in older women because of age. Very few clinical trials have studied the effect of age on PFMT efficacy. Additionally, few studies have assessed the effectiveness of PFMT in an older population. The objective of this manuscript was to review and discuss the literature on efficacy of PFMT in older women. To this end, the following sections present:

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- An overview of UI specificity in older women
- Trials comparing effectiveness of PFMT in younger and older women
- PFMT trials specific to older women with UI

Overview of UI Specificity in Older Women

In older women, UI is often a complex problem associated with menopause and age-induced changes to PFM, in addition to co-existing illnesses and comorbidity [9].

Menopause and Age-Induced Changes to PFM

Although it is difficult to separate the effects of hormonal changes due to menopause from physiological muscle loss associated with aging, both variables have been linked to morphological and functional changes in PFM [10•]. Additionally, a reduction in PFM support in older women with UI after menopause was observed using imaging technologies (MRI and US). These changes include lower pelvic floor structures, enlarged levator hiatus, and increased displacement of the bladder neck upon physical effort (i.e., cough) in older women with stress and mixed UI compared with continent older women. Furthermore, reduced PFM contractile capacity was observed through a thinning of PFM and shortening of the hiatus upon contraction in older women with stress and mixed UI compared with continent older women [11–13]. Additionally, morphological deficits present in older women appeared to be specific to each UI subtype: stress UI (leakage on sneezing/coughing) or mixed UI (incontinence on sneezing/coughing and urgency) [14]. Older women with mixed UI seem to have lower PFM resting positions and lower pelvic organ support at rest than those with stress UI or continent older women. In contrast, older women with stress UI had a higher bladder neck funneling occurrence than women with mixed UI or continent older women. Finally, PFM resting pressure or tone, maximum voluntary contractions, and coordination appear to be significantly deficient in older women with UI compared with continent women [15–19]. All these findings suggest the need for different PFMT programs specifically targeting the deficits underlying stress or mixed UI in older women.

Co-Existing Illnesses and Comorbidity

Concurrent external factors to menopause and aging may also alter PFM function and predispose older women to UI. For example, the risk of weight gain increases with menopause [20]. In addition to central adiposity, it has been hypothesized that increased intra-abdominal pressure associated with weight gain may contribute to pelvic floor dysfunction. Increased intra-abdominal pressure could therefore weaken PFM, exacerbating stress UI, and possibly, urgency UI [21]. Epidemiological research has shown that increased body mass index is an independent risk factor for all types of UI in women [22].

Furthermore, chronic cough and constipation, as well as other health conditions, such as diabetes, become more prevalent with age. These may further impact normal functioning of PFM, either through a chronic increase in intra-abdominal pressure (recurrent coughing and straining) or through neuropathy (diabetes) [23, 24].

Age-Related Cognitive Changes and UI

Older women with mixed UI typically demonstrate poorer performance on cognitive tests [25]. A study by Lussier et al. has shown that these deficits are linked to switching and sharing/dividing attention between multiple tasks [25]. These results suggest that urgency and mixed UI could be associated with executive control deficits in older women. Therefore, PFMT programs tailored to older women with mixed UI should also ideally take into consideration cognitive changes occurring with age.

Effect of Lower Extremity Strength, Balance and Mobility on UI

Similar to the link between risk of falls and UI in aging women [26–28], lower extremity strength, balance, and mobility may also be linked to UI. While some researchers found no difference in lower extremity strength between older women with and without UI [29–31, 32•], others have published contrasting results, where older women with UI showed decreased lower extremity muscle strength, compared with older women without UI [28, 33–35]. Interestingly, studies using dynamometry found no difference in lower leg strength, whereas studies using functional tasks such as sit-to-stand tests obtained contrary results. Additionally, it has been suggested that women under age 75 with UI may be less likely to have reduced lower extremity muscle strength than those over age 75 [32•]. Several studies have observed a decrease in balance in older women with UI, compared with continent older women [28, 31, 32•, 33, 36]. Finally, UI, mobility, and gait also appear to be linked in older women. Older women with UI demonstrated poorer performance in gait-related tasks, such as the Timed Up and Go test, compared with continent older women [28, 34, 37, 38]. Older women with UI have demonstrated slower gait speeds than continent older women in several studies [28, 29, 32•, 33–35, 39]. In a recent study, older women with UI, who were experiencing a strong desire to void, had slower gait speeds, shorter stride lengths, and increased gait variability [40•]. Although these alterations of gait parameters also occurred in continent women, women with UI had slower baseline gait speeds (without the strong desire to void). Slower gait speed for women with UI may increase the risk of falling

backwards [40•]. Hence, all these elements are important to include in the assessment/rehabilitation interventions of older women with UI, particularly for urgency UI or mixed UI. Therefore, PFMT programs tailored to older women with UI should also ideally take into consideration age-related changes in the lower extremities.

Overall, PFM functional and morphological dysfunctions in older women with UI are specific to this population and their incontinence subtype. There is a possible link between mixed UI and executive control deficits. In addition, mixed and urge UI is associated with lower extremity strength, balance, and mobility deficits in older women. Once more, all these findings support the complexity of UI pathophysiology in older women and highlight the need for specific PFMT programs for this subpopulation.

Trials Comparing Effectiveness of PFMT in Younger and Older Women

As age groups are not commonly distinguished in studies investigating PFMT efficacy in women, it was not possible to find literature with a direct comparison between older and younger women with a clear age cutoff. To our knowledge, only one study compared the efficacy of PFMT in premenopausal (between age 18 and 47) versus postmenopausal women (between age 65 and 88) [41]. All 120 women (41 premenopausal and 79 postmenopausal) participated in five to nine individual PFMT sessions (number of sessions allocated according to severity of symptoms and progress) of 30–45 min with a specialized PFMT physiotherapist, over a period of 3 months. Training sessions were comparable in duration and content. Fifty-nine percent of premenopausal and 70% of postmenopausal patients reported no incontinence or no relevant symptoms of incontinence ($P = 0.16$). Sixty-eight percent of premenopausal and 81% of postmenopausal patients attained their personal goal ($P = 0.09$), while 15% of premenopausal and 14% of postmenopausal patients reported the need of incontinence surgery 30 to 102 months post intervention ($P = 1.0$). Therefore, based on one RCT, menopausal status does not appear to be associated with PFMT outcomes. Several RCTs have assessed age as a predicting factor of PFMT efficacy in secondary analyses for UI in women. Contradicting results were found with some studies reporting that older participants had worse outcomes [42], and other studies showing no relationship between age and treatment effects [43–46]. These preliminary results support the following statement from the Conservative Management chapter of the International Consultation on Incontinence: *older women seem to benefit from PFMT as much as younger women* [47, 48].

Literature Specific to PFMT for Urinary Incontinence in Older Women

Two systematic reviews (one in 2012 [49] and the other in 2015 [50]) identified five RCTs investigating the effect of PFMT on UI symptoms and quality of life (QOL) in older women (age 65 and over). Using the same strategies as the 2015 review, this present updated search found seven additional RCTs. Details on each of the 12 trials can be found in Tables 1 and 2. Participants included in these trials were age 60 and over. The types of UI studied were stress UI ($n = 6$) or all UI types ($n = 6$). The trial size was small (less than 50 participants) in three trials, moderate (between 50 and 100 participants) in five trials, and large (higher than 100 participants) in four trials. Trial quality was mostly moderate with 11/12 reporting on randomization, 5/12 on blinding evaluators, and 8/12 reporting an intention-to-treat analysis. PFMT programs varied in duration from 1 week to 5 months, with one to three visits per week with the physiotherapist, while one trial prescribed home PFM exercises. Correct PFM contraction was confirmed prior to training using intravaginal evaluation in 5/12 trials. Outcomes of interest included patient reported cure, cure and improvement, UI episodes on the bladder diary, UI-specific symptoms, QOL questionnaires, leakage amount on the paper towel test, in addition to other lower urinary tract symptoms such as frequency, nocturia, and urgency. Based on the intervention component, two subgroups were identified: those with PFMT as the main comparator and those with a more holistic approach to incontinence rehabilitation in older women (PFMT +) as the main comparator.

Pelvic Floor Muscle Training Trials

Seven trials corresponded to this category: four trials compared PFMT with a control group [52, 53, 54••, 60], two trials compared PFMT + bladder training (patient education program and scheduled voiding regimen with gradually adjusted voiding interval) [1] with a control intervention [51, 61, 62], and one compared PFMT with bladder training [63]. RCTs comparing PFMT with no treatment were favorable for PFMT and showed a reduction in UI signs and symptoms, improving UI-specific QOL, and satisfaction. Trials comparing PFMT + bladder training to bladder training alone proved to favor PFMT + bladder training in reducing UI symptoms and improving UI-specific QOL. Finally, in an RCT comparing PFMT with bladder training, PFMT proved to be more effective to reduce frequency and severity of incontinence episodes and improve UI-specific QOL in women with stress UI after 20 weeks [63].

Table 1 Studies on pelvic floor muscle training for urinary incontinence in older women

1st author (year) Country	Population	Intervention	Comparison group	Outcomes/findings related to UI
Aslan (2008) [51] Turkey	Women living in nursing home with SUI, MUI, or UUI, aged ≥ 65 $n = 64$ (dropout $I = 8$, $C = 6$) Mean age: $I = 78.88$, $C = 79.44$ UI Severity: leakage ≥ 2/month	Individual training with education, PFMT and bladder training, session duration, and frequency not reported. Duration, 6 to 8 weeks	No intervention Duration, 6 to 8 weeks	• Significant decrease in urgency (52%), frequency (64%), and nocturia (32%) symptoms at 8 weeks and 6 months, compared with the control group • Significant increase in pelvic floor muscle strength in the intervention group
Kargar Jahromi (2015) [60] Iran	Community-dwelling women with SUI, aged 60–74 $n = 50$ (dropout $I = 1$, $C = 1$) Mean age: $I = 67.15$, $C = 68.05$ Severity of incontinence: urine leakage ≥ 2 per week for 90% (I) and for 93.3% (C)	Exercise class with an educational component, PFMT, body awareness, breathing, relaxation, and strength training, 45 min/session, once/week + home-based exercises, 3 times/week. Duration, 8 weeks	No intervention. Duration, 8 weeks	• Significantly lower scores on the ICIQ-UI SF at 2 months in the intervention group compared with the control group (mean, SD): $I = 9.07$ (2.33), $C = 12.30$ (3.6)
Leong (2015) [52] Hong Kong	Community-dwelling women with SUI, MUI, or UUI, aged > 65 years $n = 55$ (drop out $I = 0$, $C = 0$) Mean age: $I = 73.0$, $C = 75.4$ Severity of incontinence: mean of 11.0 (I) and 8.0 (C) urine leakages per week	Individual physiotherapy sessions with education, PFMT, and bladder training, 30 min/session, once a week for the first 4 weeks and bi-weekly afterwards. Duration, 12 weeks	Educational pamphlet with information about UI management, no other intervention. Duration, 12 weeks	• Significant reduction in the number of incontinent episodes at 3 months in the intervention group compared with the control group, (mean, SD): $I = 1.0$ (1.9), $C = 7.4$ (6.2) • Significant improvement in the quality of life at 3 months in the intervention group compared with the control group (mean Incontinence Impact Questionnaire score, SD): $I = 1.1$ (1.2), $C = 5.0$ (2.8)
McFall (2000) [61, 62] USA	Community-dwelling women with UI, aged ≥ 65 $n = 145$ (drop out $I = 23$, $C = 14$) Mean age: $I = 73.9$, $C = 75.6$ Severity of incontinence: urine leakage frequency not reported	Community-based program in group with education, bladder training, relaxation, PFMT, and social support Duration, 9 weeks	No intervention Duration, 9 weeks	• Significantly higher symptoms improvement in the intervention group compared with the control group (change in the number of incontinent episodes at 3 months) • Significantly decreased impact of UI on sexual intercourse, relationships with family, and relationships with husbands in the intervention compared with the control group
Miller (1998) [53] USA	Community-dwelling women with SUI, aged ≥ 60 $n = 27$ (dropout $I = 0$, $C = 0$) Mean age 68.4 UI severity: urine leakage ≥ 1 and ≤ 5 leaks per day, mean of 1.36 urine leakage per day	Individual assessment/consultation and education with a nurse to ensure adequate pelvic floor contraction. Duration, 1 week	No intervention. Duration, 1 week	• Significantly reduced urine loss on medium and deep cough, Paper Towel Test at 1 week (mean square centimeters of wetness area, SD): $I = 0.4$ (1.04) with knack, $C = 23.8$ (46.5) and $I = 5.4$ (15.3) with knack, $C = 26.8$ (46.7) respectively • No increase in pelvic floor muscle strength within 1 week
Radzimińska (2018) [54••] Poland	Community-dwelling women with SUI, aged ≥ 60 $n = 84$ (dropout $I = 4$, $C = 6$) Median age: $I = 69.5$, $C = 69.5$ Severity of incontinence: urine leakage frequency not reported	Exercise class with an educational component and PFMT, 45 min/session, three times a week. Duration, 4 weeks	No intervention. Duration, 4 weeks	• Significant improvement in SUI severity at 4 weeks in the intervention group compared with the control group (Revised Urinary Incontinence Scale score (0–13), median): $I = 6.00$, $C = 9.00$ • Significant decrease in myostatin concentration at 4 weeks (ng/mL, median): $I = 121.15$, $C = 153.08$

Table 1 (continued)

1st author (year) Country	Population	Intervention	Comparison group	Outcomes/findings related to UI
Sherburn (2011) [63] Australia	Community-dwelling women with urodynamic verified SUI, aged ≥ 65 $n = 83$ (drop out $I_1 = 2$, $I_2 = 5$) Mean age: $I_1 = 71.6$, $I_2 = 72$ Severity of incontinence: median of 8.5 (I_1) and 15.0 (I_2) urine leakages per week	Individual assessment/consultation with a physiotherapist (0–4 times) to ensure adequate pelvic floor contraction. Exercise class with an educational component and PFMT, 1 h/session, once a week. Home-based exercises at a suggested intensity of 7 times/week (I_1). Duration, 5 months	Individual assessment/consultation with a physiotherapist (0–4 times) to ensure adequate pelvic floor contraction. Gentle exercise class including stretches, with breath awareness and relaxation (no PFMT), education, bladder training, and group discussions (I_2). Duration, 5 months	• Significantly lower amounts of leakage during the cough test at 5 months in both groups, significant more in I_1 compared with I_2 (grams of urine loss, median): $I_1 = 0.1$, $I_2 = 0.5$ • Significantly more improvement in the ICIQ-UI SF scores at 5 months in I_1 compared with I_2 (mean, SD): $I_1 = 5.9$ (3.3), $I_2 = 8.5$ (4.4) • Significantly higher global perception of change at 5 months in I_1 compared with I_2 • Significantly lower number of weekly urine leakages at 5 months in I_1 compared with I_2 (median): $I_1 = 4.0$, $I_2 = 9.5$ • Significantly improved quality of life in both groups at 5 months (mean Assessment of Quality of Life total score, SD): $I_1 = 8.7$ (4.8), $I_2 = 8.9$ (5.2)

I, intervention group; *C*, comparison group; *UI*, urinary incontinence; *SUI*, stress urinary incontinence; *MUI*, mixed urinary incontinence; *UUI*, urgency urinary incontinence; *PFMT*, pelvic floor muscle training; *SD*, standard deviation; *ICIQ-UI SF*, International Consultation on Incontinence Questionnaire-Urinary Incontinence Short Form

Table 2 Studies on pelvic floor muscle training with additional treatment modalities in older women with UI

1st author (year) Country	Population	Intervention	Comparison group	Outcomes/findings related to UI
Kim (2007) [55] Japan	Community-dwelling women with SUI, aged ≥ 70 $n = 70$ (drop out $I = 4$, $C = 3$). Mean age: $I = 76.6$, $C = 76.6$ Severity of incontinence: urine leakage ≥ 1 per month	Exercise class with an educational component, PFMT, and fitness exercises, 1 h/session, twice a week. Duration, 12 weeks. Additional follow-up period included the same program, 1 h/session, once a month and home-based exercises at a suggested intensity of 30 min/session, twice a week. Duration, 1 year	No intervention. Duration, 12 weeks	• Significant decrease in the mean frequency score of urine leakage at 3 months in the intervention group and not in the control group (0–5 with 0 = no urine leakage and 5 = everyday leakage), (mean, SD): $I = 1.5$ (1.8), $C = 2.4$ (1.4) • Cure rate at 3 months, %: $I = 54.5\%$, $C = 9.4\%$
Kim (2011) [56] Japan	Community-dwelling women with SUI, MUI, or UUI, aged ≥ 70 $n = 147$ (drop out $I_1 = 0$, $I_2 = 2$, $C = 2$). Mean age: $I_1 = 75.7$, $I_2 = 76.7$, $C = 75.8$ Severity of incontinence: urine leakage ≥ 1 per month	Exercise class with stretching, PFMT, and fitness exercises, twice a week, alone (I_1), or with a daily heat and steam generating sheet application on lower back (I_2). Duration, 12 weeks	General education on health topics, once a month. Duration, 12 weeks	• Significant improvement in both intervention groups and not in the control group, cure rate at 3 months, %: $I_1 = 53.8\%$ for SUI, 16.7% for UUI, 30.0% for MUI; $I_2 = 61.5\%$ for SUI, 50.0% for UUI, 40.0% for MUI; $C = 9.1\%$ for SUI, 0.0% for UUI, 0.0% for MUI • Significantly lower frequency of urine leakage for SUI and UUI in both intervention groups and not in the control group
Kim (2011) [57] Japan	Community-dwelling women with SUI, MUI, or UUI, aged ≥ 70 years $n = 127$ (drop out $I = 4$, $C = 3$) Mean age: $I = 76.1$, $C = 75.7$ Severity of incontinence: urine leakage ≥ 1 per week	Exercise class with stretching, PFMT, and fitness exercises. Duration, 12 weeks	General education on health topics, once a month Duration, 12 weeks	• Significantly higher cure rate in the intervention group compared with the control group at 3 months ($I = 44.1\%$, $C = 1.6\%$) and 7 months ($I = 39.3\%$, $C = 1.6\%$) • Significant decrease in the frequency score of urine leakage (0–5 with 0 = no urine leakage and 5 = everyday leakage) in the intervention group compared with the control group at 3 and 7 months
Virtuoso (2019) [58] Brazil	Community-dwelling women with SUI, aged ≥ 60 $n = 32$ (dropout $I = 2$, $C = 4$). Mean age: $I = 64.8$, $C = 66.5$ Severity of incontinence: urine leakage ≥ 2/week	PFMT and weight training, 50 min/session, twice a week. Home-based exercises at a suggested intensity of 30 contractions per day. Duration, 12 weeks	PFMT only, 30 min/session, twice a week. Home-based exercises at a suggested intensity of 30 contractions per day. Duration, 12 weeks	• Significantly higher rate of absence of symptoms at 4 months in the intervention group compared with the control group: $I = 58.3\%$, $C = 14.8\%$ • No significant differences in the reduction in International Consultation on Incontinence Questionnaire-Urinary Incontinence Short Form scores (mean differences, SD): $I = 8.0$ (5.6), $C = 9.1$ (5.0) • Similar decrease in UI with sneezing, coughing, and laughing in both groups.
Wagg (2019) [59••] Bangla-desh	Community-dwelling women with SUI, MUI, or UUI, aged 60–75 $n = 625$ (dropout $I = 37$, $C = 9$) Mean age: $I = 64.5$, $C = 64.7$ Severity of incontinence: mean of 12.6 (I) and 11.3 (C) urine leakages over 3 days	Exercise class with an educational component, PFMT, and brisk walking, 1 h/session + 30 min of walking, twice a week. Duration, 12 weeks	Educational classes, 1 h/session, twice a week. Duration, 12 weeks	• Significantly lower number of leakage episodes over 3 days at 24 weeks in the intervention group compared with the control group (mean, SD): $I = 1.7$ (1.0), $C = 8.2$ (2.4)

I, intervention group; *C*, comparison group; *UI*, urinary incontinence; *SUI*, stress urinary incontinence; *MUI*, mixed urinary incontinence; *UUI*, urgency urinary incontinence; *PFMT*, pelvic floor muscle training; *SD*, standard deviation

Pelvic Floor Muscle Training + Trials

Five trials were consistent with this category: two trials compared PFMT + general fitness exercises with a control group [55, 57], one trial compared PFMT + walking with a control group [59••], one trial compared PFMT + strength training with a PFMT alone [58], and one compared PFMT + general fitness exercises with PFMT + general fitness exercises and local heat [56]. Both RCTs on PFMT + general fitness (body awareness, breathing, relaxation, and strength training for the trunk and lower extremities) proved to be more effective than the control for UI cure, walking speed, and adductor muscle strength after intervention and at follow-up, for all types of UI and with greater effect on stress UI. In the PFMT + brisk walking trial, improvement of UI symptoms was found in both treatment arms, but patients in the PFMT + brisk walking group had fewer leakage episodes than the education-only group. PFMT + strength training (moderate intensity weight training) reduced UI symptoms earlier in the intervention, with its advantage over the other treatment disappearing after the 12-week intervention. In another trial, PFMT + general fitness exercise and PFMT + general fitness exercise + local heat demonstrated significant improvements in muscle strength and walking speed compared with the education group. Moreover, the group with local application of heat (thin flexible sheet generating heat and steam) showed a higher UI cure rate, than the treatment group without heat application, after a 12-week intervention.

Despite unfavorable conditions for older women (longer duration and more severe UI symptoms, higher prevalence of urgency UI and mixed UI, which are more difficult to treat, the presence of structural age and hormone-related changes, potential co-morbidities, in addition to lower extremity strength, balance, mobility, and cognitive deficits), our review shows that PFMT and PFMT + reduce incontinence symptoms immediately after treatment and in the medium term in older women. These findings suggest that older women are able to integrate motor learning strategies like the "Knack" [53], as well as improve PFM neuromuscular function to reduce urinary leakage [51]. To this end, Aslan reported secondary outcomes supporting this increase in PFM morphometry and function [51]. Furthermore, an RCT by Alves et al. [64], on the impact of a PFMT program on PFM contractility in postmenopausal women with UI, found an increase in PFM electromyography (EMG) activity and a higher grade on the digital palpation scale after PFMT, when compared with the control intervention. Additionally, a cohort study measuring the impact of PFMT on PFM function and morphometry in older women with UI [65, 66] found positive changes in PFM function (as measured with dynamometry), the urethral sphincter and PFM morphometry (as measured with MRI) after PFMT. Finally, in a pre-post cohort study, Radziminska et al. [54••] studied biochemical changes occurring after PFMT in older women with UI. They measured myostatin levels, since the inhibition of serum myostatin increases muscle strength and mass. They found that PFMT caused a down-regulation of myostatin concentrations, which supports the increase in muscle morphometry and function observed after PFMT in previous studies.

Of great interest, a large number of RCTs compared a more holistic approach with PFMT in an inactive/active control group [55–58, 59••]. This new approach is based on present knowledge (detailed previously) of concurrent cognitive, gait, and balance deficits in older women with UI, particularly those with mixed UI and urgency UI. To this end, Kim et al. [55–57] and Wagg et al. [59••] trained gait and lower extremity strength in addition to PFMT. In an earlier cohort study, Elliott and Dumoulin [65] used a PFMT+ cognitive, gait, and balance training program to treat UI in older women. Results supported the value of this holistic approach not only to reduce leakage frequency and quantity and improve PFM function [65] but also to improve gait stability and cognitive performance during dual tasks [67•].

A more holistic approach of PFMT consisting of PFMT + lower extremity strength, mobility, and cognitive training could have potential advantages over PFMT alone to treat UI signs and symptoms specific to this subpopulation. There is however no RCT to date comparing standard PFMT with a more holistic approach. Further high-quality trials are needed to validate these new holistic PFMT approaches on multifactorial aspects of UI in older women. This is especially important because of the rapidly aging population, which is at risk of UI and its associated psychosocial and economic burdens.

Conclusion

UI in older women is specific to the complexity of its pathophysiology (aging, hormonal changes, comorbidities and strength, mobility, and cognitive deficits). Evidence to date suggests that healthy older women with UI benefit from PFMT as much as younger women. In older incontinent women, PFMT benefits are shown across all types of UI, using different PFMT regimens and as assessed by multiple outcomes. PFMT should be promoted, as first-line treatment, to all older women with UI.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflicts of interest.

Human and Animal Rights This article does not contain any studies with human or animal subjects performed by any of the authors.

References

Papers of particular interest, published recently, have been highlighted as:
- • Of importance
- •• Of major importance

1. Haylen BT, De Ridder D, Freeman RM, Swift SE, Berghmans B, Lee J, et al. An International Urogynecological Association (IUGA)/International Continence Society (ICS) joint report on the terminology for female pelvic floor dysfunction. Neurourol Urodyn. 2010;29(1):4–20.
2. Milsom I, Altman D, Cartwright R, Lapitan M, Nelson R, Sjöström S, et al. Epidemiology of urinary incontinence (UI) and other lower urinary tract symptoms (LUTS), pelvic organ prolapse (POP) and anal (AI) incontinence. In: Abrams PHCL, Khoury AE, Wein A, editors. 6th Ed International consultation on incontinence. Bristol: International Continence Society; 2017. p. 1–142.
3. Dugan E, Roberts CP, Cohen SJ, Preisser JS, Davis CC, Bland DR, et al. Why older community-dwelling adults do not discuss urinary incontinence with their primary care physicians. J Am Geriatr Soc. 2001;49(4):462–5.
4. Ashton-Miller JA, DeLancey JO. On the biomechanics of vaginal birth and common sequelae. Annu Rev Biomed Eng. 2009;11:163–76.
5. Salvatore S, Rademakers K, DeLancey J, Igawa Y, Koelbl H, Laterza R, et al. Pathophysiology of urinary incontinence, faecal incontinence and pelvic organ prolapse. In: Abrams PHCL, Khoury AE, Wein A, editors. 6th Ed International consultation on incontinence. Bristol: International Continence Society; 2017. p. 361–496.
6. Bø K. Pelvic floor muscle training is effective in treatment of female stress urinary incontinence, but how does it work? Int Urogynecol J. 2004;15(2):76–84.
7. •• Dumoulin C, Cacciari LP, Hay-Smith EJC. Pelvic floor muscle training versus no treatment, or inactive control treatments, for urinary incontinence in women. Cochrane Database Syst Rev. 2018;(10) **This is a meta-analysis of studies assessing efficacy of PFMT for treatment of different types of UI in women of all ages.**
8. Abrams P, Andersson K, Apostolidis A, Birder L, Bliss D, Brubaker L, et al. Recommendations of the International Scientific Committee: evaluation and treatment of urinary incontinence, pelvic organ prolapse and faecal incontinence. In: Abrams PHCL, Khoury AE, Wein A, editors. 6th Ed International consultation on incontinence. Bristol: International Continence Society; 2017. p. 2549–612.
9. Wagg A, Kung Chen L, Johnson T II, Kirschner-Hermanns R, Kuchel G, Markland A, et al. Incontinence in frail older persons. In: Abrams PHCL, Khoury AE, Wein A, editors. 6th Ed International consultation on incontinence. Bristol: International Continence Society; 2017. p. 1309–442.
10. • Dumoulin C, Pazzoto Cacciari L, Mercier J. Keeping the pelvic floor healthy. Climacteric. 2019;22(3):257–62 **This is a review summarizing the direct and indirect changes to women's PFMs after menopause and due to aging.**
11. Weemhoff M, Shek KL, Dietz HP. Effects of age on levator function and morphometry of the levator hiatus in women with pelvic floor disorders. Int Urogynecol J. 2010;21(9):1137–42.
12. Constantinou C, Hvistendahl G, Ryhammer A, Nagel LL, Djurhuus J. Determining the displacement of the pelvic floor and pelvic organs during voluntary contractions using magnetic resonance imaging in younger and older women. BJU Int. 2002;90(4):408–14.
13. Fradet S, Morin M, Kruger J, Dumoulin C. Pelvic floor morphometric differences in elderly women with or without urinary incontinence. Physiother Can. 2018;70(1):49–56.
14. Pontbriand-Drolet S, Tang A, Madill SJ, Tannenbaum C, Lemieux MC, Corcos J, et al. Differences in pelvic floor morphology between continent, stress urinary incontinent, and mixed urinary incontinent elderly women: an MRI study. Neurourol Urodyn. 2016;35(4):515–21.
15. Dumoulin C, Gravel D, Bourbonnais D, Lemieux M, Morin M. Reliability of dynamometric measurements of the pelvic floor musculature. Neurol Urodyn. 2004;23(2):134–42.
16. Trowbridge ER, Wei JT, Fenner DE, Ashton-Miller JA, DeLancey JO. Effects of aging on lower urinary tract and pelvic floor function in nulliparous women. Obstet Gynecol. 2007;109(3):715–20.
17. Morin M, Gravel D, Bourbonnais D, Dumoulin C, Ouellet S. Reliability of dynamometric passive properties of the pelvic floor muscles in postmenopausal women with stress urinary incontinence. Neurourol Urodyn. 2008;27(8):819–25.
18. Morin M, Bourbonnais D, Gravel D, Dumoulin C, Lemieux MC. Pelvic floor muscle function in continent and stress urinary incontinent women using dynamometric measurements. Neurourol Urodyn. 2004;23(7):668–74.
19. Gajdosik RL, Vander Linden DW, McNair PJ, Riggin TJ, Albertson JS, Mattick DJ, et al. Slow passive stretch and release characteristics of the calf muscles of older women with limited dorsiflexion range of motion. Clin Biomech. 2004;19(4):398–406.
20. Varady KA. Dietary strategies for weight loss in midlife women. Menopause. 2018;25(6):697–9.
21. Subak LL, Wing R, West DS, Franklin F, Vittinghoff E, Creasman JM, et al. Weight loss to treat urinary incontinence in overweight and obese women. N Engl J Med. 2009;360(5):481–90.
22. Hannestad YS, Rortveit G, Daltveit AK, Hunskaar S. Are smoking and other lifestyle factors associated with female urinary incontinence? The Norwegian EPINCONT Study. BJOG. 2003;110(3):247–54.
23. Bunyavejchevin S. Risk factors of female urinary incontinence and overactive bladder in Thai postmenopausal women. J Med Assoc Thail Chotmaihet thangphaet. 2005;88:S119–23.
24. McGarvey L, Ing A. Idiopathic cough, prevalence and underlying mechanisms. Pulm Pharmacol Ther. 2004;17(6):435–9.
25. Lussier M, Renaud M, Chiva-Razavi S, Bherer L, Dumoulin C. Are stress and mixed urinary incontinence associated with impaired executive control in community-dwelling older women? J Clin Exp Neuropsychol. 2013;35(5):445–54.
26. Brown JS, Vittinghoff E, Wyman JF, Stone KL, Nevitt MC, Ensrud KE, et al. Urinary incontinence: does it increase risk for falls and fractures? J Am Geriatr Soc. 2000;48(7):721–5.
27. Chiarelli PE, Mackenzie LA, Osmotherly PG. Urinary incontinence is associated with an increase in falls: a systematic review. Aust J Physiother. 2009;55(2):89–95.
28. Fritel X, Lachal L, Cassou B, Fauconnier A, Dargent-Molina P. Mobility impairment is associated with urge but not stress urinary incontinence in community-dwelling older women: results from the Ossebo study. BJOG Int J Obstet Gynaecol. 2013;120(12):1566–72.
29. Brown SJ, Seeley GD, Fong MJ, Black ED, Ensrud EK, Grady ED. Urinary incontinence in older women: who is at risk? Obstet Gynecol. 1996;87(5, Part 1):715–21.
30. Suskind AM, Cawthon PM, Nakagawa S, Subak LL, Reinders I, Satterfield S, et al. Urinary incontinence in older women: the role of body composition and muscle strength: from the health, aging, and body composition study. J Am Geriatr Soc. 2017;65(1):42–50.
31. Parker-Autry C, Houston DK, Rushing J, Richter HE, Subak L, Kanaya AM, et al. Characterizing the functional decline of older women with incident urinary incontinence. Obstet Gynecol. 2017;130(5):1025–32.

32.• Le Berre M, Morin M, Corriveau H, Hamel M, Nadeau S, Filiatrault J, et al. Characteristics of lower limb muscle strength, balance, mobility, and function in older women with urge and mixed urinary incontinence: an observational pilot study. Physiother Can. 2019;(aop):1–11 **This is a cohort study describing leg strength, balance and mobility in older women with and without incontinence.**

33. Tinetti ME, Inouye SK, Gill TM, Doucette JT. Shared risk factors for falls, incontinence, and functional dependence: unifying the approach to geriatric syndromes. J Am Med Assoc. 1995;273(17): 1348–53.

34. Seino S, Yabushita N, Kim M-J, Nemoto M, Jung S, Osuka Y, et al. Physical performance measures as a useful indicator of multiple geriatric syndromes in women aged 75 years and older. Geriatr Gerontol Int. 2013;13(4):901–10.

35. Huang AJ, Brown JS, Thom DH, Fink HA, Yaffe K. Group SoOFR. Urinary incontinence in older community-dwelling women: the role of cognitive and physical function decline. Obstet Gynecol. 2007;109(4):909–16.

36. Nelson PR, Irish KR, Cleary KK. Preliminary study on balance performance and fall status in older women with urinary incontinence. J Women's Health Phys Ther. 2015;39(3):102–8.

37. Ibrahim A, Singh DKA, Shahar S. 'Timed Up and Go' test: age, gender and cognitive impairment stratified normative values of older adults. PLoS One. 2017;12(10) (no pagination)):e0185641.

38. Gosch M, Talasz H, Nicholas JA, Kammerlander C, Lechleitner M. Urinary incontinence and poor functional status in fragility fracture patients: an underrecognized and underappreciated association. Arch Orthop Trauma Surg. 2015;135(1):59–67.

39. Ruggero CR, Bilton TL, Teixeira LF, Ramos Jde L, Alouche SR, Dias RC, et al. Gait speed correlates in a multiracial population of community-dwelling older adults living in Brazil: a cross-sectional population-based study. BMC Public Health. 2013;13:182.

40.• Paquin M, Duclos C, Dubreucq L, Lapierre N, Rousseau J, Meunier J, et al.. Impact of a strong desire to void on gait in continent and incontinent community-dwelling older women who have experienced fall in the last year. International Continence Society (ICS) Annual Meeting; 2018; Philadelphia. **This is a cohort study describing the impact of urinary urgency on gait in older women with and without incontinence**.

41. Betschart C, Mol SE, Lütolf-Keller B, Fink D, Perucchini D, Scheiner D. Pelvic floor muscle training for urinary incontinence: a comparison of outcomes in premenopausal versus postmenopausal women. Female Pelvic Med Reconstr Surg. 2013;19(4):219–24.

42. Labrie J, Lagro-Janssen A, Fischer K, Berghmans L, Van der Vaart CJ. Predicting who will undergo surgery after physiotherapy for female stress urinary incontinence. Int Urogynecol J. 2015;26(3): 329–34.

43. Wyman JF, Fantl JA, McClish DK, Bump RC. Comparative efficacy of behavioral interventions in the management of female urinary incontinence. Continence program for women research group. Am J Obstet Gynecol. 1998;179(4):999–1007.

44. Burgio KL, Goode PS, Locher JL, Richter HE, Roth DL, Wright KC, et al. Predictors of outcome in the behavioral treatment of urinary incontinence in women. Obstet Gynecol. 2003;102(5 Pt 1):940–7.

45. Hay-Smith J, Herbison GP, Wilson PD. Pevic floor muscle training for women with symptoms of stress urinary incontinence: a randomised trial comparing strengthening and motor relearning approaches. Neurol Urodyn. 2002;21(4):371–2.

46. Theofrastous J, Wyman J, Bump R, McClish D, Elser D, Bland D, et al. Effects of pelvic floor muscle training on strength and predictors of response in the treatment of urinary incontinence. Neurol Urodyn. 2002;21(5):486–90.

47. Dumoulin C, Adewuyi T, Booth J, Bradley C, Burgio K, Hagen S, et al. Adult conservative management. In: Abrams PHCL, Khoury AE, Wein A, editors. 6th Ed International consultation on incontinence. Bristol: International Continence Society; 2017. p. 1443–628.

48. Moore K, Dumoulin C, Bradley C, Burgio K, Chambers T, Hagen S, et al. Adult conservative management. In: Abrams PH, Cardozo L, Khoury AE, Wein A, editors. 5th International Consultation on Incontinence. Paris: International Consultation on Urologic Diseases-European Association of Urology (ICUD-EAU); 2013. p. 1101–227.

49. Pereira VS, Escobar AC, Driusso P. Effects of physical therapy in older women with urinary incontinence: a systematic review. Braz J Phys Ther. 2012;16(6):463–8.

50. Stenzelius K, Molander U, Odeberg J, Hammarström M, Franzen K, Midlöv P, et al. The effect of conservative treatment of urinary incontinence among older and frail older people: a systematic review. Age Ageing. 2015;44(5):736–44.

51. Aslan E, Komurcu N, Beji NK, Yalcin O. Bladder training and Kegel exercises for women with urinary complaints living in a rest home. Gerontology. 2008;54(4):224–31.

52. Leong B, Mok NW. Effectiveness of a new standardised Urinary Continence Physiotherapy Programme for community-dwelling older women in Hong Kong. Hong Kong Med J. 2015;21(1):30–7.

53. Miller JM, Ashton-Miller JA, DeLancey JO. A pelvic muscle precontraction can reduce cough-related urine loss in selected women with mild SUI. J Am Geriatr Soc. 1998;46(7):870–4.

54.•• Radzimińska A, Weber-Rajek M, Strączyńska A, Podhorecka M, Kozakiewicz M, Kędziora-Kornatowska K, et al. The impact of pelvic floor muscle training on the myostatin concentration and severity of urinary incontinence in elderly women with stress urinary incontinence–a pilot study. Clin Interv Aging. 2018;13:1893 **This is a randomized controlled trial assessing biochemical changes in PFM after training.**

55. Kim H, Suzuki T, Yoshida Y, Yoshida H. Effectiveness of multidimensional exercises for the treatment of stress urinary incontinence in elderly community-dwelling Japanese women: a randomized, controlled, crossover trial. J Am Geriatr Soc. 2007;55(12):1932–9.

56. Kim H, Yoshida H, Suzuki T. Effects of exercise treatment with or without heat and steam generating sheet on urine loss in community-dwelling Japanese elderly women with urinary incontinence. Geriatr Gerontol Int. 2011;11(4):452–9.

57. Kim H, Yoshida H, Suzuki T. The effects of multidimensional exercise treatment on community-dwelling elderly Japanese women with stress, urge, and mixed urinary incontinence: a randomized controlled trial. Int J Nurs Stud. 2011;48(10):1165–72.

58. Virtuoso JF, Menezes EC, Mazo GZ. Effect of weight training with pelvic floor muscle training in elderly women with urinary incontinence. Res Q Exerc Sport. 2019;90(2):141–50.

59.•• Wagg A, Chowdhury Z, Galarneau J-M, Haque R, Kabir F, MacDonald D, et al. Exercise intervention in the management of urinary incontinence in older women in villages in Bangladesh: a cluster randomised trial. Lancet Glob Health. 2019;7(7):e923–e31 **This is a randomized controlled trial on the effect of PFM exercice and brisk walking on urinary incontinence in older women.**

60. Jahromi MK, Talebizadeh M, Mirzaei M. The effect of pelvic muscle exercises on urinary incontinency and self-esteem of elderly females with stress urinary incontinency, 2013. Global J Health Sci. 2015;7(2):71.

61. McFall SL, Yerkes AM, Cowan LD. Outcomes of a small group educational intervention for urinary incontinence: episodes of incontinence and other urinary symptoms. J Aging Health. 2000;12(2):250–67.

62. McFall SL, Yerkes AM, Cowan LD. Outcomes of a small group educational intervention for urinary incontinence: health-related quality of life. J Aging Health. 2000;12(3):301–17.

63. Sherburn M, Bird M, Carey M, Bø K, Galea MP. Incontinence improves in older women after intensive pelvic floor muscle training: an assessor-blinded randomized controlled trial. Neurourol Urodyn. 2011;30(3):317–24.
64. Alves FK, Riccetto C, Adami DB, Marques J, Pereira LC, Palma P, et al. A pelvic floor muscle training program in postmenopausal women: a randomized controlled trial. Maturitas. 2015;81(2):300–5.
65. Elliott V, de Bruin ED, Dumoulin C. Virtual reality rehabilitation as a treatment approach for older women with mixed urinary incontinence: a feasibility study. Neurourol Urodyn. 2015;34(3):236–43.
66. Madill SJ, Pontbriand-Drolet S, Tang A, Dumoulin C. Changes in urethral sphincter size following rehabilitation in older women with stress urinary incontinence. Int Urogynecol J. 2015;26(2):277–83.
67.• Fraser SA, Elliott V, de Bruin ED, Bherer L, Dumoulin C. The effects of combining videogame dancing and pelvic floor training to improve dual-task gait and cognition in women with mixed-urinary incontinence. Games Health J. 2014;3(3):172–8 **This is a cohort study describing the impact of pelvic floor muscle training on dual-task gait and cognition, in older women with incontinence.**