Effect of pelvic floor muscle training during pregnancy and after childbirth on prevention and treatment of urinary incontinence: a systematic review

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ABSTRACT

Background Urinary incontinence (UI) is a common condition in women causing reduced quality of life and withdrawal from fitness and exercise activities. Pregnancy and childbirth are established risk factors. Current guidelines for exercise during pregnancy have no or limited focus on the evidence for the effect of pelvic floor muscle training (PFMT) in the prevention and treatment of UI.

Aims Systematic review to address the effect of PFMT during pregnancy and after delivery in the prevention and treatment of UI.

Data sources PubMed, CENTRAL, Cochrane Library, EMBASE and PEDro databases and hand search of available reference lists and conference abstracts (June 2012).

Methods Study eligibility criteria: Randomised controlled trials (RCTs) and quasiexperimental trials published in the English language. Participants: Primiparous or multiparous pregnant or postpartum women. Interventions: PFMT with or without biofeedback, vaginal cones or electrical stimulation. Study appraisal and synthesis methods: Both authors independently reviewed, grouped and qualitatively synthesised the trials.

Results 22 randomised or quasiexperimental trials were found. There is a very large heterogeneity in the populations studied, inclusion and exclusion criteria, outcome measures and content of PFMT interventions. Based on the studies with relevant sample size, high adherence to a strength-training protocol and close follow-up, we found that PFMT during pregnancy and after delivery can prevent and treat UI. A supervised training protocol following strength-training principles, emphasising close to maximum contractions and lasting at least 8 weeks is recommended.

Conclusions PFMT is effective when supervised training is conducted. Further high-quality RCTs are needed especially after delivery. Given the prevalence of female UI and its impact on exercise participation, PFMT should be incorporated as a routine part of women's exercise programmes in general.

INTRODUCTION

Current exercise guidelines recommend all pregnant women to be physically active on preferably all weekdays throughout pregnancy and to conduct both cardiovascular and strength-training exercise.[1–3] The prescription for exercise is more detailed for the cardiovascular component of training than the strength-training component. This may, to some extent, be explained by the fact that there are fewer published clinical trials on strength-training programmes for pregnancy and birth outcomes than endurance training.[4 5]

Pregnancy and childbirth are known risk factors for weakening and injury to the perineum and pelvic floor. Stretch and rupture of peripheral nerves, connective tissue and muscles may cause urinary and faecal incontinence, pelvic organ prolapse, sensory and emptying abnormalities of the lower urinary tract, defecation dysfunction, sexual dysfunction and chronic pain syndromes.[6] About 50% of women lose some of the supporting function of the pelvic floor due to childbirth,[7] and recent research using ultrasound and MRI reports the prevalence of major injuries to the pelvic floor muscles of 20–26% following vaginal delivery.[8–10] Hence, vaginal childbirth can be considered equivalent to a major sport injury, but has not been given the same attention concerning prevention or treatment.

Urinary incontinence is the most prevalent symptom of pelvic floor dysfunction, with the prevalence rates varying between 32% and 64%.[11] Stress urinary incontinence (UI) is defined as a 'complaint of involuntary loss of urine during on effort or physical exertion (eg, sporting activities), or on sneezing and coughing'[12] and is the most common form of UI in all age groups. Prevalence rates between 4.5% (swimming) and 80% (trampoline jumping) have been found in young elite athletes.[13] In the general female population, UI causes withdrawal from exercise and fitness activities and is a barrier to regular participation in physical activities.[13] Surprisingly, strength training of the pelvic floor muscles is not mentioned at all in the Guidelines of the American College of Obstetricians and Gynecologists[1] and only briefly mentioned in the British and Canadian guidelines. Furthermore, there are no or few references to evidence from clinically controlled trials in the existing guidelines.[2 3]

Two important questions are[1] whether UI and other pelvic floor disorders can be prevented by training the pelvic floor muscles (PFM) before problems arise (primary prevention), or[2] whether women at risk at an early stage can be identified with a view to secondary prevention using PFM training (PFMT). Reviews on PFMT in prevention of UI report inconsistent results and there seems to be some doubt about the effect.[14 15] This may be due to the use of different inclusion criteria of studies and different criteria to classify studies as either prevention or treatment interventions. Some authors do not separate between antenatal or postpartum interventions,[14] and there seems to be little attention paid to dose–response issues in the

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training protocols. The aims of the present systematic review were to answer the following questions.

1. Is there evidence that *pregnant* women should be advised to do PFMT to *prevent* or *treat* UI?
2. Is there evidence that *postpartum* women should be advised to do PFMT to *prevent* or *treat* UI?
3. What is the *most optimal training dosage* for effective antenatal and postpartum PFMT in the prevention and treatment of UI?
4. What is the *long-term* effect of PFMT during pregnancy and after childbirth?

METHODS

PubMed (search date June 12 2012), the Cochrane Central Register of Controlled Trials (CENTRAL in the Cochrane Library, Wiley, Issue 6 of 12 June 2012), EMBASE (through OvidSP, 1980 to 2012, week 24) and Physiotherapy Evidence Database (PEDro, edition 12 June 2012) were searched to identify studies. Keywords used in different combinations in the search were the following: pregnancy, pelvic floor muscle, exercise, training, incontinence, after delivery, postpartum, childbirth, effect, prevention. Inclusion criteria were quasiexperimental and randomised controlled trials (RCTs) written in the English or Scandinavian languages. Both meeting abstracts and full publications were included. In addition to database searches, reference lists of selected papers and manual search in meeting abstract books published by the World Confederation of Physical Therapy (1993–2011), International Continence Society and International Urogynecology Association (1990–2011) were undertaken.

Scoring of methodological quality was performed according to the PEDro rating scale giving one point for each of the following factors for internal validity: random allocation, concealed allocation, baseline comparability, blinded assessor, blinded subjects, blinded therapists, adequate follow-up (≥85%), intention to treat (ITT) analysis, between-group comparison, report of point estimates and variability.[16] The two authors independently scored the studies. Any disagreement was solved by consensus.

RESULTS

The database searches resulted in 117 references after deduplication. In addition to the studies included in the *Cochrane Systematic Review* 2008,[15] eight new RCTs[17–24] and one quasiexperimental study[25] were found. Eight were short-term original studies and one[20] was a 7-year follow-up study.

Pelvic floor muscle exercises during pregnancy to prevent UI including both women with and without UI

Ten RCTs,[17 18 21–23 26–30] and two long-term follow-up studies[31 32] were identified. In all the studies, women were recruited at 22 weeks prior to pregnancy (table 1). All the trials, except the RCT by Stafne *et al*,[23] included primigravid/nulliparous women. Three trials were primary prevention trials including only continent women;[22 26 29] one trial included only women at risk of developing UI (with increased bladder neck mobility) and no previous UI.[29] Seven studies included women who had not been selected on the basis of incontinence or risk factors.[17 18 21 23 27 28 30] However, in two of these trials,[23 28] results from the subgroup of women who were continent at inclusion were reported (primary prevention). PEDro scores varied between 7 and 8 out of 10 in the trials published as articles (table 5). The abstracts were difficult to score owing to limited information.

Training protocol

The exercise period started between 20 and 22 weeks of pregnancy in six studies,[23 30] between 11 and 14 weeks in 1[22] and between 16 and 24 weeks in three trials.[17 18 21] However, the length of the training period, the follow-up by health professionals, the training intensity and frequency varied.

The training protocol in all the studies, except for one,[27] addressed both regular home training and follow-up (monthly and weekly) by a physical therapist with few (up to 30 contractions/day) and strong (near maximal) contractions. Hughes *et al*[27] used a protocol consisting of only one individual session and one group session in addition to regular home training.

In all but two studies,[18 26] the control groups were not discouraged from doing PFMT on their own, but received standard care including advice about PFMT. In one trial,[28] the control group was given the same individual instructions in correct PFM contraction (including vaginal palpation and feedback) as the training group. Adherence to the PFMT protocol was reported in most trials;[17 21–23 26 28–30] however, different classification systems of adherence were used. No specific questionnaires/instruments to report adherence were used. Some studies used exercise diaries.[23 28 29]

Outcomes

Clinically relevant and statistically significant effects of the interventions were documented in seven trials,[18 21 23 26 28–30] showing a significant reduction in symptoms, episodes of UI or a lower percentage of women with UI in late pregnancy or during the first 3 months after delivery. A specific preventive effect of PFMT was shown in the studies by Reilly *et al*,[29] Gorbea Chávez *et al*[26] and in the subgroup of women with no previous UI at inclusion in the trials from Mørkved *et al*[28] and Stafne *et al*.[23] No adverse effects of the interventions were reported. Sampselle *et al*[30] found that the short-term effect was not present at 1-year follow-up. Eight years follow-up data from Reilly *et al*'s[29] trial showed no significant difference in UI between the original intervention and control groups.[31] Mørkved *et al*[32] reported that the percentage of continent women in the training group was similar at 3 months and 6 years' follow-up, while the percentage of continent women in the control group had increased in the period, and the statistically significant differences between groups were no longer present.

Pelvic floor muscle exercises during pregnancy to treat UI including only women with UI

Two RCTs[19 33] and one quasiexperimental study were found (table 2).[25] Incontinent parous or nulliparous women were included. PEDro scores were 5 and 7 out of 10 (table 5).

Training protocol

The training protocols and follow-up varied. In the trial by Woldringh *et al*,[33] the programme consisted of three individual sessions during pregnancy weeks 23–30 and one 6 weeks after delivery, while the control group received routine care including instruction on PFMT. The dropout rate was about 50%, and the adherence to regular PFMT among the women that stayed in the training group was 77%. Dinc *et al*[19] addressed both regular home training and follow-up between 20 and 36 weeks of pregnancy, and few (up to 30 contractions/day) and close to maximal contractions, while the study by Sangsawang and Serisathien[25] used a 6-week training programme.

Table 1 Studies assessing the effect of pelvic floor muscle exercises during pregnancy to prevent urinary incontinence including both women with and without urinary incontinence at inclusion

Author	Design	Subjects	Training protocol	Losses to follow-up/Adherence	Outcomes (Numbers and percentage (%))
Sampselle *et al*[30]	2-Arm RCT 1. Control (n=38): Routine care 2. Intervention (n=34): A tailored PFMT programme	N=72 primigravid women recruited at 20-week pregnancy. Some women had existing UI. Groups comparable at baseline. Single centre, USA	1. Control: routine care 2. A tailored PFMT programme beginning with muscle identification progressing to strengthening. 30 contractions/ at max or near-max intensity from 20-week pregnancy. Correct VPFMC checked	Losses to follow-up: 36 adherence PFMT: ▶ 35-week pregnancy: 85% ▶ 1-year postpartum: 62–90% Adverse events not stated. Self-reported adherence. Partial ITT analysis	Change in mean UI symptom score: Control / Intervention / p 35-week pregnancy : 0.20 / −0.02 / 0.07 6-week postpartum: 0.25 / −0.06 / 0.03 6-month post partum: 0.15 / −0.11 / 0.05 12-month post partum: 0.06 / 0.00 / 0.74 PFM strength: NS difference (low numbers)
Hughes *et al* (abstract) [27]	2-arm RCT 1. Control (n=583): routine care 2. Intervention (n=586): a tailored PFMTprogramme	N=1169 pregnant nulliparous women recruited at 20-week pregnancy. Some women had existing UI. Single centre, UK	1. Control: routine care that may have included advice on PFMT. 2. Intervention: one individual session with physiotherapist, and one group PFMT session between 22-week and 25-weekpregnancy. Home training daily for up to 11 months.VPFMC checked	Losses to follow-up: 40% at 6-week postpartum 27% at 3-month postpartum 34% at 6-month postpartum 461/586 women in the intervention group attended the PFMT session	SUI Bristol Female Urinary Tract Symptoms Questionnaire: Control / intervention 36-week pregnancy: 66% / 61% OR (95% CI) 0.78 (0.59 to 1.04) 6-month postpartum: 38% / 36% OR (95% CI) 0.90 (0.64 to 1.28)
Reilly *et al*[29] Agur *et al*[31] 8-year follow-up	2-Arm RCT 1. Control (n=129): routine care 2. Intervention (n=139): 20-week intensive PFMT 1. Control (n=85): 2. Intervention(n=79)	N=268 primigravid, continent women with increased bladder neck mobility recruited at 20-week pregnancy. Single centre, UK164/268 (61%) of the original group	1. Control: routine antenatal care (verbal advice) 2. Intervention: individual PFMT with physiotherapist at monthly intervals from 20-week until delivery, with additional home exercises 3 sets of 8 contractions (each held for 6 s) repeated twice daily. Instructed to contract the PFM when coughing or sneezing	Losses to follow-up at 12 months: 14% Adherence PFMT: ▶ 11% completed less than 28 days of PFMT ▶ 46% completed 28 days or more of PFMT Adverse events not stated ITT analysis ▶ 38% in the intervention group were doing PFMT twice or more per week	Self-reported UI at 3-month postpartum: 1. Control: 36/110 (32.7%) 2. Intervention: 23/120 (19.2%) RR (95% CI) 0.59 (0.37 to 0.92) p=0.023 Quality of life: higher score in the exercise group p=0.004 Pad test: NS difference Bladder neck mobility: NS difference PFM strength: NS difference Self-reported UI at 8 years follow-up: 1. Control: 38.8% 2. Intervention: 35.4% p=0.75
Mørkved *et al*[28] Mørkved *et al* (abstract) [32] 6-year follow-up	2-Arm RCT 1. Control (n=153): customary information from general practitioner/ midwife 2. Intervention (n=148 m): 12-weeks of intensive PFMT 1. Control (n=94) 2. Intervention (n=94)	N=301 primigravid women recruited at 20-weekpregnancy. Some women had existing UI. Three outpatient physiotherapy clinics in Norway 188/301 (62%) returned the questionnaire	1. Control: customary information from general practitioner/midwife. Not discouraged from PFMT. Correct PFM contraction checked at enrolment 2. Intervention: 12 weeks of intensive PFMT (in a group) led by physiotherapist, with additional home exercises 10 max contractions (each held for 6 s) and to the last 4 were 3–4 fast contractions added, repeated twice daily, between 20-week and 36-week pregnancy. Correct VPFMC checked at enrolment Control group received information about the results of the trial and the training programme, about 1 year after delivery	Losses to follow-up 12/301(5 intervention and 7 controls). Adherence to PFMT: ▶ 81% adherence to PFMT in the intervention group Adverse events not stated ITT analysis 45% adherence to PFMT in both groups	Self-reported UI at 36-week pregnancy: 1. Control: 74/153 (48%) 2. Intervention: 48/148 (32%) RR (95% CI) 0.67 (0.50 to 0.89) p=0.007 UI at 3 months postpartum: 1. Control: 49/153 (32%) 2. Intervention: 29/148 (19.6%) RR (95% CI): 0.61 (0.40 to 0.90) p=0.018 PFM strength: sign difference in favour of the intervention group UI at 6 years follow-up: 1. Control: 17% 2. Intervention: 23% p=0.276

Continued

Table 1 Continued

Author	Design	Subjects	Training protocol	Losses to follow-up/Adherence	Outcomes (Numbers and percentage (%))
Gorbea Chávez *et al*(abstract)[26]	2-arm RCT 1. Control (n=34 after dropouts) No PFMT 2. Intervention (n=38 after dropouts) PFMT	75 pregnant nulliparous continent women recruited at 20-week pregnancy.Single setting, Mexico	1. Control: requested not to perform PFMT during pregnancy or postpartum 2. Intervention: individual PFMT with physiotherapist. 10 VPFMC each held for 8 s each followed by 3 fast 1 s contraction; 6 s rest. Clinic appointments weekly for 8 weeks, then weekly phone calls up to 20 weeks Biofeedback and training diary. Correct VPFMC checked	Losses to follow-up 3/75 (4%) Adherence to PFMT: 84% attended 7 or 8 physiotherapy appointments. ITT analyses	Urinary incontinence: Control Intervention p 28-week pregnancy: 17% 0 <0.05 35-week pregnancy: 47% 0 <0.05 6 weeks postpartum: 47% 15% <0.05
Mason *et al*[22]	2-arm RCT 1. Control (n=148) 2. Intervention (n=141): PFMT	N=311 nulliparous pregnant women with no symptoms of SUI at 11–14-week pregnancy Two hospitals in England	1. Control 2. Intervention: 45 min physiotherapy class once per month for 4 months. Additional home exercises 8–12 max contractions (each held for 6 s) and to the last 4 were 3–4 fast contractions added, repeated twice daily, between 20-week and 36-week pregnancy. Correct VPFMC checked at enrolment in most women	Losses to follow-up: 8% Some significant differences between responders and non-responders 90 women (31.4%) completed all sets of questionnaires 91/141 (49.1%) in the intervention group attended a PFMT class Significantly more PFMT in the intervention group compared to the control group	Self-reported UI at 36-week pregnancy: 1. Control: 51/96 (53%) 2. Intervention: 24/60 (40%) OR (95%CI) 1.7 (0.884 to 3.269) p=0.138 UI at 3 months postpartum: 1. Control: 33/80 (41.3%) 2. Intervention: 23/68 (33.8%) OR (95%CI) 1.374 (0.702 to 2.688) p=0.397 No significant difference in symptoms and episodes of UI, between groups
Ko *et al*[21]	2-arm RCT 1. Control (n=150): Routine care 2. Intervention (n=150): 20 weeks of intensive PFMT	N=300 nulliparous women recruited at 16–24-week pregnancy. Some women had existing UI. Single centre, Taiwan	1. Control: routine antenatal care 2. Intervention: Individual PFMT with physiotherapist once per week between 20–36-weekpregnancy, with additional home exercises three sets of eight contractions (each held for 6 s) repeated twice daily. Instructed to contract the PFM when coughing or sneezing	Losses to follow-up: no. Adherence PFMT: ► 87% practised PFMT at least 75% of the time Adverse events not stated. ITT analysis	Self-reported UI at 36-week pregnancy: sjekk 1. Control: 76/150 (51%) 2. Intervention: 52/150 (34%) p<0.01 Self-reported UI at 3days postpartum: 1. Control: 62/150 (41%) 2. Intervention: 46/150 (30%) p=0.06 Self-reported UI at 6 weeks postpartum: 1. Control: 53/150 (35%) 2. Intervention: 38/150 (25%) p=0.06 Self-reported UI at 6-month postpartum: 1. Control: 42/150 (27%) 2. Intervention: 25/150 (16%) p=0.04 Significant improvement of in the intervention group in Scores on the Incontinence Impact Questionnaire and Urogenital Distress Inventory, in late pregnancy and up to 6-month postpartum
Bø and Haakstad[17]	2-arm RCT 1. Control (n=53): 2. Intervention (n=52): 12–16-week aerobic fitness class including PFMT	N=105 nulliparous women recruited within 24-week pregnancy. Some women had existing UI. Single centre, Norway	1.Control: 2. Intervention: 12–16 weeks of aerobic exercise classes twice per week during pregnancy, including intensive PFMT (in a group) led by aerobic instructor. Additional home exercises 10 max contractions (each held for 6 s) and to the last 4 were 3–4 fast contractions added ×3/day. Correct VPFMC was not checked at enrolment	Losses to follow-up: 21/105 (10 intervention and 11 control). Adherence to training sessions: 40% Adverse events not stated Not IIT analysis	Self-reported UI at 36–38-week pregnancy: 1. Control : 7/53 2. Intervention: 9/52 Self-reported UI at 3-month postpartum: 1. Control: 6/53 2. Intervention: 5/52 No significant difference

Stafne *et al*[23]	2-arm RCT 1. Control (n=426): customary information from general practitioner/midwife. 2. Intervention (n=429): 12-week intensive PFMT	N=855 pregnant women recruited 20-week pregnancy. Some women had existing UI. Two hospitals in in Norway	1.Control: customary information from general practitioner/midwife and written information. Not discouraged from PFMT 2. Intervention: 12 weeks of exercise class including led by physiotherapist, with additional home exercises 3×10 max contractions (each held for 6 s and to the last 4 were 3–4 fast contractions added) at least three times per week between 20-week and 36-week pregnancy. Correct VPFMC checked at enrolment	Losses to follow-up: 93/855 (32 intervention and 61 controls). Adherence to PFMT: ▸ 67% adherence to PFMT in the intervention group ▸ 40% adherence to PFMT in the control group No adverse events ITT analysis	Self-reported UI at 34–38-week pregnancy: Any UI 1. Control: 192/365 (53%) 2. Intervention: 166/397 (42%) p=0.004 UI once per week or more 3. Control: 68/365 (19%) 4. Intervention: 44/397 (11%) p=0.004
Dias A *et al* (abstract)[18]	3-arm RCT 1. Control group (n=29) 2. Supervised group (n=29) 3. Observational group (n=29)	N=87 primigravidas women recruited 18-week pregnancy Some women had existing UI. Single centre Brazil	1. Control: no exercising 2. Supervised:exercising under supervision of a physiotherapist monthly + daily home exercises 3. Observational group: unsupervised daily home exercises	Losses to follow-up: ?	Self-reported UI at 38-week pregnancy: 1. Control: 96% 2. Supervised: 6,9% 3. Observational: 6.9%

ITT, intention to treat analysis; max, maximum; NS, non-significant; PFM. pelvic floor muscles; PFMT, pelvic floor muscle training; RCT, randomised controlled trial; RR, relative risk; SUI; stress urinary incontinence; UI, urinary incontinence; VPFMC, voluntary pelvic floor muscle contraction.

Outcomes

Woldringh *et al*[33] found no difference in UI between the intervention and control groups during pregnancy and at the follow-up at 6 and 12 months post partum. Conversely, Dinc *et al*[19] and Sangsawang and Serisathien[25] demonstrated a significant difference in UI after the intervention period in favour of the training group, both in late pregnancy and 6–8 weeks post partum.

Pelvic floor muscle exercises after delivery to prevent UI including women with and without UI

Five short-term studies were found,[34–38] and in addition, long-term results from two studies[39 40] have been reported (table 3). Two of the short-term studies were RCTs:[34 38] one a nested RCT,[35] one a quasirandomised study[36] and one a matched controlled study.[37] PEDro scores varied between 4 and 8 out of 10 (table 5). The studies included both primiparous and multiparous women. Chiarelli and Cockburn[34] included only women with forceps or ventouse delivery or birth of a baby weighing 4000 g or more.

Training protocol

In three studies, the training period started while the women were still at the hospital,[34 35 38] whereas the training started 8 weeks after delivery in the other studies. The length of the training period, follow-up by health professionals, training intensity and frequency varied. Sleep and Grant[38] gave one individual session of PFMT, while in hospital, in addition to standard care and recommended to the women in the intervention group to do a specific PFMT task each week at home in 4 weeks. The 8-week training protocol in the study by Mørkved and Bø[37] addressed individual instructions in PFM contractions, regular home training (2 sets of 10 near maximal contractions/day) and close weekly follow-up in groups. Meyer *et al*[36] added biofeedback and electrical stimulation to the 6-week PFMT programme, whereas the intervention group in the RCT by Chiarelli and Cockburn[34] received individually tailored PFMT including two individual contacts with a physical therapist and thorough information. The Health Beliefs Model was used as a framework to underpin the development of a successfully implemented postnatal continence programme. In addition, social marketing strategies were implemented in the development of materials used within the programme.[34] Adherence to the PFMT protocol was reported in four studies;[34 35 37 38], different classification systems of adherence were used. Some studies used exercise diaries.[34 37 38]

Most studies compared PFMT with current standard care, allowing self-managed PFMT but not introducing supervised intervention. In one study,[37] the control group was given the same individual instructions in correct PFM contraction (including vaginal palpation and feedback) as the training group.

Outcomes

Three studies[34 36 37] reported clinically relevant and statistically significant effects of the interventions, with a significant reduction in symptoms or frequency of UI after the intervention period. Two trials reported no significant results of the intervention.[35 38] No adverse effects of the interventions were reported. Mørkved and Bø[40] found that the effect of PFMT was still present 1 year after cessation of the training programme, while Chiarelli and Cockburn demonstrated short-term effects but no difference in UI between groups at 1-year and 6-year follow-up.[34 39] However, Chiarelli *et al*[39] reported that

Table 2 Studies assessing the effect of pelvic floor muscle exercises during pregnancy to treat urinary incontinence including only women with urinary incontinence at inclusion

Author	Design	Subjects	Training protocol	Losses to follow-up/ adherencee må sjekkes	Outcomes (numbers and percentage (%))
Woldringh *et al*[33]	2-arm RCT 1. Control (n=152): Routine care. 2. Intervention (n=112): Four sessions of individual instructions in PFMT	N=264 women with UI at 22-week pregnancy. Multi centre, the Netherlands	1. Control: routine care. Nearly 2/3 received some instruction on PFMT. 2. Intervention: three sessions of individual therapy during 23–30-week pregnancy and one 6 weeks after delivery, combined with written information.	Losses to follow-up %: Control/Intervention 35 weeks: 17/148-week postpartum: 25/186-month postpartum: 30/2912-month postpartum: 42/35v Adherence to PFMT: ► 54% in the intervention group participated during the whole study period, and 77% of these women reported regular PFMT at 35 weeks of pregnancy. ► 50% in the control group participated during the whole study period, and 40% of these women reported regular PFMT at 35 weeks of pregnancy. Adverse events not stated ITT analysis	Self-reported severity of any UI: Control Intervention p 35-week pregnancy: 93% 88% 0.338-week postpartum: 68% 62% 0.446-month postpartum: 60% 56% 0.6312-month postpartum: 63% 58% 0.611-year postpartum: Negative correlation between training intensity and severity of UI
Dinc *et al*[19]	2-arm RCT 1. Control (n=46) 2. Intervention (n=46): PFMT	N=92 pregnant women recruited at 20–34 week pregnancy. All women had existing UI. Primiparous and multiparous. Single centre, Turkey	1. Control 2. Intervention: 3–16 weeks of intensive PFMT, with thorough instruction and additional home exercises between 20 and 36 weeks of pregnancy. 3 sets of 10–15 contractions 2–3 times per day. Both fast and slow (3–10 sec) contractions Correct VPFMC checked at enrolment in both groups	Losses to follow-up: 24/92 (6 in both groups) after first evaluation, second 12 lost to follow-up (5 intervention and 7 controls). Adherence to PFMT: ? Not ITT analysis	Self-reported UI at 36–38-week pregnancy: 1. Control: 25/35 (71.4%) 2. Intervention: 16/37 (43.2%) UI at 6–8-week postpartum: 1. Control: 13/33 (38.4%) 2. Intervention: 6/35 (17.1%) Significant difference in episodes of UI, Urgency, number of voids and amount of urine in pad test in favour of the intervention group both at 36–38-week pregnancy and at 6–8-week postpartum PFM strength: sign difference (p=0.00) in favour of the intervention group both at 36–38-week pregnancy and at 6–8-week postpartum
Sangsa-wang *et al*[25]	Quasiexperimental design, pre-test and post-test 1. Control (35)2. 2. Intervention (35) PFMT	N=70 with SUI at gestational age of 20–30 weeks Single centre, Thailand	1. Control 2. Intervention: 6-week PFMT	Losses to follow-up: 4 in the intervention group Adherence to PFMT: ? Not ITT analysis	Severity of SUI after intervention: Significantly lower frequency and amount of urine leakage and score of perceived SUI severity in the intervention group

ITT, intention to treat analysis; NS, non-significant; PFM, pelvic floor muscles; PFMT, pelvic floor muscle training; RCT, randomised controlled trial; RR, relative risk; SUI, stress urinary incontinence; UI, urinary incontinence; VPFMC, voluntary pelvic floor muscle contraction.

continued adherence to PFMT at 12 months was predictive of UI at that time, with less UI among women training the PFM.

The effect of pelvic floor muscle exercises after delivery to treat UI including only women with UI

Four RCTs were found,[24 41–43] and there were two follow-up studies (table 4).[20 44] PEDro scores were between 4 and 8 out of 10 (table 5). All of the women who were included were incontinent, and they were recruited from 3 months [42 43] or more[41] after delivery. Both primiparous and multiparous women were included.

Training protocol

The interventions followed different training protocols. All the trials included individual instructions in PFMT. Wilson and Herbison[43] and Glazener *et al*[42] advised the women to perform 80–100 contractions/day and introduced 3–4 follow-up sessions in the period up to 9 months after delivery. Dumoulin *et al*[41] addressed close follow-up (weekly) by a physical therapist and used a training protocol including a lower number of high-intensity contractions. In the eight weekly physical therapy appointments, they included biofeedback and electrical stimulation in the training programme. Only Dumoulin *et al*[41] introduced an intervention in the control group (massage), while the two other trials compared PFMT with current standard care, allowing self-managed PFMT but no control intervention. Adherence to the PFMT protocol was reported in two trials,[42 43] but none of them used exercise diaries.

Outcomes

All trials[24 41–43] reported clinically relevant and statistically significant short-term effects of PFMT, with a significant reduction

Table 3 Studies assessing the effect of pelvic floor muscle exercises after delivery to prevent urinary incontinence including both women with and without urinary incontinence at inclusion

Author	Design	Subjects	Training protocol	Losses to follow-up/adherence	Outcomes (Numbers and percentage (%))
Sleep and Grant[38]	2-arm RCT 1. Control (n=900): Current standard care 2. Intervention (n=900): Current standard care +individual sessions PFMT	N=1800 postpartum women recruited within 24 h of vaginal delivery. Some women had existing UI. Single centre, England	1. Controls: Current standard antenatal and postnatal care. Recommended to do PFM contractions as often as remembered and mid-stream urine stop. 4-week health diary. 2. Intervention: as above plus one individual session daily while in hospital with midwifery co-ordinator. 4-week health diary including section recommending a specific PFMT task each week.	Losses to follow-up at 3 months: 84/900 in control and 107/900 in intervention group. Adherence to PFMT: ▶ 3-month postpartum 58% in the intervention group and 42% in the control group Adverse events not stated Not ITT analysis	Self-reported UI 3-month postpartum: 1. Control: 175/793 (22%) 2. Intervention: 180/816 (22%) RR (95% CI): 1(0.83 to 1.20)
Mørkved and Bø[37] Mørkved and Bø One-year follow-up[40]	Prospective matched controlled 1. Control (n=99): Customary written postpartum instructions from the hospital. 2. Intervention (n=99): 8 weeks PFMT1. Control (n=81)2. Intervention (n=81)	N=198 women, included 8-week postpartum . Some women had existing UI. The criteria for matching: age (±2 years), parity (1, 2, 3, 4 ≥ deliveries) and type of delivery. Single centre, Norway N=180 women 1-year postpartum. All women, who had participated in a matched controlled trial were contacted per telephone 1 year after delivery.	1. Control: customary written postpartum instructions from the hospital. Not discouraged from performing PFMT on their own. Correct PFM contraction checked at enrolment. 2. Intervention: 8 weeks of intensive PFMT (in a group) led by physiotherapist, with additional home exercises 10 max contractions (each held for 6 s) and to the last 4 were 3–4 fast contractions added, repeated twice daily, between 8 and 16-week postpartum. Correct VPFMC checked at enrolment.	Losses to follow-up in the intervention group: 7 women Adherence to PFMT: ▶ 100% in the intervention group ▶ 65% in the control group. Adverse events not stated All longitudinal changes were conducted using a constant sample, including the 81 matched pairs that attended all tests . ▶ 53% in the training group and ▶ 24% in the control group reported that they were doing PFMT between 16 weeks and 1-year postpartum.	Self-reported UI at 16-week postpartum: 1 Control: 28/99 (28.3%) 2 Intervention: 14/99 (14.1%) p=0.015Standardised pad test:1. Control: 13/99 (13.1%) 2. Intervention: 3/99 (3.0%) p=0.009PFM strength: Sign difference in favour of the intervention groupSelf-reported UI at 12-month postpartum:1. Control: 31/81 (38%)2. Intervention: 14/81 (17%) p=0.003Standardised pad test: 1. Control: 14/81 (13%) 2. Intervention: 5/81 (3%) p<0.03PFM strength: Sign difference in favour of the intervention group
Meyer *et al*[36]	Allocated to two groups 1. Control (n=56): no education 2. Intervention (n=51): 12sessions PFMTover 6 weeks withphysiotherapist	N=107 primiparous women recruited 12–39-week pregnancy: 9/56 controls and 16/51 in the intervention group had self-reported SUI. Single centre, Switzerland.	1. Control (n=56): No pelvic floor re-education offered from 2–10-month postpartumIntervention (n=51): Begun at 2-month postpartum. 12 sessions over 6 weeks with physiotherapist. PFMT followed by 20 min of biofeedback and 15 min of electrostimulation.	Losses to follow-up: No Adherence not reported Adverse events not stated Not ITT analysis	Self-reported SUI 10-month postpartum: 1. Control: 8/56 (32%) 2. Intervention: 6/51 (12%)RR (95% CI): 0.82 (0.31, 2.21) Subjects cured: 1. Contro1: 1/51 (2%) p=1.0 2. Intervention: 10/56 (19%) p=0.02PFM strength: NS difference Bladder neck position and mobility: NS difference Urodynamic parameters: NS differences
Chiarelli and Cockburn [34] Chiarelli *et al*[39]	2-arm RCT 1. Control (n=350): Usual care. 2. Intervention (n=370): Continence promotion 1. Control (n=294): Usual care 2. Intervention (n=275): Continence promotion	N=720 postnatal women following forceps or ventouse delivery, or delivered a baby > or=4000 g. Some women had existing UI. Recruited at postnatal ward. Multicentre (3), Australia.	1. Control : usual care. 2. Intervention: continence promotion: One contact with physiotherapist on postnatal ward and another at 8-week postpartum (correct PFM contraction checked at second visit). Intervention included individually tailored PFMT, use of transversus abdominus contraction, the 'Knack', techniques to minimise perineal descent, postpartum wound management. Written and verbal information. Adherence strategies	Losses to follow-up: 6% in each group Adherence to PFMT: 1. Control: 57.6% 2.Intervention:83.9% ▶ Adverse events not stated IT T analysis Losses to follow-up: 30% ITT analysis	Self-reported UI 3-month postpartum: 1. Control: 126/328 (38.4%) 2. Intervention: 108/348 (31.0%)(95% CI 0.22% to 14.6%) p=0.044 OR of incontinence for the women in the intervention group compared with control group was: 0.65 (0.46–0.91), p=0.01 Self-reported UI 12-month postpartum: NS difference between groups. Practice of PFMT at 12-month promotes continence at this time
Ewings *et al*[35]	Nested RCT1. Control (n=117): Usual care2. Intervention (n=117): PFMT	N=234 women in risk or with UI recruited from postnatal wards. Two centres, UK	1. Control: usual postnatal care including verbal promotion of postnatal PFMT and leaflet explaining how to do PFMT. 2. Intervention: taught one to one with physiotherapist in hospital, with intervention to attend PFMT group at 2 and 4 months after delivery. No details of PFMT programme given.	Losses to follow-up: total 19%1. Control: 17/1002. Intervention:27/90Adherence to PFMT in the intervention group: 5/90 (5,6%) ITT analysis	Urinary incontinence at 6-month postpartum: 1. Control: 47/117 (47%) 2. Intervention: 54/117 (60%)RR (95% CI): 1.28 (0.98% to 1.67%), p=0.10

ITT; intention to treat analysis; NS, non-significant; PFM, pelvic floor muscles; PFMT, pelvic floor muscle training; RCT, randomised controlled trial; RR, relative risk; SUI, stress urinary incontinence; UI, urinary incontinence; VPFMC, voluntary pelvic floor muscle contraction.

Table 4 Studies assessing the effect of pelvic floor muscle exercises after delivery to treat urinary incontinence including only women with urinary incontinence at inclusion

Author	Design	Subjects	Training protocol	Losses to follow-up/adherence	Outcomes (numbers and percentage (%))
Wilson and Herbison[43]	2-arm RCT 1. Control (n=117): Standard postnatal PFM exercises 2. Intervention (n=113): 12 weeks of intensive PFMT	N=230 women with UI 3-month postpartum. Single centre, New Zealand	1. Control: standard postnatal PFM exercises 2. Intervention: instructions by physiotherapist (80–100 fast/slow contractions daily) 3, 4, 6 and 9-month postpartum. Use of perineometer to teach awareness of VPFMC. Three groups: a. 39 women performed only PFMT b. 36 women only trained with c. vaginal cones 15 min/day d. 38 women used both a and b	Losses to follow-up 12-month outcome assessment: 36.9% 1. Control: 91/117 2. Intervention: 54/113 Adherence to PFMT: Last month :89% Every day: 48% ► 12 months postnatally was mean number of VPFMC 86 in the intervention group and 35 in the control group	Self-reported UI at 12-month postpartum: 3. Control: 69/91 (76%) 4. Intervention: 27/54 (50%) p=0.003 Pad test: NS difference Perineometry: NS difference
Glazener *et al*[42] Glazener *et al*[44]	2-arm RCT1. Control (n=376): no visit2. Intervention (n=371): Advice+visits3 centres: Aberdeen, Birmingham, Dunedin6-year follow-up 1. Control: n=253 2. Intervention: n=263	N=747 women with UI 3 months postnatally Multicentre trial, New Zealand, UK N=516	1. Control: no visit 2. Intervention: assessment of UI, with advice on PFMT (80–100 fast/slow contractions daily) followed up 5, 7, and 9 months after delivery supplemented by bladder training if appropriate at 7 and 9 months	Lost to follow-up at 12 months: 31% 1. Control: 35% 2. Intervention: 25%Adherence to PFMT: ► In the 11th postnatal months had 78% in the intervention group (mean 20 VPFMC) and 48% in the control group (mean 5 VPFMC) done some PFMT. ITT analysis Lost to follow-up: 30% Performing any PFMT: 1. Control: 50% 2. Intervention: 50%	Self-reported UI at 12-month postpartum:Any UI 1. Control: 169/245 (69%) 2. Intervention: 167/279 (59.9%) p=0.037Severe UI: 1. Control: 78/245 (31.8%) 2. Intervention: 55/279 (19.7%) p=0.002Severe UI at 6 year follow-up: 1. Control: 99/253 (39%) 2. Intervention: 100/263 (38%) p=0.867
Dumoulin *et al*[41] Elliott *et al* (abstract)[20]	3-arm RCT 1. Control (n=20) 2. PFM rehabilitation (n=21) 3. PFM rehabilitation+training of deep abdominal muscles (n=23) A 7-year follow-up Combination of the previous two PFM rehabilitation groups (n=35)	N=64 parous women under 45 years, still presenting symptoms of SUI at least once per week 3 months or more after their last delivery. Recruited during annual gynaecological visit at an obstetric clinic, Canada	1. Control: 8 weekly sessions of massage 2. PFM rehabilitation: Weekly sessions supervised by physiotherapist for 8 weeks: 15 min electrical stimulation+25 min PFMT with biofeedback+home training 5 days/ week. 3. PFM rehabilitation as group 2+30 min of deep abdominal muscle training	Losses to follow-up: 3% Adherence rate not stated Adverse events not stated ITT analysis Performing any PFMT: 54%	Self-reported UI after the intervention period: Objective cure (less than 2 g urine on pad test): 1. Control: 0/19 2. PFM rehabilitation: 14/20 3. PFM rehabilitation+training of deep abdominal muscles: 17/23Sign difference in favour of the intervention groups (p=0.001) NS difference between the two intervention groups Incontinence Impact Questionnaire: Sign difference in favour of the intervention groups PFM strength: NS difference Objective cure (less than 2 g urine on pad test) (performed by 26 out of 35 women): 14/26 53% Incontinence Impact Questionnaire: sign. Better than at baseline
Kim *et al*[24]	2-arm RCT1. Control intervention (n=10)2. Intervention (n=10)	N=20 Postpartum women with UI Single centre, Korea	4. Control intervention: unsupervised PFMT5. Intervention: supervised PFMT	Losses to follow-up: 2/20 Adherence: ? Adverse events not stated No ITT analysis	Significant difference in favour of the supervised PFMT group on after the intervention period: ► Bristol Female Lower urinary tract Symptoms ► Vaginal squeeze pressure

ITT, intention to treat analysis; NS, non significant; PFM, pelvic floor muscles; PFMT, pelvic floor muscle training; RCT, randomised controlled trial; RR, relative risk; SUI, stress urinary incontinence; UI, urinary incontinence; VPFMC, voluntary pelvic floor muscle contraction.

Table 5 Studies assessing the effect of pelvic floor muscle exercises during pregnancy (to prevent/treat urinary incontinence), studies published as only abstracts are not included

Study	Eligibility criteria specified	Subjects randomly allocated to groups	Allocation was concealed	Groups were similar at baseline	Subjects were blinded	Therapist administrating the treatment was blinded	Assessors were blinded	Measures of key outcomes obtained from > 85% of subjects	Data analysed by intention to treat	Statistical comparison between groups were conducted	Point measures and measures of variability provided	Total score
Sleep and Grant[38]	?	+	?	?	–	–	–	+	–	+	+	4/10
Mørkved and Bø[37]	+	–	–	+	–	–	–	+	–	+	+	4/10
Wilson and Herbison[43]	+	+	+	+	–	–	–	–	–	+	+	5/10
Sampselle *et al*[30]	+	+	+	+	–	–	+	–	+	+	+	7/10
Glazener *et al*[42]	+	+	+	+	–	–	+	–	+	+	+	7/10
Meyer *et al*[36]	+	?	?	?	–	–	?	+	?	+	+	3/10
Chiarelli and Cockburn[34]	+	+	+	+	–	–	?	+	+	+	+	7/10
Reilly *et al*[29]	+	+	+	+	–	–	+	+	+	+	+	8/10
Mørkved *et al*[28]	+	+	+	+	–	–	+	+	+	+	+	8/10
Dumoulin *et al*[41]	+	+	+	+	–	–	+	+	+	+	+	8/10
Ewings *et al*[35]	+	+	+	+	–	–	–	–	+	+	+	7/10
Gorbea Chàvez *et al*[26]	+	+	+	+	–	–	–	+	+	+	?	7/10
Woldringh *et al*[33]	+	+	–	+	–	–	?	–	+	+	+	6/10
Dinc *et al*[19]	+	+	+	+	–	–	–	?	+	+	+	7/10
Mason *et al*[22]	+	+	+	+	–	–	+	–	–	+	+	7/10
Ko *et al*	+	+	+	+	–	–	?	+	?	+	+	7/10
Bø and Haakstad[17]	+	+	+	+	–	–	+	–	–	+	+	7/10
Stafne *et al*[23]	+	+	+	+	–	–	+	+	+	+	+	8/10
Sangsa-wang *et al*[25]	+	–	–	+	–	–	?	+	–	+	+	5/10
Kim *et al*[24]	+	+	–	+	–	–	+	+	–	+	+	7/10

PEDro quality score of randomised controlled trial in systematic review. +, Criterion is clearly satisfied, –, criterion is not satisfied, ?, not clear if the criterion was satisfied. Total score is determined by counting the number of criteria that are satisfied, except that scale item one is not used to generate the total score. Total scores are out of 10.

in the symptoms or frequency of UI. No adverse effects of the interventions were reported. Glazener *et al*[42] found no difference in UI between groups at 6-year follow-up, while Elliott *et al*[20] reported that, in the PFMT groups, over 50% of the women were still continent according to pad testing after 7 years. Incontinence-specific signs, symptoms and quality of life remained better than before treatment, although they were not as good as immediately after cessation of the supervised training.

DISCUSSION

This review of randomised and quasiexperimental studies in the field of PFMT, during pregnancy and after delivery, highlights the very large heterogeneity in the populations studied, use of inclusion and exclusion criteria, ways of including participants, use of outcome measures and content of the PFMT interventions. The 2008 Cochrane Review[15] concluded that women without prior UI who were randomised to intensive antenatal PFMT were 56% less likely to report UI in late pregnancy and about 30% up to 6 months postpartum. Postnatal women with persistent UI 3 months after delivery were 20% less likely than those not receiving PFMT to report UI 12 months after delivery. Hay-Smith *et al*[15] stated that it was unclear whether the population-based approach was effective and that there was not enough evidence about the long-term effects. Brostrøm and Lose[14] concluded from a narrative review that published studies on PFMT in general are small, underpowered and of uneven quality, and the available evidence suggests a lack of long-term efficacy of peripartum PFMT. Here, we focus on the methodological quality of the studies, dose–response issues in exercise trials and challenges in the long-term assessment of PFMT during pregnancy and after childbirth.

Methodological quality

Using the PEDro rating scale, 10 is the top score. However, in exercise trials, 7–8 of 10 reflects high quality, accepting that the two criteria related to blinding of the therapist and patient are almost impossible to meet in this kind of interventions. In this review, 13[17 19 21–23 26 28–30 34 35 41 42] of 18 studies received a PEDro score of 7 or 8 (table 5).

In addition to the PEDro criteria, sample size is a crucial factor in RCTs. A small sample size may cause type II error, meaning that a possible effect is not revealed because of low power. On the other hand, it is also well known that a large sample size may overestimate results in clinical trials, as small and clinically irrelevant effect sizes may reach statistical significance. We disagree with Brostrøm and Lose[14] that most antenatal and postpartum PFMT trials are small, as most of them have several hundred participants. However, there are two big trials in this area with 1169 and 1800 participants [27 38] that are of great concern when judging the effect of antenatal and postpartum PFMT. These two trials have applied very weak interventions, meaning very few visits with either a physical therapist or a midwife. Herbert and Bø[45] have shown how one trial with huge numbers clearly dilutes the effect of smaller high-quality studies when pooling them in a meta-analysis. The training dosage in the two aforementioned studies was minimal and had extremely little potential for bringing significant effects. In addition, the training period in one of the studies was only 4 weeks.[38]

Quality of the intervention: dose–response issues

There is a strong dose–response relationship in exercise training. The type of exercise and frequency, intensity and duration of the training, as well as adherence to the exercise protocol, will decide the effect size.[46 47] In the area of PFMT, the six trials with no or little effect have either used inadequate training dosages,[27 38] left the participants alone to train[27 35 38] or have huge dropouts and/or low adherence to the training protocol.[17 22 33 35 38] If the patients are not following the training protocol, we cannot evaluate the effect of PFMT. Conclusions can only be drawn on the feasibility of the programme, which is another research question. None of the studies used specific questionnaires or instruments to assess adherence. Questions about home exercise were either asked in general questionnaires or in a personal interview, and some studies used exercise diaries. Registration of adherence to the supervised training sessions was performed by those providing the supervision. Self-report by the participants may overestimate actual adherence, and we recommend that future studies improve the methods used to register adherence.

Several RCTs in the PFMT literature support the early finding by Bø *et al*[46] that there is a very large difference in the effect size between programmes with more or less intensive training and follow-up.[47] The term 'intensive training' comes from the RCT of Bø *et al*,[46] but the interpretation of this term can be questioned. The general recommendations for effective strength training to increase muscle cross-sectional area and strength are three sets of 8–12 close to maximum contractions 3–4 times/week.[48] Intensity in the exercise science literature on strength training is defined as the percentage of 1 repetition maximum (1RM), meaning how close the contraction is to the maximal contraction.[49] Bø *et al*[46] emphasised close to maximum contractions, and strength measurements were done throughout the training period. The same protocol has been used in several peripartum studies, and all of these trials show clinically relevant and statistically significant effects.[19 21 23 24–26 28 29 37 41] In a recent assessor-blinded RCT of PFMT to reduce pelvic organ prolapse, Brækken *et al*[50] found that this protocol significantly increased PFM strength and muscle thickness, reduced the muscle length and area of the levator hiatus, in addition to lifting the position of the bladder neck and rectal ampulla. Hence, PFMT is changing muscle morphology, working in the same way as strength training of general skeletal muscles.

Training volume is the total workload of training.[49] In the PFMT literature, exercise programmes with only one supervised individual or group training session/week are named intensive. Some physicians suggest that follow-up once a week does not translate into clinical reality.[14] However, it is common to offer physiotherapy at least 2–3 times a week for other conditions such as neck and low back pain; injured athletes are given supervised training at least once a day, and in rehabilitation centres, patients exercise several hours per day. There are no pharmaceutical companies that would allow treatment or research with their drugs with an ineffective dosage. Nor would anyone suggest that surgeons should do suboptimal surgery. In the long run, there is no money to be saved on low or suboptimal training dosages in physiotherapy because treating a large number of patients with ineffective interventions can be very costly. Furthermore, by recommending low dosage or unsupervised training, the patients with no or little effect may believe they have tried PFMT and may not be motivated for conducting a new period of more optimal dosage and supervised training before opting for other treatment options. Evidence-based practice means to use protocols from high-quality RCTs showing worthwhile effect sizes.[45 51]

Another specific problem in studies evaluating the effect of antenatal and postpartum PFMT is that, in most countries, it is

established practice to advise all women to do PFMT. Hence, most of the PFMT studies have compared PFMT with 'usual care'. 'Usual care' can vary between thorough individual instruction with clinical assessment and motivation for training to only providing women with written information. In some studies, the control group has done substantial PFMT.[33] Gorbea *et al*[26] compared the effect of PFMT with a group specifically asked not to train the PFM, and the difference between groups was highly significant with no women reporting UI in the PFMT group compared to 47% in the control group. To date, there are no studies comparing the effect of 'usual care' with no exercise. For some women who are able to perform strong contractions and are highly motivated to train, such initiatives may be enough, but there will be difficulties showing differences between the intervention and the control groups. However, studies have shown that few women exercise regularly with a recommended dosage during pregnancy and after childbirth without supervision.[52 53]

Physiotherapists, nurses and physicians conducted the PFMT in all the clinical trials included in the present review, and to date there has been no comparison of the effects of interventions given by different professionals. Given the widespread prevalence of UI in the female population and the evidence for PFMT, we suggest that PFMT should be part of general strength-training programmes for women. This would imply that proper teaching of PFM function and dysfunction and how to teach PFMT correctly should be part of the curricula in exercise science, fitness and sport studies.

Long-term effects

Another general critique of the effect of PFMT is a possible lack of long-term benefit especially in the peripartum studies.[14] However, the effect of any training programme will diminish with time if it is not continued. In general, strength gains decline at a slower rate than that at which strength increases owing to training. There are few studies investigating the minimal level of exercise necessary to maintain the training effect. A 5–10% loss of muscle strength per week has been shown after training cessation.[49] Greater losses have been shown in the elderly (65–75 years old) compared to the younger age group (20–30 years old), and for both groups, the majority of strength loss was from 12 to 31weeksafter cessation of training. The rate of strength loss may depend on the length of the training period prior to detraining, type of strength test used and the specific muscle groups examined. Fleck and Kraemer[49] concluded that research has not yet indicated the exact resistance, volume and frequency of strength training or the type of programme needed to maintain the training gains. However, studies indicate that to maintain strength gains or slow down strength loss, the intensity should be maintained, but the volume and frequency of training can be reduced. One or 2 days a week seem to be an effective maintenance frequency for individuals already engaged in a resistance training programme.[54]

So far, no studies have evaluated how many contractions have to be performed by subjects to maintain PFM strength after cessation of organised training. However, a long-term effect cannot be expected if the women stop exercising. In addition, a long-term effect, meaning for more than 1 year, in pregnant and postpartum women is almost impossible to evaluate, as many women would be pregnant again during the follow-up period. This is likely to negatively interfere with the short-term effect. Furthermore, in most trials, the control groups are given information or supervised training after cessation of the RCT. This was shown in the study by Mørkved *et al*[32] where the control group received the training programme after the results of the RCT were published. In the following period up to 6 years, the adherence to the PFMT programme was similar both in the original control group and the training group. The continence rate in the training group was nearly the same at 3 months and 6 years' follow-up, while the number of incontinent women in the control group had decreased in the period. However, in another study, Mørkved and Bø[37 40] showed that the initial effect of postpartum PFMT was maintained 1 year after delivery. Hence, the demand for long-term follow-up studies of PFMT in general can be questioned, and longer follow-up periods than 1 year after birth, in our opinion, are not warranted.

CONCLUSION

Based on studies with a relevant sample size, high adherence to a strength-training protocol and close follow-up, pelvic floor muscle training both during pregnancy and after delivery can prevent and treat UI. The most optimal dosage for effective PFMT is still not known. However, a training protocol following general strength-training principles, emphasising close to

Box 1

How to tell if you are contracting the pelvic floor muscles correctly

- Sit on the arm of a chair or the edge of a table. Lift the pelvic floor up from the surface you are sitting on by pulling up and contracting around the urethra, vagina and rectum. Squeeze so hard that you feel a slight trembling in your vagina. When you squeeze hard enough, you can feel the lower part of the stomach being pulled in slightly at the same time. Release the contraction without pressing downward. Try to feel the difference between relaxing and tightening the pelvic floor.
- Try to stop the flow when you are urinating. If these muscles are weak, it may be difficult to stop the flow when it is strongest. You can then test yourself towards the end of urination, which is much easier. This is only a test to see whether you are using the muscles correctly. Do not use urination for training, as this can interfere with the ability to empty your bladder completely.
- If you are not sure about whether you are doing it correctly, contact your doctor and ask for a referral to a physiotherapist with special training in women's health.

Training programme

- Lift up and inward around your urethra, vagina and rectum. Squeeze as hard as you can during each contraction and try to hold it for 6–8 s before you gently relax. Relax and breathe with a slow, regular and gentle rhythm out and in both during and between the muscle contractions. Do 8–12 repetitions in three sets. If this seems too difficult, start with fewer repetitions. Choose one or more of these starting positions:
- Sit with your legs apart and your back straight. Lift upwards and inwards around the openings in the pelvic floor.
- Stand with your legs apart, and check that the buttock muscles are relaxed while you squeeze the pelvic floor muscles.
- Kneel on all fours with your knees out to the side and feet together. Lift the pelvic floor upwards and inwards.

maximum contractions and at least an 8-week training period can be recommended. Evidence-based practice of PFMT during pregnancy and after delivery implies using protocols from high-quality RCTs showing clinically relevant and statistically significant results. Given the detrimental negative effect of a non-functioning pelvic floor on women's participation in sport and physical activity, there is a need to update the exercise in pregnancy guidelines. New guidelines for exercise during pregnancy and after childbirth should include detailed recommendations for effective PFMT, and we provide an outline in box 1.

What are the new findings?

- Pelvic floor muscle training both during pregnancy and after delivery can prevent and treat urinary incontinence. A training protocol following general strength-training principles, emphasising close to maximum contractions and at least an 8-week training period can be recommended.

How might it impact on clinical practice in the near future?

- New guidelines for exercise during pregnancy and after childbirth should include detailed recommendations for effective pelvic floor muscle training (PFMT). Curricula for instructors and coaches providing general strength-training programmes for women should include the evidence for PFMT on UI.

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REFERENCES

1 Artal R, O'Toole M. Guidelines of the American College of Obstetricians and Gynecologists for exercise during pregnancy and the postpartum period. *Br J Sports Med* 2003;37:6–12.
2 Wolfe LA, Davies GAL. Canadian guidelines for exercise in pregnancy. *Clin Obstet Gynecol* 2003;46:488–95.
3 Royal College of Obstetricians and Gynaecologists. Exercise in pregnancy, 2006; Statement 4.
4 Kramer MS. Aerobic exercise for women during pregnancy (Review). *Cochrane Database Syst Rev* 2006 Jul 19;CD000180.
5 Melzer K, Schutz Y, Boulvain M, *et al*. Physical activity and pregnancy. *Sports Med* 2010;40:493–507.
6 Bump R, Norton P. Epidemiology and natural history of pelvic floor dysfunction. *Obstet Gynecol Clin North Am* 1998;25:723–46.
7 Swift SE. The distribution of pelvic organ support in a population of female subjects seen for routine gynecologic health care. *Am J Obstet Gynecol* 2000;183:277–85.
8 DeLancey JO, Kearney R, Chou Q, *et al*. The appearance of levator ani muscle abnormalities in magnetic resonance images after vaginal delivery. *Obstet Gynecol* 2003;101:46–53.
9 DeLancey JOL, Low LK, Miller JM, *et al*. Graphic integration of causal factors of pelvic floor disorders: an integrated life span model. *Am J Obstet Gynecol*, 2008;199:610.e1–5.
10 Dietz PH, Lanzarone V. Levator trauma after vaginal delivery. *Obstet Gynecol* 2005;106:707–12.
11 Milsom I, Altman D, Lapitan MC, *et al*. Epidemiology of urinary (UI) and faecal (FI) incontinence and pelvic organ prolapse (POP). In: Abrams P, Cardozo L, Khoury S, Wein A. *Incontinence 4th International Consultation on Incontinence. Committee 1*. Birmingham, UK:Health Publication Ltd, 2009:35–111.
12 Haylen BT, de Ridder D, Freeman RM, *et al*. An International Urogynecological Association (IUGA)/International Continence Society (ICS) joint report on the terminology for female pelvic floor dysfunction. *Neurourol Urodyn* 2010;29:4–20.
13 Bø K. Urinary incontinence, pelvic floor dysfunction, exercise and sport. *Sports Med* 2004;34:451–64.
14 Brostrøm S, Lose G. Pelvic floor muscle training in the prevention and treatment of urinary incontinence in women—what is the evidence? *Acta Obstet Gynecol Scand* 2008;87:384–402.
15 Hay-Smith J, Morkved S, Fairbrother KA, *et al*. Pelvic floor muscle training for prevention and treatment of urinary and faecal incontinence in antenatal and postnatal women. *Cochrane Database Syst Rev* 2008(4):CD007471–1.
16 Maher CG, Sherrington C, Herbert RD, *et al*. Reliability of the PEDro scale for rating quality of randomized controlled trials. Phys Therg 2003;83:713–21.
17 Bø K, Haakstad LA. Is pelvic floor muscle training effective when taught in a general fitness class in pregnancy? A randomised controlled trial. *Physiotherapy* 2011;97:190–5.
18 Dias A, Assis L, Barbosa A, *et al*. Effectiveness of perineal exercises in controlling urinary incontinence and improving pelvic floor muscle function during pregnancy (abstract). *Neurourol Urodyn* 2011;30:968.
19 Dinc A, Kizilkaya Beji N, Yalcin O. Effect of pelvic floor muscle exercises in the treatment of urinary incontinence during pregnancy and the postpartum period. *Int Urogynecol J Pelvic Floor Dysfunct* 2009;20:1223–31.
20 Elliott V, Dumoulin C, Martin C, *et al*. Physical therapy for persistent postpartum stress urinary incontinence: A seven year follow-up study (abstract). *Neurourol Urodyn* 2009;28:820.
21 Ko PC, Liang CC, Chang SD, *et al*. A randomized controlled trial of antenatal pelvic floor exercises to prevent and treat urinary incontinence. *Int Urogynecol J Pelvic Floor Dysfunct* 2011;22:17–22.
22 Mason L, Roe B, Wong H, *et al*. The role of antenatal pelvic floor muscle exercises in prevention of postpartum stress incontinence: a randomised controlled trial. *J Clin Nurs* 2010;19:2777–86.
23 Stafne S, Salvesen K, Romundstad P, *et al*. Does regular exercise including pelvic floor muscle training prevent urinary and anal incontinence during pregnancy? A randomised controlled trial. *BJOG* 2012;119:1270–80.
24 Kim EY, Kim SY, Oh DW. Pelvic floor muscle exercises utilizing trunk stabilization for treating postpartum urinary incontinence: randomized controlled pilot trial of supervised versus unsupervised training. *Clin Rehabil* 2012;26:132–41.
25 Sangsawang B, Serisathien Y. Effect of pelvic floor muscle exercise programme on stress urinary incontinence among pregnant women. *J Adv Nurs* 2012;68:1997–2007.
26 Gorbea Chavez V, Velazquez Sanchez MdP. Efecto de los ejercicios del piso pelvico durante el embarazo y el puerperio en la prevencion de la incontinencia urinaria de esfuerzo (Effect of pelvic floor exercise during pregnancy and puerperium on prevention of urinary stress incontinence). *Ginecol Obstet Mex* 2004;72:628–36.
27 Hughes P, Jackson S, Smith A, *et al*. Can antenatal pelvic floor exercises prevent postnatal incontinence? (abstract). *Neurourol Urodyn* 2001;20:447–8.
28 Mørkved S, Bø K, Schei B, *et al*. Pelvic floor muscle training during pregnancy to prevent urinary incontinence: a single-blind randomized controlled trial. *Obstet Gynecol* 2003;101:313–19.
29 Reilly ET, Freeman RM, Waterfield MR, *et al*. Prevention of postpartum stress incontinence in primigravidae with increased bladder neck mobility: a randomised controlled trial of antenatal pelvic floor exercises. *BJOG* 2002;109:68–76.
30 Sampselle CM, Miller JM, Mims BL, *et al*. Effect of pelvic muscle exercise on transient incontinence during pregnancy and after birth. *Obstet Gynecol* 1998;91:406–12.
31 Agur WI, Steggles P, Waterfield M, *et al*. The long-term effectiveness of antenatal pelvic floor muscle training: eight-year follow up of a randomised controlled trial. *BJOG* 2008;115:985–90.
32 Mørkved S, Rømmen K, Schei B, *et al*. No difference in urinary incontinence between training and control group six years after cessation of a randomized controlled trial, but improvement in sexual satisfaction in the training group (abstract). *Neurourol Urodyn* 2007;26:667.
33 Woldringh C, van den Wijngaart M, Albers-Heitner P, *et al*. Pelvic floor muscle training is not effective in women with UI in pregnancy: a randomised controlled trial. *Int Urogynecol J Pelvic Floor Dysfunct* 2007;18:383–90.
34 Chiarelli P, Cockburn J. Promoting urinary continence in women after delivery: randomised controlled trial. *BMJ* 2002;324:1241–6.
35 Ewings P, Spencer S, Marsh H, *et al*. Obstetric risk factors for urinary incontinence and preventative pelvic floor exercises: cohort study and nested randomized controlled trial. *J Obstet Gynaecol* 2005;25:558–64.

36 Meyer S, Hohlfeld P, Achtari C, *et al*. Pelvic floor education after vaginal delivery. *Obstet Gynecol* 2001;97(5 Pt 1):673–7.
37 Mørkved S, Bø K. The effect of postpartum pelvic floor muscle exercise in the prevention and treatment of urinary incontinence. *Int Urogynecol J Pelvic Floor Dysfunct* 1997;8:217–22.
38 Sleep J, Grant A. Pelvic floor exercises in postnatal care. *Midwifery* 1987;3:158–64.
39 Chiarelli P, Murphy B, Cockburn J. Promoting urinary continence in postpartum women: 12-month follow-up data from a randomised controlled trial. *Int Urogynecol J Pelvic Floor Dysfunct* 2004;15:99–105.
40 Mørkved S, Bø K. Effect of postpartum pelvic floor muscle training in prevention and treatment of urinary incontinence: a one-year follow up. *BJOG* 2000;107:1022–8.
41 Dumoulin C, Lemieux MC, Bourbonnais D, *et al*. Physiotherapy for persistent postnatal stress urinary incontinence: a randomized controlled trial. *Obstet Gynecol* 2004;104:504–10.
42 Glazener CM, Herbison GP, Wilson PD, *et al*. Conservative management of persistent postnatal urinary and faecal incontinence: randomised controlled trial. *BMJ* 2001;323:593–6.
43 Wilson PD, Herbison GP. A randomized controlled trial of pelvic floor muscle exercises to treat postnatal urinary incontinence. *Int Urogynecol J Pelvic Floor Dysfunct* 1998;9:257–64.
44 Glazener CM, Herbison GP, MacArthur C, *et al*. Randomised controlled trial of conservative management of postnatal urinary and faecal incontinence: six year follow up. *BMJ* 2005;330:337.
45 Herbert RD, Bo K. Analysis of quality of interventions in systematic reviews. *BMJ* 2005;331:507–9.
46 Bø K, Hagen RH, Kvarstein B, *et al*. Pelvic floor muscle exercise for the treatment of female stress urinary incontinence. III. Effects of two different degrees of pelvic floor muscle exercises. *Neurourol Urodyn* 1990;9:489–502.
47 Imamura M, Abrams P, Bain C, *et al*. Systematic review and economic modelling of the effectiveness and cost-effectiveness of non-surgical treatments for women with stress urinary incontinence. *Health Technol Assess* 2010;14:1–188.
48 Haskell WL. Dose-response issues from a biological perspective. In: Bouchard C, Shephard RJ, Stephens T, eds. *Physical activity, fitness, and health*. Champaign, IL: Human Kinetics Publishers, 1994:1030–9.
49 Fleck SJ, Kraemer WJ. *Designing resistance training programs*. 3rd edn. Champaign, IL: Human Kinetics Publishers, 2004.
50 Braekken IH, Majida M, Engh ME, *et al*. Morphological changes after pelvic floor muscle training measured by 3-dimensional ultrasonography: a randomized controlled trial. *Obstet Gynecol* 2010;115(2 Pt 1):317–24.
51 Bø K, Herbert RD. When and how should new therapies become routine clinical practice? *Physiotherapy* 2009;95:51–7.
52 Bø K, Haakstad AH, Voldner N. Do pregnant women exercise their pelvic floor muscles? *Int Urogynecol J Pelvic Floor Dysfunct* 2007;18:733–6.
53 Bø K, Owe KM, Nystad W. Which women do pelvic floor muscle exercises six months' postpartum? *Am J Obstet Gynecol* 2007;197:49 e41–45.
54 Kraemer WJ, Ratamess NA. Fundamentals of resistance training: progression and exercise prescription. *Med Sci Sports Exerc* 2004;36:674–88.

APPENDIX

EMBASE (through OvidSP) 1980 to 2012 week 35

1	exp Pregnancy/ OR Pregnancy complication/ OR Maternal disease/ OR Puerperal disorder/
2	Pelvis floor/
3	Pelvis/ AND (Muscle/ OR Skeletal Muscle/ OR Muscle Contraction/ OR Muscle Training/)
4	2 OR 3
5	Kinesiotherapy/ OR Muscle Training/
6	4 AND 5
7	6 OR Pelvic Floor Muscle Training/
8	Urine Incontinence/
9	1 AND 7 AND 8

CENTRAL through Wiley's Cochrane Library) Issue 8 of 12 August 2012

1	Pregnan* OR maternal OR gravidity OR gestation OR "after delivery" OR "post delivery" OR post-partus OR post-partum OR postpartus OR postpartum OR "post labor" OR postnatal* OR prenatal* OR antenatal* OR childbirth OR childbearing OR "child bearing"
2	(Pelvis OR pelvic) AND (floor OR muscle* OR musculat* OR diaphragm*)
3	Exercis* OR training OR pfmt OR strengthen* OR myofunctional
4	(Urine OR urinary) AND (continen* OR incontinen* OR leak* OR wetting)
5	1 AND 2 AND 3 AND 4

PubMed

1	exp Pregnancy OR Puerperal Disorders(mesh:noexp) OR Pregnan*(tiab) OR maternal(tiab) OR gravidity(tiab) OR gestation(tiab) OR "after delivery"(tiab) OR "post delivery"(tiab) OR post-partus(tiab) OR post-partum(tiab) OR postpartus(tiab) OR postpartum(tiab) OR "post labor"(tiab) OR postnatal*(tiab) OR prenatal*(tiab) OR antenatal*(tiab) OR childbirth(tiab) OR childbearing(tiab) OR "child bearing"(tiab)
2	Pelvis(mesh) OR pelvis(tiab) OR pelvic(tiab)
3	Exercise therapy(mesh) OR Exercise(mesh) OR Exercise Movement Techniques(mesh) OR exercis*(tiab) OR strengthen*(tiab) OR training(tiab)
4	Urinary Incontinence(mesh) OR ((urine(tiab) OR urinary(tiab)) AND (continen*(tiab) OR incontinen*(tiab) OR leak*(tiab) OR wetting(tiab)))
5	Clinical trial(pt) OR random*(tiab) OR trial(tiab) OR group(tiab) OR groups (tiab)
6	1 AND 2 AND 3 AND 4 AND 5

PEDro (www.pedro.org.au) update date 4 September 2012
Therapy: 'Strength Training'
Problem: 'Incontinence'
Body Part: 'Lumbar spine, sacroiliac joint or pelvis'

Total

EMBASE	69 references
CENTRAL	34 references
PubMed	73 references
PEDro	5 references
Total from databases	181 references (of which 43 duplicates)
Total deduplicated	138 references