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Determining the Optimal Pelvic Floor Muscle Training Regimen for Women with Stress Urinary Incontinence

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Pelvic floor muscle (PFM) training has received Level-A evidence rating in the treatment of stress urinary incontinence (SUI) in women, based on meta-analysis of numerous randomized control trials (RCTs) and is recommended in many published guidelines. However, the actual regimen of PFM training used varies widely in these RCTs. Hence, to date, the optimal PFM training regimen for achieving continence remains unknown and the following questions persist: how often should women attend PFM training sessions and how many contractions should they perform for maximal effect? Is a regimen of strengthening exercises better than a motor control strategy or functional retraining? Is it better to administer a PFM training regimen to an individual or are group sessions equally effective, or better? Which is better, PFM training by itself or in combination with biofeedback, neuromuscular electrical stimulation, and/or vaginal cones? Should we use improvement or cure as the ultimate outcome to determine which regimen is the best? The questions are endless. As a starting point in our endeavour to identify optimal PFM training regimens, the aim of this study is (a) to review the present evidence in terms of the effectiveness of different PFM training regimens in women with SUI and (b) to discuss the current literature on PFM dysfunction in SUI women, including the up-to-date evidence on skeletal muscle training theory and other factors known to impact on women's participation in and adherence to PFM training. *Neurourol. Urodynam. 30:746–753, 2011.* © 2011 Wiley-Liss, Inc.

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INTRODUCTION

National and international clinical practice guidelines recommend supervised pelvic floor muscle (PFM) training as a first-line treatment for stress urinary incontinence (SUI) in women (Level of evidence A).[1–4] The goal is to improve the functioning of the PFMs.[2] Essentially, PFM training can be prescribed to increase:

- PFM strength (the maximum force generated by a muscle in a single contraction),
- PFM endurance (the ability to perform repetitive contractions or to sustain a single contraction over time), and
- PFM coordination (muscular activity prior to effort and on exertion), or
- any combinations of these.

Supervised by a trained health professional, progressive PFM training involves various PFM exercises either with or without adjunctive biofeedback, electro-neurostimulation, intra-vaginal resistance, and/or a bladder diary.[1] The uncertainty about which of these strategies are most effective in training women to use their PFM to cure or improve symptoms of SUI has been identified by a wide panel of patients and experts to be one of the key clinical questions which needs to be prioritized.[5]

In order to determine the best regimen for treating SUI in women, this study begins with a review of the up-to-date evidence of the effectiveness of PFM training regimens alone as compared to no treatment or a placebo treatment, the evidence for the comparative effectiveness of different types of PFM training regimens and, finally, the evidence for PFM training in combination with various adjunct therapies.

PFM TRAINING ALONE VERSUS NO TREATMENT STUDIES

The effects of PFM training for women with urinary incontinence (UI) as compared to no treatment, a placebo or sham treatment were recently evaluated in a Cochrane Review.[2] The Cochrane Incontinence Group's Specialised Trials Register and the reference lists of relevant articles were searched (February 18, 2009). Randomized and quasi-randomized trials and the targeted population (women with stress, urgency, or mixed UI) were among the selection criteria. In this review, at least one component of each trial had to include PFM training. The comparators were no treatment, a placebo or a sham treatment, or another type of inactive control treatment.

Fourteen trials involving 836 women met the inclusion criteria. Within the 14 trials, only 8 (370 women) contributed data exclusively for women with SUI and were also suitable for analysis (Table I). There were considerable variations in the exercise regimens and often their descriptions were not extensive. Generally, the exercise programmes consisted of strength,

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TABLE I. PFM Training Programs From RCTs Comparing PFM Training to a Control

Refs.	Training type	Training program	Training duration	Notes
Miller et al.[19]	Coordination training (13) versus control (14)	VPFMC instructed confirmed by palpation Short programme aimed at improving coordination between a VPFMC and a rise in intra-abdominal pressure	1 week	Dropouts: none
Bø et al.[32]	Strength training (29) versus control (32)	VPFMC confirmed by palpation Set: 8–12 high-intensity maximal VPFMC with a 6–8 sec hold followed by 3–4 fast contractions at the end of each, and a 6 sec rest between maximal contractions Sets per day: 3 Exercises done in different body positions included supine, kneeling, sitting, and standing—all with the legs apart	6 months	Supervision: weekly 45 min exercise class Monthly clinic visit with physiotherapist Drop out: 4/29 PFMT, 2/32 controls
Aksac et al.[33]	Strength training (20) versus control (10)	VPFMC confirmed by palpation Set: 10 VPFMC, with 5 sec hold and 10 sec rest. Progressed at 2 weeks to 10 sec hold and 20 sec rest Sets per day: 3	8 weeks	Supervision: weekly visit Drop out: not stated
Yoon et al.[34]	Strength and endurance training (15) versus control (14)	VPFMC confirmed by surface electromyography with nurse Set: not stated (not clear if 30 total or 30 each), taking 15–20 min/day Strength: burst of intense activity lasting a few seconds Endurance: 6 sec holds progressed by 1 sec/week to 12 sec Sets per day: 30 VPFMC	8 weeks	Supervision: weekly clinic visit with nurse Drop out: 2/15 PFMT, 2/14 controls
Burns et al.[35]	Endurance training (43) versus control (40)	Set: 10 VPFMC with 3 sec hold, and 10 VPFMC with 10 sec hold. Progressed by 10 per set to daily maximum of 200 Sets per day: 4	8 weeks	Supervision: weekly exercise reminder cards mailed between visits Weekly clinic visits with nurse Drop out: 10 group not specified
Henalla et al.[36]	Endurance training (26) versus control (25)	Correct VPFMC taught by physiotherapist Sets: 5 VPFMC with 5 sec hold Sets per day: 1 set per hour	12 weeks	Supervision: weekly clinic visit Drop out: none
Castro et al.[37]	Combined training (26) versus control (24)	VPFMC taught by trained physiotherapist Sets: 5 VPFMC with 10 sec hold, 10 VPFMC with 5 sec hold, 20 PFMC with 2 sec hold, 20 VPFMC with 1 sec hold, 5 contractions with cough Sets per day: once, 3 times/week	6 months	Supervision: 3 group session per week for 6 months Drop out: 3/26 PFMT, 5/24 controls
Kim et al.[38]	Combined training (35) versus control (35)	VPFMC taught by trained physiotherapist Sets: 10 VPFMC with 3 sec hold, 10 VPFMC with 10 sec hold in sitting, lying, and standing positions with the legs apart Sets per day: 2 times/week	12 weeks	Supervision: exercise class twice a week Drop out: 2/35: PFMT, 3/35 control

PFM, pelvic floor muscle; VPFMC, voluntary PFM contraction; PFMT, PFM training; Set, one episode or sequence of PFM contractions or training, including length of time of holding contraction, positions while performing contractions and number of repetitions of contractions.

endurance or coordination training, or a combination of these:

1. Programmes with a low number of repetitions and high loads (maximal effort) were classified as strength training.
2. Those that included a high number of repetitions or prolonged contractions with low-to-moderate loads (submaximal contractions) were classified as endurance training.
3. Those that employed the repeated use of a PFM contraction in response to a specific situation (e.g., prior to cough, "The Knack") were classified as coordination training.
4. For the most part, PFM training programmes were difficult to categorize because they described either a mixed (e.g., strength and endurance) programme or omitted a key training parameter (e.g., the amount of voluntary effort per contraction, number or duration of contractions per set, duration or frequency of sets per day, Table I).

Despite these difficulties, the review found that PFM-trained women with SUI were about 17 times more likely to report cure of incontinence compared to those having non-active control management in one trial (RR 16.8, 95% CI: 2.4–119.0). Additionally, PFM-trained women with SUI were 17 times more likely to report improvement or cure of their symptoms (RR 17.33, 95% CI: 4.31–69.64, in two trials). Moreover, they experienced between 0.8 and 3 fewer leakage episodes per 24 hr compared to women in non-active treatments. Finally, PFM-trained women with SUI were 5–16 times more likely to be continent on a short pad test than women in non-active treatments.[2]

Overall, the best conclusion that could be derived from the review is that PFM training is better than no treatment, placebo drug, or inactive control treatments for women with SUI. Variations in the PFM training programmes were a major source of clinical heterogeneity, preventing a comparative analysis of the training programmes and their potential effectiveness. The study trials, however suggested that treatment effects (in terms of self-reported cure/improvement) might be greater in women with SUI participating in a supervised PFM training programme for at least 3 months.[2]

COMPARISON OF DIFFERENT PFM TRAINING REGIMENS

Twelve trials comparing different PFM exercise regimens in SUI women were found in the literature review, very few of which compared the same regimens. In most trials, the participant numbers were few; consequently the confidence intervals were wide and the results were inconclusive (Table II).[6–17] Because of this limitation, the review of the available data was unable to discern clear differences between the following training regimens:

- maximal versus submaximal strength training,[6]
- strength/motor relearning versus motor relearning alone,[7]
- PFM training with and without deep abdominal muscle training,[8]
- exercises in the supine position versus a combination of positions (supine, sitting, and standing),[9]
- direct PFM training versus indirect or imitation PFM training through the hip abductor muscles,[10,11] or
- modified pilates.[12]

In contrast, women were more likely to report cure/improvement if PFMT was taught and supervised by a health professional versus self-administered.[14] Further, self-reported cure or cure/improvement in SUI women was more likely with more health professional contact during PFMT versus less health professional contact (Table II).[15,16]

PFM TRAINING IN COMBINATION WITH VARIOUS ADJUNCT THERAPIES STUDIES

More recently, the effectiveness of PFM training combination with various adjunct therapies has been studied using mixed treatment comparison models. These are sophisticated meta-analyses that handle evidence about several interventions from many trials in one analysis, producing comparisons between all pairs of interventions, including those which have not been directly compared in any trial.[18] The Cochrane Incontinence Group's Specialised Trials Register and the reference lists of relevant articles were searched (up to June 2008). Randomized and quasi-randomized trials where more than 50% of participants had SUI were eligible. The primary outcome measures were (1) cure and (2) improvement of the symptoms of SUI. These outcomes were measured in the trials as either patient-reported (where available), or clinician-reported (as a proxy for the patient-reported outcome when this was not reported).

Eighty-eight trials were identified (9,721 women).[18] The mixed treatment comparison analysis compared 14 interventions (including "no active treatment") and included data from 55 trials (6,608 women) that reported cure or improvement. Interventions were on average more effective than no treatment. Further, there was clear evidence that PFM training either with extra sessions (more than 2 per month) or combined with biofeedback, was better than no treatment, for *cure* of incontinence, while a basic frequency of PFM training sessions (2 or less per month) was not. Vaginal cones, bladder training, PFM training with electrical stimulation and PFM training with both bladder training and biofeedback were also more likely to cure incontinence than no treatment (Fig. 1). Furthermore, all of the interventions examined (with the exceptions of PFM training with vaginal cones and biofeedback, and PFM training with Duloxetine), were significantly better than no treatment at *improving* SUI (HTA monograph[18] Fig. 32, p. 105). Moreover, there was also clear evidence that when women attended for PFM training in more than 2 sessions per month it was more effective than 2 or fewer sessions per month (cure: median odds ratio 8.36, 95% credible interval 3.74–21.7; improvement: median odds ratio 5.75, 95% credible interval 2.11–16.2). Therefore, PFM training reinforced with biofeedback or PFM provided in extra sessions appear to be the most effective interventions, although there is some uncertainty surrounding this.[18]

So in summary, in terms of treatments specifically targeting women with SUI, the up-to-date evidence does not clearly identify an optimal PFM training regime. However, the evidence does suggest that supervised PFMT programmes delivered more often (more than 2 sessions per month) or augmented with biofeedback appear to be more effective. In order to identify the parameters of an optimal PFM training, rigorous adequately powered RTCs must be conducted in which different models of PFM training regimens are compared.

This being said, there are, however, certain elements in the literature pertaining to (a) the biological rationale for PFM training, (b) PFM dysfunction in women with SUI, (c) skeletal muscle training theory as progressive overload, and (d) behavior and adherence strategies which impact on women's participation and adherence to PFM training programmes. These are discussed in detail below and must be taken into consideration when designing optimal PFM training regimens which might be amenable to testing by randomized control trial (RCT).

BIOLOGICAL RATIONALE FOR PFM TRAINING

The biological rationale for using PFM training is twofold. Firstly, a voluntary contraction before and during a cough (a maneuver termed "The Knack") has been shown to effectively reduce urinary leakage during a cough.[19] Hence, simply learning to contract the PFM before a cough may be, in and of itself, sufficient treatment for those women who experience leakage during coughing; and as such should be included in all PFM training regimens for SUI women. Secondly, improving PFM strength is thought to build up long-lasting structural support of the pelvis by elevating the levator plate to a higher location in the pelvis: this is also enhanced by hypertrophy of the muscles which will increase the stiffness of the PFMs and connective tissues.[20] Thus, improving PFM strength could prevent perineal descent during increased intra-abdominal pressure and facilitate PFM before and during effort, thereby reducing SUI in women. Given the above biological rationale, when treating SUI the focus of any PFM training should be to improve the timing (of the contraction relative to a stressor), strength, and stiffness of the PFM.

PFM DYSFUNCTION LITERATURE IN WOMEN WITH SUI

Further to the biological rationale, a growing body of literature focuses on the differences in PFM function in continent and SUI women. Using instruments such as dynamometers, which can provide direct measurements of PFM function (muscle tone, strength, coordination, and endurance), and other innovative technologies such as ultrasound (US) and magnetic resonance imaging (MRI), these studies have provided a unique

TABLE II. PFM Training Programs From RCTs Comparing Different Programs

Refs.	Training type	Training program	Training duration	Effectiveness	Notes
Bo et al.[15]	Intensive PFMT (23) versus Home PFMT (29)	Intensive PFMT: Home PFMT + 45 min PFMT exercise course in groups, once a week for 6 months Course: sets of 8–12 VPFMC with 6–8 sec holds in standing, sitting, lying, and kneeling with legs apart; 3–4 fast contractions added after held contraction Home PFMT: 8–12 maximal VPFMC per set, 3 times a day	6 months	Patients perceived cure and improvement (continent/almost continent/improved) Intensive PFMT: (22/23 (96%), Home PFMT: (19/29(66%) RR 1.46 (95% CI: 1.11–1.93), $P = 0.01$	Drop out: Intensive PFMT: 3, Home PFMT: 2
Ramsay and Thou[10]	Direct PFMT (22) versus indirect PFMT (22)	Direct PFMT: 4 maximum VPFMC with 4 sec hold and 10 sec rest, 1 set every waking hour Indirect PFMT: as direct PFMT but comprising of hip abductor muscle contraction with feet crossed at the ankles	3 months	Patient-perceived improvement: Direct PFMT: 14/22 (64%), Indirect PFMT: 14/22 (64%) RR 1 (95% CI: 0.64–1.56), $P = 1$	Drop out: none
Wong et al.[17]	PFMT with clinic-visits (21) versus PFMT home-based (26)	PFMT with clinic-visits: 8 PFMT clinic visits + daily PFMT at home PFMT home-based: single clinic visit + daily PFMT at home	4 weeks	Cure: (<2 g on 1-hr pad test): 26/47, data by group allocation not reported	Drop out: not reported
Johnson[6]	Maximal PFMT(16) versus sub-maximal PFMT (16)	Maximal PFMT: 10 min, 3 times a day, at 90% of maximal VPFMC intensity Sub-maximal PFMT: 15 min, 3 times a day, at 60% of maximum VPFMC intensity	6 weeks	Cure (no episodes of urine loss on daily diary): Maximal PFMT: 6/16 (38%), submaximal PFMT: 4/16 (25%) RR 1.5 (95% CI: 0.52–4.32), $P = 0.44$	Drop out: 14%
Hay-Smith[7]	Motor relearning PFMT (62) versus strength training PFMT (61)	Motor relearning: VPFMC in different body positions, preceding and sustained during different provocative activities Strength training: 10–12 near maximal VPFMC, 6–8 sec hold with equivalent rest, 3 times a day, at least 3 days a week	18–20 weeks	Patient perceived improvement: (cure/much better/somewhat better): Motor relearning: 4/62 (6.4%)/25/62 (40%)/19/62 (31%) Strength training: 1/61 (2%)/24/61 (39%)/27/61 (44%) Cure: RR 3.94 (95% CI: 0.45–34.22), $P = 0.36$ Much better: RR 1.02 (95% CI: 0.66–1.58), $P = 0.92$ Somewhat better: RR 0.69 (95% CI: 0.43–1.11), $P = 0.12$	Drop out: <5%
Dumoulin et al.[8]	PFMT (20) versus PFMT + deep abdominal muscle training (23)	Weekly individual PFM training	8 weeks	Cure (according to the 20-min pad test): PFMT: 14/20 (70%) PFMT + deep abdominal muscle training: 17/23 (74%) RR 0.95 (95% CI: 0.65–1.38), $P = 0.78$	Drop out: <5%
Ghoneim et al.[11]	PFMT (47) versus Imitation PFMT (50)	PFMT: 3 sets of 10 long VPFMC with 6–8 sec hold, and 2 sets of 10 rapid VPFMC with 1–2 sec hold, 4 days weekly + Knack Imitation PFMT: hip abductor muscle contraction for 6–8 sec with feet crossed at the ankles. 3 sets of long and 2 sets of rapid contractions, 4 times weekly	12 weeks	Responders (≥50% decrease in IEF): PFMT: 11/44 (25%) Imitation PFMT: 12/46 (26%) RR 0.96 (95% CI: 0.47–1.94), $P = 0.92$	Drop out: PFMT: 9 Imitation PFMT: 9

(*Continued*)

TABLE II. (*Continued*)

Refs.	Training type	Training program	Training duration	Effectiveness	Notes
Savage[12]	PFMT (4) versus modified pilate (6)	PFMT: 6 individual physiotherapy sessions of 30–45 min over a 12 weeks + home versus PFMC Modified pilates: lumbopelvic stability training exercises taught using the modified pilates method	12 weeks	Cure: satisfaction 100%: PFMT: 1/4 (25%) Modified pilates: 1/6 (17%) RR 1.5 (95% CI: 0.13–17.67), $P = 1$ Improvement: satisfaction 80–99%: PFMT: 1/4 (25%) Modified pilates: 3/6 (50%) RR 0.5 (95% CI: 0.08–3.27), $P = 0.58$	Drop out: PFMT: 1 Modified Pilate: 0
Borello-France et al.[9]	Supine PFMT (22) versus different position PFMT (22)	Twice daily VPFMC in a supine position Twice daily VPFMC in a combination of positions: supine, sitting and standing	12 weeks	Cure: prevalence of USI after treatment: Supine PFMT: 9/22, (41%) Different position PFMT: 9/22 (41%) RR 1 (95% CI: 0.49–1.03), $P = 1$ Note: The prevalence of USI at baseline: Supine PFMT: 12/22 (55%) Different position PFMT: 14/22 (64%) RR 1 (95% CI: 0.49–1.03), $P = 1$	Drop out: 18%
Williams et al.[13]	HP supervised PFMT (77) versus standard care (75)	HP supervised PFMT: individualized VPFMC regimen, sets per day (4+) + 4 clinic visits Standard care: given a leaflet + 4 clinic visits	12 weeks	Patients perceived cure (no symptoms): HP supervised PFMT: 4/77 (5%) Standard care: 6/75 (8%) RR 0.65 (95% CI: 0.19–0.21), $P = 0.53$ Patient perceived improvement: (mild or no problem): HP supervised PFMT: 47/77 (61%) Standard care: 53/75 (71%) RR 0.86 (95% CI: 0.69–1.09), $P = 0.21$	Drop out: HP supervised PFMT: 3 Standard care: 3
Konstantinidou et al.[16]	PFMT individual (10) versus PFMT + group sessions (12)	PFMT individual: at home, 3 sets of fast contractions and 3–4 sets of slow contractions daily in lying, sitting, and standing positions readjusted according to subject's progress PFMT with group sessions: As above + weekly session in a group of 5	12 weeks	Patient perceived improvement: PFMT individual: 2/10 (20%) PFMT + group sessions: 12/12 (100%) RR 0.2 (95% CI: 0.06–0.69), $P = 0.0001$	Drop out: PFMT: 5 PFMT + group session: 3
Zanetti et al.[14]	PFMT HP unsupervised (21) versus PFMT HP supervised (23)	PFMT unsupervised: 10 VPFMC of 5 sec hold and 5 sec rest, 20 VPFMC of 2 sec hold and 2 sec rest, 20 VPFMC of 1 sec hold and 1 sec rest, and 5 VPFMC of 10 sec hold and 10 sec rest, followed by 5 strong contractions together with a cough, with 1-min intervals with each set PFMT supervised: as above + VPFMC performed under guidance from a physiotherapist, twice a week, for 45 min	3 months	Cure: (pad test negative): PFMT unsupervised: 2/21 (10%) PFMT supervised: 11/23 (48%) RR 0.2 (95% CI: 0.05–0.80), $P = 0.005$	Drop out: not reported

PFM, pelvic floor muscle; VPFMC, voluntary PFM contraction; PFMT, PFM training; HP, health professional; Set, one episode or sequence of PFM contractions or training, including length of time of holding contraction, positions while performing contractions and number of repetitions of contractions.

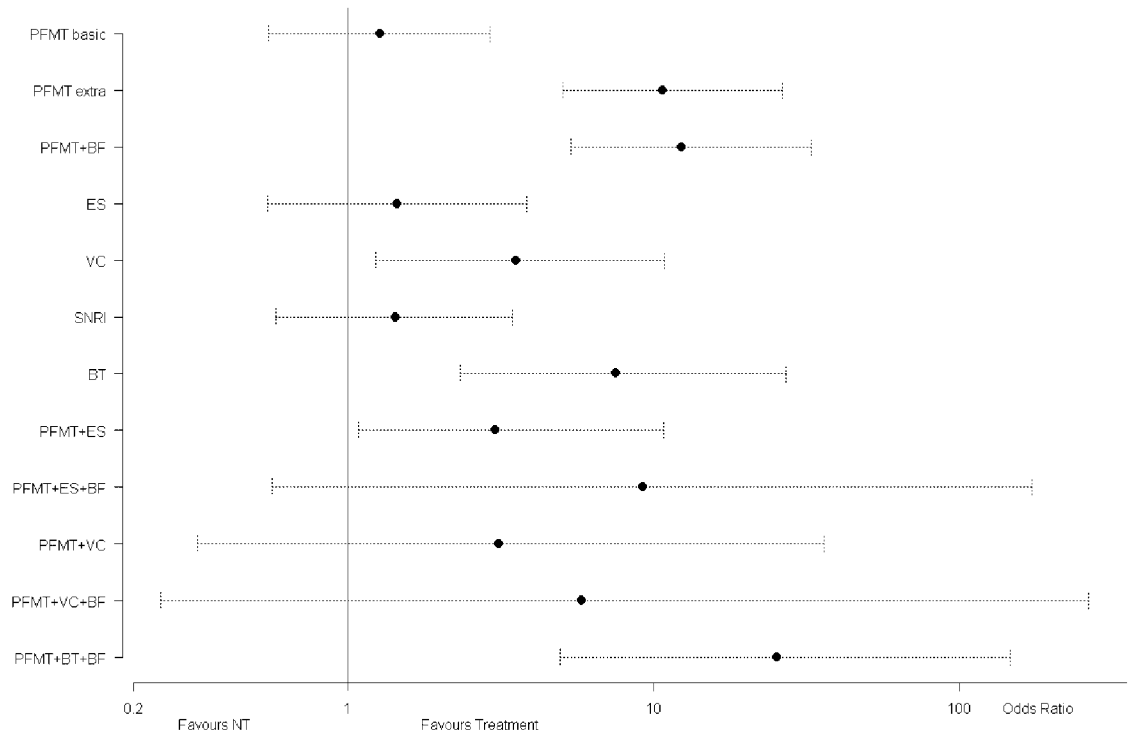

Fig. 1. Mixed treatment comparison: odds ratio for cure of urinary incontinence for each treatment versus no treatment. Posterior distributors median (circle) with 95% central credible intervals. The horizontal axis is plotted on the log scale. PFMT basics: ≤2 sessions per month; PFMT basics: >2 sessions per month; VC, vaginal cones; SNRI, Duloxetine; BF, biofeedback; BT, bladder training; ES, electrical stimulation.

way of studying PFM function, displacement, and morphological integrity in continent women versus those with SUI. Such studies have already increased our understanding of SUI pathophysiology, determined the causes of functional abnormalities, and might, in future, enable us to identify and better tailor PFM training regimens to SUI women. Some examples include:

In a cohort study evaluating PFM function in 59 premenopausal women, using dynamometry, Morin et al.[21] demonstrated that incontinent women as compared to continent women had lower passive force at rest (muscle tone), showed lower endurance, and were unable to produce as many rapid contractions in 15 sec; indicative of PFM dysfunction at rest and during an active contraction.

In another study by the same author, which evaluated PFM function in 34 continent women and 33 post-menopausal women with SUI, incontinent women showed a reduction of the PFM involuntary response during a maximal cough such as a lower PFM-contraction rapidity, a decrease in maximal PFM force, and a reduction of the PFM force measured at peak maximum intra-abdominal pressure. This indicates abnormalities in the involuntary responses of the PFM during coughing in women with SUI.[22]

Conversely, Verelst and Leivseth,[23] in a study evaluating PFM function using dynamometry on 26 control and 20 SUI parous women, concluded that normalized strength differed between continent and SUI women; the incontinent women had weaker PFMs.

Further, in Lovegrove et al.[24] used US to characterize the displacement, velocity, and acceleration of the PFM during a cough in 23 asymptomatic and 9 SUI women. They found that during a cough, PFM activation in continent women produced a timely compression of the PFMs and provided additional external support to the urethra, reducing displacement, velocity, and acceleration. In women with SUI, this PFM pre-contraction did not occur; consequently, the urethras of women with SUI had to move further and faster for a longer duration.

Finally, using MRI, Hoyte[25] found differences between continent and SUI women in terms of the position of the levator plate at rest, which is indicative of stiffness; the levator plate being higher in continent women.

All these findings indicate that PFM function is deficient in SUI women at rest (in terms of tone and stiffness), during a maximal voluntary contraction (maximal strength, rapidity, and endurance), and during effort (timing and maximal strength). Therefore, PFM assessments could be used to identify which aspects of structure or function are deficient; subsequent training regimens could then be designed to address these dysfunctions by using a diversity of exercises, possibly tailored to individual women's abilities. Ultimately, the development of clinical prediction rules based on such assessments could improve clinical practice, enabling SUI women to be matched to the optimal intervention for their condition.

SKELETAL MUSCLE TRAINING THEORY AS PROGRESSIVE OVERLOAD

The American College of Sports Medicine recently issued a special communication on evidence-based progression models for resistance training in healthy adults.[26] These recommendations could be used to elaborate exercise regimen protocols aimed at improving timing, strength, and stiffness. The article sets out the basic principles, including progressive overload, specificity, and periodization, that need to be incorporated into any resistance-training programme in order to achieve maximum results.

PFM training regimens should also adhere to these principals. For example, in relation to PFM training, progressive overload implies that the intensity of the exercises and the number of repetitions should be gradually increased throughout the exercise programme, the speed or tempo of the repetitions with submaximal loads should be adjusted according to the desired goal (i.e., to train for either endurance or strength), the rest periods should be shortened for endurance-improvement training or lengthened for strength and power training, and, finally, the overall volume of training should be increased gradually.

Further, in order to increase muscle strength, the progression model suggests using a repetition range of 8–12 maximum contractions at moderate velocity, a 1- to 2-min rest between sets, an initial training frequency of 2–3 times per week progressing to 4–5 times, and the application of a 2–10% increase in load when an individual can perform the current workload for 1–2 repetitions over the targeted number.

For endurance training, the progression model suggests the need for light to moderate loads (40–60% of maximal load) with high repetitions (>15) and short rest periods (<90 sec). In PFM training this can be achieved by changing positions from gravity-free to anti-gravity (i.e., from lying to sitting to standing) or through the introduction of cones into the exercise sessions.

Finally, rapidity and coordination training ("The Knack") would include the use of repetitive, voluntary PFM contractions in response to specific situations; for example, prior to and during coughing, lifting an object, or jumping.

TYPES OF BEHAVIOR AND ADHERENCE STRATEGIES FOR EFFECTIVE PFM TRAINING

A few studies have examined factors that impact on women's participation in and adherence to a PFM training regimen during treatment (in class and at home), as well as in the long-term, post-treatment.[27–29] In a qualitative descriptive study using individual and focus-group interviews, In 2006, Milne and Moore[27] studied the self-care strategies employed by community-dwelling individuals to adhere to the PFM training regimen at home. Factors that facilitated home-based PFM training included realistic goals and expectations, positive affirmations, follow-up, and a regular exercise routine. Barriers noted were insufficient information about the exercise, the characteristics of the exercises, competing interests, financial costs, and minor psychosocial impacts.[27]

In 2007, Martin and Dumoulin[28] also studied factors that facilitate or impede the participation of women with UI in a weekly PFM-exercise classes and their adherence to a daily, home-based PFM exercise programme. Four facilitating factors in terms of participation in a weekly PFM exercise classes were identified: a desire to reduce UI, a sense of responsibility towards the programme, close supervision by a physiotherapist, and group support. Impediments were illness, medical appointments, and planned social activities. Facilitators for the home-based PFM exercise programme were a desire to reduce UI and commitment to making exercises part of a daily routine. Impediments were a busy schedule, the length of the exercise programme, and illness.

Hines et al.[29] conducted a survey 1-year post-treatment of 164 community-dwelling, post-menopausal women to identify predictors of long-term adherence to PFM and bladder training exercises. Results indicated that women incorporated PFM training into their lives using either a routine or ad hoc approach. Those participants who used a routine approach were 12 times more likely (than those employing an ad hoc approach) to have a high adherence level at 3 months (OR = 12.4, 95% CI = 4.0–38.8, $P < 0.001$) and were significantly more likely to have maintained that level 12 months post-intervention (OR = 2.7, CI = 1.2–6.0, $P < 0.014$). Practicing bladder training was also related to high adherence.

Finally, two trials have investigated the use of adherence strategies as a means of rendering PFM training more effective in women with SUI. In both trials, two groups followed the same daily home-based PFM training programme, but one was provided with an adherence strategy.[30,31] In the Sugaya study, participants were provided with a device emitting a rhythmic beep, signaling them to undertake a contraction; they also pressed a button on the device to record each contraction.[30] Participants in the Gallo study were given an audiotape of exercise instructions that counted out 25 consecutive PFM contractions.[31] Participants who used the beeping device to cue PFM contractions were more compliant and more likely to be satisfied with the treatment outcome, compared to the control group (RR 3.17, 95% CI: 1.02–9.88).[30] Those who used the audiotape of exercise instructions were more likely to perform the exercises twice daily, as per instruction (RR 7.05; 95% CI: 2.78–17.88).[31] Whether these adherence strategies impact on objective continence outcomes remains inconclusive, as the results were not significant in Sugaya's study and impact was not measured in Gallo's.

Interestingly, the ability to incorporate an exercise regime into one's daily routine or using an adherence strategy were both facilitators for adherence to the home-based exercise programme, including its continuation post-treatment. Results from these studies should be taken into consideration when defining protocols for PFM training regimens to achieve optimal participation during training, at home and, most importantly, post-treatment.

CONCLUSION

PFM training has been shown to be effective in treating SUI in women. However, to date there are only limited indications as to which type of PFM training is the most effective. While supervised PFM training which is delivered more often (more than 2 sessions per month) or augmented with biofeedback appear to be more effective, data and hence consensus are lacking as to which elements of a PFM training regimen are most effective, such as the strength and duration of the muscle contractions, the type of training employed, the number of contraction repetitions used, the positions in which exercises are performed, the inclusion or exclusion of the use of ancillary muscles (such as abdominal ones), and the treatment session approach (e.g., individual versus a class approach), among many others. Moreover, factors and treatment strategies that affect compliance and long-term adherence are only just beginning to be examined.

It is no longer a question of whether PFM training programmes work but what components (including adjunct therapies) and combinations thereof are most effective. Nor can PFM training be studied without due consideration of PFM dysfunction, resistance training and adherence factors and strategies, derived from physiological theory and innovative technological investigations. Future RTCs which incorporate methods and strategies that have been shown to be effective, both for treatment for and to encourage long-term adherence, are needed to address some of the uncertainties in how best to treat women with SUI.

PFM training programmes work but the how and for whom is still ill understood. In order to improve treatment for SUI women more studies in the following areas are required:

1. Which PFM components impact, and to what degree, on the success of PFM training: strength and duration of the muscle contractions, number of contraction repetitions, exercise positions, inclusion or exclusion of ancillary muscles, and individual versus group treatment approach?
2. Do adjunct therapies make PFMT more effective; and is success really linked to frequency of contact with health professionals?
3. Which clinical and patient-specific characteristics determine the effectiveness and acceptability of PFM training?
4. Which, if any, PFM assessment indicators best predict patient-specific outcomes enabling clinicians to better match women to the optimal intervention for their condition and individual characteristics?
5. Which physiological and psychological factors and/or treatment strategies influence compliance and long-term adherence to a PFM exercise regimen?

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