Pelvic Floor Exercises During and After Pregnancy: A Systematic Review of Their Role in Preventing Pelvic Floor Dysfunction

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Abstract

Objective: To review the literature on the origin, anatomical rationale, techniques, and evidence-based effectiveness of peripartum pelvic floor exercises (PFEs) in the prevention of pelvic floor problems including urinary and anal incontinence, and prolapse.

Data Sources: Literature was reviewed for background information. MEDLINE, EMBASE, CINAHL, and proceedings of scientific meetings were searched for evidence-based data. A comprehensive literature search was performed to find all studies that involved the use of antepartum and/or postpartum PFEs. For the MEDLINE (1966 to 2002) and CINAHL (1980 to 2002) searches, the following key words were used: urinary incontinence (prevention and control, rehabilitation, therapy), fecal incontinence, exercise or exercise therapy, Kegel, muscle contraction, muscle tonus, muscle development, pelvic floor, pregnancy, puerperium, puerperal disorders. For the EMBASE (1980 to 2002) search, the following key words were used: micturition disorder (prevention, rehab, disease management, therapy), fecal incontinence, labour complication, pregnancy disorder, puerperal disorder, antepartum care, pregnancy, kinesiotherapy, exercise, pelvic floor, bladder. A manual search was performed of available abstracts presented at the annual scientific meetings of the International Continence Society (1997, 1999 to 2002), American Urogynecologic Association (1997 to 1998, 2000 to 2002), and International Urogynecological Association (1997, 1999 to 2002). Twelve studies evaluating the role of antepartum PFE were found, of which 3 randomized controlled trials (RCTs) comparing PFEs for the prevention of urinary incontinence to controls were included. Twelve studies evaluating postpartum PFEs for prevention of urinary incontinence were reviewed, of which 4 RCTs were included. Five studies evaluating postpartum PFEs for the prevention of anal incontinence were reviewed, of which 4 RCTs were included. Participants in the studies were primiparous women.

Data Tabulation and Integration: Data were extracted using a standardized collection form. Quality of the data was evaluated using the Jadad scale. Where possible, a meta-analysis was conducted using a random effect model. Heterogeneity between trials was assessed and sensitivity analyses were performed.

Results: Antepartum PFEs, when used with biofeedback and taught by trained health care personnel, using a conservative model, does not result in significant short-term (3 months) decrease in postpartum urinary incontinence, or pelvic floor strength. Postpartum PFEs, when performed with a vaginal device providing resistance or feedback, appear to decrease postpartum urinary incontinence and to increase strength. Reminder and motivational systems to perform "Kegel" exercises are ineffective in preventing postpartum urinary incontinence. Postpartum PFEs do not consistently reduce the incidence of anal incontinence.

Conclusion: Postpartum PFEs appear to be effective in decreasing postpartum urinary incontinence. Data regarding the effect of PFEs on prevention of anal incontinence are lacking, and also on its prevention of prolapse.

Résumé

Objectif : Présenter une synthèse des publications médicales sur l'origine, les justifications anatomiques, les techniques et les preuves de l'efficacité des exercices du plancher pelvien (EPP), faits avant ou après l'accouchement, dans le but de prévenir les problèmes du plancher pelvien, notamment l''incontinence urinaire et anale et le prolapsus.

Sources des données : Les publications permettant d'avoir une vue d'ensemble historique ont été analysées. Une recherche sur MEDLINE, EMBASE, CINAHL a été menée pour recueillir les documents susceptibles de fournir des données scientifiques sur la question. Les comptes-rendus de réunions scientifiques ont été examinés, suivi par une recherche approfondie de toutes les publications qui présentaient des rapports d'étude portant sur les EPP effectués avant ou après l'accouchement. Pour la recherche sur MEDLINE (1966–2002) et CINAHL(1980–2002), les mots clés suivants furent utilisés : *urinary incontinence (prevention and control, rehabilitation, therapy), fecal incontinence, exercise or exercise therapy, Kegel, muscle contraction, muscle tonus, muscle development, pelvic floor, pregnancy, puerperium, puerperal disorders.* Pour la recherche sur EMBASE (1980–2002), les mots clés suivants furent utilisés: *micturition disorder (prevention, rehab, disease management, therapy), fecal incontinence, labour complication, pregnancy disorder, puerperal disorder, antepartum care, pregnancy, kinesiotherapy, exercise, pelvic floor, bladder.* On a fait une recherche bibliographique des résumés présentés aux rencontres scientifiques annuelles de l'*International Continence Society* (1997, 1999–2002), de l'*American Urogynecologic Association* (1997–1998, 2000–2002) et de l'*International Urogynecological*

Key Words
Pelvic floor exercises, Kegel, biofeedback, urinary incontinence, fecal incontinence, pelvic floor dysfunction

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Association (1997, 1999–2002). Douze études évaluant le rôle des EPP avant l'accouchement comparant les EPP à des témoins en matière de prévention de l'incontinence urinaire chez les primipares ont été receuillies, desquels 3 essais comparatives randomises (ECR) ont été inclus et analysés. Douze études évaluant le role des EPP après l'accouchement comparant les EPP à des témoins en matière de prévention de l'incontinence urinaire chez les primipares ont été receuillies, desquels 4 essais comparatives randomises (ECR) ont été inclus et analysés. Cinq études évaluant le role des EPP après l'accouchement comparant les EPP à des témoins en matière de prévention de l'incontinence fécale chez les primipares ont été receuillies, desquels 4 essais comparatives randomises (ECR) ont été inclus et analysés.

Compilation et intégration des données : Les données pertinentes ont été recueillies au moyen d'un formulaire normalisé conçu à cette fin. L'évaluation de la qualité des données a été effectuée à partir de l'échelle de Jadad. Dans la mesure du possible, on a mené une méta-analyse utilisant un modèle à effets aléatoires. L'hétérogénéité des essais entre eux a été évaluée et soumise à des analyses de sensibilité.

Résultats : À court terme (3 mois), lorsqu'ils sont employés avec biofeedback et enseignés par un personnel médical formé, les EPP faits avant l'accouchement n'entraînent pas, de façon statistiquement significative, une réduction de l'incontinence urinaire ni une augmentation de la force du plancher pelvien après l'accouchement, selon une évaluation à partir d'un modèle conservateur. Faits après l'accouchement, les EPP, pour lesquels la patiente utilise un dispositif vaginal offrant une résistance ou une rétroaction, semblent réduire l'incontinence urinaire de postpartum et améliorer la force du plancher pelvien. Les systèmes de rappel ou de motivation pour la pratique des « exercices de Kegel » n'offrent pas une prévention efficace de l'incontinence urinaire de postpartum. Les EPP faits pendant le postpartum ne réduisent pas l'incidence d'incontinence anale de manière prévisible.

Conclusion : Les EPP faits pendant le postpartum semblent être efficaces pour la réduction de l'incontinence urinaire de postpartum. Les données sur l'effet des EPP pour la prévention de l'incontinence anale et du prolapsus sont insuffisantes.

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INTRODUCTION

Pelvic floor exercises (PFEs) involve the voluntary contraction of the levator ani (pelvic floor) muscles in order to increase their tone, strength, and endurance. PFEs are generally recommended for pregnant women to reduce urinary incontinence postpartum, although there is little existing data to support this recommendation. This article reviews the current literature on PFE, including the reported efficacy and proposed mechanism of cure.

HISTORICAL BACKGROUND

During the 1920s and 1930s, Minnie Randell, Sister-in-Charge of the Conjoint Massage and Remedial Exercises Training Course in London, UK, trained student physiotherapists to encourage women to contract their pelvic floor,[1] as a means of preventing urine loss and prolapse.[2] These exercises are thought to have originated from Swedish gymnastics.[3] In 1948, Dr A. H. Kegel first reported the use of voluntary exercise of the pelvic floor musculature.[4] Kegel's work was inspired by personal communication with van Skolkvik,[4] who noted unusually firm perinea in South African tribal native women: "Exercises by contraction of vaginal muscles on [the midwife's] distended fingers was begun several days after birth and was continued periodically for several weeks, until the desired result was obtained."[4]

The first study on the effectiveness of "Kegel exercises" reported a 75% cure rate in 117 women.[5] It was noted that injured muscle would regain most of its function when there was a demand for its use.[6] On this premise, Kegel designed his perineometer, a biofeedback apparatus to exercise the pelvic floor.

EPIDEMIOLOGY OF PERIPARTUM PELVIC FLOOR DYSFUNCTION

Pelvic floor dysfunction refers mainly to urinary incontinence, anal incontinence, and pelvic organ prolapse.

URINARY INCONTINENCE

In pregnancy, the estimated prevalence of urinary incontinence ranges between 42%[7] and 53%.[8] Approximately 38%[7,9] to 61%[10] of primigravid women will develop urinary incontinence during their pregnancy, of whom half will remain incontinent 8 weeks postpartum.[7] Of the continent pregnant women, 34% will develop *de novo* incontinence after childbirth, and most will remain incontinent at 8 weeks postpartum.[7] Therefore, approximately 35% of primiparous women will be incontinent 2 months postpartum.[10-12] Lower incontinence rates of 10% to 16% have been reported for women who delivered by Caesarean section.[10,12] Postpartum incontinence seems to be mild in severity and exerts little impact upon quality of life.[9,13]

ANAL INCONTINENCE

Anal incontinence is the unwanted passage of gas (flatal incontinence) or solid or liquid feces (fecal incontinence) via the anal canal. Flatal incontinence has been reported in 8.2% of primigravid women before or during pregnancy.[14] The incidence of fecal incontinence before delivery ranges from 0%[14] to 2.1%,[15] and in primigravid women, is almost always related to bowel disease such as inflammatory bowel disease or irritable bowel syndrome. In a longitudinal study[16] evaluating 59 nulliparous women through their first 2 deliveries, 22% complained of anal incontinence (including flatal) after their first delivery, with deterioration after the second vaginal delivery occurring in 88% of the women. Similar rates have been reported by other authors.[17,18] Farrell *et al.*[17] noted that instrumented vaginal delivery substantially increased the risk of anal incontinence, with symptoms occurring in 33% of women following vacuum-assisted

delivery, and in 44% of women following forceps delivery. Other studies have suggested that 1.2% to 4% of women develop fecal incontinence after spontaneous vaginal delivery, 3% after Caesarean section, and 9% after forceps delivery.[15,17,18]

PELVIC ORGAN PROLAPSE

The limited investigation of prolapse during and after delivery has documented that primiparous women can develop (mild) detectable prolapse during pregnancy[19] and following childbirth.[20,21] Forty percent of women who delivered vaginally had a cystocele, whether or not the delivery was instrumented.[21] No data have been reported for women who delivered by Caesarean section.

ANATOMY OF THE PELVIC FLOOR

A brief review of the anatomy of the pelvic floor is *de rigueur* to better understand the role of the pelvic musculature.[22] The endopelvic fascia participates in the supra levator support of pelvic organs. This fascia attaches the pelvic organs to the arcus tendineus fascia pelvis via the round, cardinal, uterosacral ligaments, pubocervical fascia (between the vaginal and bladder), and the rectovaginal fascia. The arcus tendineus fascia pelvis is a condensation of the fascia covering the inner surface of the obturator internus and extends from the posterior surface of the pubis to the ischial spine. The combined action of the endopelvic fascia and the levator muscles is similar to that of a hammock.[23]

The pelvic floor muscles consist of two groups of muscles: the urogenital diaphragm and the pelvic diaphragm. The urogenital diaphragm is the most inferior supporting structure of the pelvic floor. It consists of the bulbocavernosus, transversalis, and ischiocavernosus muscles, and its function is to provide stabilization of the perineal body (onto which these muscles insert), which in turn supports the anal sphincter and the lower vagina.

The pelvic diaphragm includes the levator ani, obturator, and coccygeus muscles, of which the levator ani is functionally the most important and consists of the puborectalis, pubococcygeus, and ileococcygeus. The puborectalis originates from the posterior aspect of the pubis and inserts medially into the perineal body, the vagina, and the lower anal canal. The pubococcygeus originates from the pubis and inserts into the coccyx. The ileococcygeus originates from the arcus tendineus levator ani and inserts into the coccyx. The muscular fibres of the levator ani consist of slow and fast twitch fibres. The slow twitch fibres provide basal tone; the fast twitch fibres allow voluntary control and reflex contraction in response to rapid increases in intra-abdominal pressure (e.g., cough, sneeze).

ROLE OF PELVIC FLOOR EXERCISES IN PELVIC FLOOR DYNAMICS

In the resting state, the sling-like puborectalis closes the genital hiatus in proximity to the pubis. The pelvic organs rest above the levator plate, formed by the pubococcygeus and the ileococcygeus. During micturition or defecation, the puborectalis sling and levator plate relax, allowing the bladder (or rectum) to evacuate its contents. When contracted (whether reflexively with a cough or voluntarily), the puborectalis sling closes off the genital hiatus. Poor levator ani function may contribute to stress incontinence as a result of lack of posterior support to the bladder neck, as it is postulated that a strong pelvic floor provides a backboard against which the bladder neck gets "compressed" during increases in intra-abdominal pressure.[24] Pelvic floor muscle exercises are devised mainly to strengthen this muscle group and thus promote urinary continence and pelvic organ support. An effective pelvic floor contraction is able to produce an increase in maximum urethral closure pressure.[25] Whether this reflects contraction of the levator ani or of the external striated urethral sphincter has not been clarified. However, an increase of intraurethral pressure (maximal urethral closure pressure) has not been consistently shown,[26-28] 3 months after treatment with PFEs for urinary incontinence.

Furthermore, Jones *et al.*[29] concluded that PFEs can improve a woman's "abiliry to voluntarily contract the external anal sphincter either by improving the strength of the sphincter and/or by increasing the patient's ability to perceive weak distension of the rectum."[29]

AVAILABLE PELVIC FLOOR EXERCISE TECHNIQUES

Pelvic floor exercises can be performed either independently (commonly referred to as Kegel exercises or voluntary pelvic floor muscle contraction)[3] or with the assistance from biofeedback,[3] weighted vaginal cones,[3] electrical stimulation,[3] or any intravaginal resistance devices such as the Kegelmaster2000, or the Magic Banana, which do not provide feedback.

"KEGELS"

A voluntary pelvic floor muscle contraction is often unofficially called a "Kegel" contraction. It is done repetitively on a daily basis, preferably while sitting or standing, to improve muscle strength, and does not involve any intravaginal device to increase resistance or provide feedback on strength. The woman may be coached to contract the pelvic floor in the same manner as she would to interrupt the stream while urinating. However, she is *strongly discouraged* from continuing to perform Kegels during micturition, as this could potentially affect bladder function.[30] For better effectiveness, the woman can place a finger into her vagina and squeeze on the finger by contracting her pelvic muscles only, taking care not to use other muscles in the abdomen, legs, or buttocks. If she can feel her muscles tighten around her finger, she has identified the correct muscles to be exercised.

Originally, Dr Kegel proposed that 20 to 40 hours of progressive resistance training while using his perineometer

were required to restore tone and function.[4] These hours would be best spread over 20 to 60 days, with 20 minutes of exercises 3 times a day. Progressive resistance was assured by gradual increment of pressure by 1 mm to 2 mm of mercury daily.[4]

Other recommended regimens include the following:

- Contract maximally for 6 to 8 seconds, then rest for a few seconds. Repeat 10 to 12 times for each set, performing 3 sets 3 to 4 times weekly.[31,32]
- Contract near-maximally for 6 to 8 seconds, with each contraction immediately followed by 3 to 4 fast contractions, followed by a 6-second rest. Repeat 8 to 12 times, twice daily.[33]

BIOFEEDBACK

Biofeedback,[3] in the context of controlling pelvic floor dysfunction, refers to a device inserted into the vagina or anal canal that measures the level of muscle activity generated by a voluntary pelvic floor contraction. This muscle activity can be detected via the actual pressure produced or the electrical activity created by the muscle contraction. The muscle activity is transmitted to a computerized or mechanical device that produces a visual readout of the strength generated. Additionally, electromyogram (EMG) surface electrodes (similar to those used for recording of electrocardiograms) can be placed on the abdominal wall to record and discourage abdominal activity.

A typical biofeedback session lasts 30 minutes and can be performed at home or in an office setting. Biofeedback courses in our centre commonly include 10 weekly sessions of 15 minutes of active exercises. In addition, women are encouraged to perform 10 to 15 minutes of Kegel exercises three times daily at home.

WEIGHTED VAGINAL CONES

Vaginal cones[3] provide a form of sensory feedback. A commercial set usually contains 5 cones of varying weights (typically 20 g to 70 g) and, sometimes, of varying sizes. The woman inserts the cone well into the vagina, above the levator muscles, with the pointed end toward the introitus, and she contracts the levator muscles to prevent the cone from slipping out. The lightest cone is used first, and once she is able to hold it in for 15 to 20 minutes twice daily, for 2 days in a row, she uses the next weight. As training proceeds, cones of increased weight are used. When satisfactory continence is obtained, the cone use can be reduced to 3 times a week to maintain strength. The cones are cleaned with soap and water, and sterilization is not required.

ELECTRICAL STIMULATION

Electrical stimulation[3] is a passive way of exercising and strengthening the pelvic floor using a vaginal device that delivers variable rates of current through a vaginal probe. The intent is to stimulate successfully each pudendal nerve to activate the pelvic-floor musculature and thereby improve urethral closure pressure. This is particularly useful in women who are completely unable to voluntarily contract their levator ani and so cannot perform Kegel exercises or use biofeedback or vaginal cones.

A typical protocol in our institution consists of a weekly session of 7.5 minutes of stimulation on each side of the pelvis, at a frequency of 50 Hz. The intensity is sufficient to provide a pelvic floor muscle contraction and as high as is comfortable for the women. The muscle is exercised for 2 seconds and allowed to rest for 4 seconds. Treatment usually lasts for 10 weeks.

RESISTANCE DEVICES

Multiple resistive devices are marketed directly to women, with each manufacturer suggesting their own protocol. Generally, the devices are inserted into the vagina to provide a resistance against which the levator muscles are contracted. Resistive devices do not provide a feedback.

EVIDENCE-BASED EFFECTIVENESS OF ANTEPARTUM AND POSTPARTUM PELVIC FLOOR EXERCISES

METHODS

The objectives of this part of the review were to establish if antepartum or postpartum PFEs prevented postpartum urinary incontinence or improved postpartum pelvic floor strength, and to determine if PFEs prevented postpartum anal incontinence or prolapse.

Studies were included if they randomized pregnant women between any technique of PFEs (biofeedback, vaginal cones, electrical stimulation, Kegel, supervised Kegel) and control treatment. Non-randomized trials were not included in the analysis, but included in a commentary section. Outcomes studied included presence of postpartum urinary incontinence as determined by self-report, urodynamic studies, standardized pad test, or diary; pelvic floor strength as evaluated by perineometry; and self-report of anal (flatal and fecal) incontinence.

SEARCH STRATEGY

A comprehensive literature search was performed to find all studies that involved the use of antepartum and/or postpartum PFEs. For the MEDLINE (1966 to 2002) and CINAHL (1980 to 2002) searches, the following key words were used: urinary incontinence (prevention and control, rehabilitation, therapy), fecal incontinence, exercise or exercise therapy, Kegel, muscle contraction, muscle tonus, muscle development, pelvic floor, pregnancy, puerperium, puerperal disorders. For the EMBASE (1980 to 2002) search, the following key words were used: micturition disorder (prevention, rehab, disease management, therapy), fecal incontinence, labour complication, pregnancy disorder, puerperal disorder, antepartum care, pregnancy, kinesiotherapy, exercise, pelvic floor, bladder.

A manual search was performed of available abstracts presented at the annual scientific meetings of the International

Continence Society (1997, 1999 to 2002), American Urogynecologic Association (1997 to 1998, 2000 to 2002), and International Urogynecological Association (1997, 1999 to 2002).

ANALYSIS

Eligible articles were evaluated for methodological quality and appropriateness for inclusion. Assessment of methodological quality was undertaken using the Jadad scale,[34] which rates aspects of randomized controlled trials (RCTs) thought to have the most influence on bias: randomization, double blinding, and treatment of withdrawals and dropouts. A maximum of 5 points can be attributed and a score of 0 denotes poor methodology.

When possible (i.e., if methodology was comparable), RCTs were combined in a meta-analysis (MetaView 4.1, Review Manager 4.1.1, Cochrane Collaboration). Standardized mean differences were used for continuous data and relative risk for dichotomous data. When pooling was not possible, results were discussed. Heterogeneity was tested, and if significant, a random effects' estimation was used to combine inhomogeneous studies.

RESULTS

Antepartum Pelvic Floor Exercises to Prevent Postpartum Urinary Incontinence and to Improve Pelvic Floor Strength

Overall, 2 postal surveys,[11,35] 4 non-randomized controlled trials,[36-39] and 6 randomized controlled trials[13,40-44] were found. A meta-analysis evaluating the role of physical therapies for prevention of urinary and fecal incontinence in adults was also published.[45]

Three RCTs were included.[13,41,43] One meeting abstract[42] was discarded because full publication followed,[43] and one RCT was excluded because data were not presented in a usable way.[40] One RCT[44] consisted of a long-term follow-up of a previous publication[13] and was not included into the meta-analytic statistical calculation.

No RCTs limited recruitment to continent primigravidae: all enrolled both continent and incontinent primigravid women early in their second trimester. The trials were methodologically homogeneous. All experimental groups had direct teaching and supervision of the technique by experienced physiotherapists and daily PFEs; in the control groups, PFEs were neither discouraged nor recommended. PFEs continued in the postpartum period in one study.[41] Further details of trial methodology are presented in Table 1 for included studies.[13,41,43]

Testing for heterogeneity was significant (chi-square = 7.18; $df = 2$; $P = 0.028$). Heterogeneity is an attribute of a meta-analysis that suggests a difference in the studies themselves that would limit the ability to combine them to produce an overall estimate of the effect. Since the methodology of the studies was similar, we combined them, despite the heterogeneity found. However, we used a random effect model, which provides a more conservative estimate.

Antepartum PFE and Urinary Incontinence: RCT

As noted in Figure 1, the analysis resulted in a (not statistically significant) 25% decrease in the relative risk of urinary incontinence 3 to 6 months postpartum in the PFE groups compared to controls (relative risk [RR], 0.75; 95% confidence interval [CI], 0.56–1.02). Thus, 17 women would have to do PFEs to prevent one case of urinary incontinence. At 12 months postpartum, the effect seems to persist, according to one long-term study.[44]

When a sensitivity analysis was performed, excluding the one study published only in abstract form that had more dissemblance with the other two,[41] there was a significant 35% decrease in the relative risk of urinary incontinence at 3 to 6 months postpartum in the PFE groups compared to controls (RR, 0.65; 95% CI, 0.51–0.82; data not shown, random effect model).

The effect of regular aerobic exercises in pregnancy on urinary incontinence was evaluated[46] in a randomized controlled trial on 370 nulliparous women. The study intervention consisted of 1 hour of aerobic exercise (at 60% to 70% maximal heart rate), 3 times weekly, from 20 weeks to birth. There was no difference compared to controls in urinary incontinence 3 months postpartum. However, compliance was low in the experimental group: only 23% attended an exercise session at least once a week for 16 weeks.

Antepartum Pelvic Floor Exercises and Pelvic Floor Muscle Strength: RCT

As noted in Figure 2, pelvic floor muscle (PFM) strength was non-significantly better in the antenatal PFE groups (standardized mean difference, 0.75 cm H_2O; 95% CI, –0.42–1.91). The RCT[40] not included in the meta-analysis showed that PFEs significantly decreased urinary incontinence postpartum and increased PFM strength at 6 weeks and 6 months postpartum.

Antepartum Pelvic Floor Exercises and Urinary Incontinence: Non-RCT Studies

Surveys of daily antepartum PFEs in preventing urinary incontinence suggested a protective effect, but were of poor methodologic quality.[11,35] One controlled study reported on the symptom of stress urinary incontinence[39]: women instructed on the performance of antepartum PFE presented with less urinary incontinence at 3 months postpartum.

Antepartum Pelvic Floor Exercises and Pelvic Floor Muscle Strength: Non-RCT Studies

Controlled (non-randomized) studies mainly looked at a surrogate outcome: pelvic floor muscle strength.[36-39] Although studies with surrogate outcomes are suboptimal, there is a positive correlation between PFM strength measured by perineometry and stress urinary incontinence.[36] These controlled studies showed that women instructed to perform daily PFEs during the pregnancy consistently improved their muscle strength.[36,37]

TABLE I

ANTENATAL PFE IN PREVENTION OF URINARY INCONTINENCE: SUMMARY OF RANDOMIZED CONTROLLED TRIALS*

Authors	Methods	Population	Intervention	Outcome	Results	Quality Rating†
Sampselle 1998[40]	• 2 arms RCT • Masked assessor	• N = 72 (TG 34, CG 38) • Primigravida • <20 weeks	• Instruction on PFEs • Correct technique taught and verified • 30 Kegel contractions daily (maximum intensity)	• Muscle strength (instrumented speculum) • UI questionnaire • 6 and 12 months PP	• UI at 6 mo: decreased UI in TG • UI at 12 mo: no difference • Muscle strength: no difference	3
‡Hughes 2001[41] (Abstract only)	• 2 arms RCT	• N = 1169 (TG 585, CG 584) • Primigravida	PFE teaching sessions: • Small groups • One-to-one sessions • Written instruction • Daily Kegels ante- and postpartum	• BFLUTS • 6 months PP	• No difference in UI	2
‡Mørkved 2003[43]	• 2 arms RCT • Concealed allocation • Masked assessor	• N = 289 (TG 145, CG 144) • 20 weeks • Primigravida	• 12-week intensive PFM course given by physiotherapist • Home Kegel exercises	• PFM strength (perineometry) • UI questionnaire • 3 months PP	• PFM stronger in TG • UI less in TG (20% vs. 31%, $P = 0.043$)	2
‡Reilly 2002[13]	• 2 arms RCT • Masked assessor	• N = 230 (TG 120, CG 110) • Primigravida • Increased BN mobility at Valsalva on u/s at 20 weeks	• Monthly visit with physiotherapist • Kegel BID in pregnancy • Instructed to voluntarily contract PFEs during cough/sneeze	• UI questionnaire • 1 h pad test • PFM strength (perineometer) • BN mobility QOL (SF36, KHQ) • 3 months PP	• SUI: less with PFEs (19% vs. 32%, $P = 0.023$)	3
Udayasankar 2002[44] (Abstract only)	4 years' follow-up of population from Reilly's 2002 study[13] N = 100 (TG 42, CG 58)				• SUI: less with PFEs (17% vs. 45%, $P < 0.01$)	2

*BFLUTS: Bristol Female Urinary Tract Symptom questionnaire; BID: twice daily; BN: bladder neck; CG: control group; KHQ: King's health questionnaire; mo: months; N: number of subjects in study; PFEs: pelvic floor exercises; PFM: pelvic floor muscles; PP: postpartum; QOL: quality of life; RCT: randomized controlled trial; SF36: Medical Outcome Study Short form; SUI: stress urinary incontinence; TG: treatment group; UI: urinary incontinence.

†Quality rating as per Jadad scale[34]: poor (0), good (3), excellent (5).

‡The RCTs included in the meta-analysis.

Comparison: PFE Prenatal and UI
Outcome: Incidence of UI with Prenatal PFE

Study	Treatment n/N	Control n/N	RR (95% CI Random)	Weight %	RR (95% CI Random)
Hughes[41]	211 / 585	223 / 584		43.0	0.94 [0.81, 1.10]
Mørkved[43]	48 / 148	74 / 153		33.8	0.67 [0.50, 0.89]
Reilly[13]	23 / 120	36 / 110		23.2	0.59 [0.37, 0.92]
Total (95% CI)	282 / 853	333 / 847		100.0	0.75 [0.56, 1.02]

Test for heterogeneity:
chi-square = 7.18, *df* = 2, *P* = 0.028
Test for overall effect:
z = −1.83, *P* = 0.07

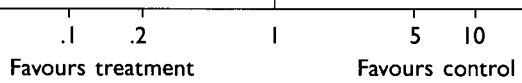

Figure 1. Effect of antenatal PFEs on the incidence of urinary incontinence at 3 to 6 months.
PFE: pelvic floor exercise; UI: urinary incontinence; RR: relative risk; CI: confidence interval.

Comparison: PFE Prenatal and Strength
Outcome: PFM Strength (cm H_20)

Study	Treatment n	Mean (SD)	Control n	Mean (SD)	SMD (95% CI Random)	Weight %	SMD (95% CI Random)
Mørkved[43]	148	29.50 (3.08)	153	25.60 (2.74)		50.5	1.34 [1.09, 1.59]
Reilly[13]	68	11.50 (7.90)	64	10.50 (5.50)		49.5	0.15 [−0.20, 0.49]
Total (95% CI)	216		217			100.0	0.75 [−0.42, 1.91]

Test for heterogeneity:
chi-square = 30.35, *df* = 1, *P* < 0.00001
Test for overall effect:
z = 1.25, *P* = 0.2

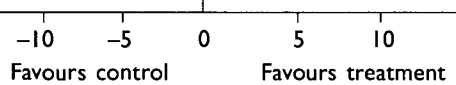

Figure 2. Effect of antenatal PFEs on the pelvic floor strength at 3 to 6 months.
PFE: pelvic floor exercise; PFM: pelvic floor muscle; SD: standard deviation;
SMD: standardized mean difference; CI: confidence interval.

Postpartum Pelvic Floor Exercises for the Prevention of Postpartum Urinary Incontinence and the Improvement of Pelvic Floor Strength

Four non-randomized controlled trials[47-50] and 8 randomized controlled trials[51-58] have evaluated postpartum pelvic floor exercises to prevent and/or treat postpartum urinary incontinence. Of the 8 RCTs,[51-58] 4 were included in this analysis (Table 2),[52-54,57] and 3 trials[55,56,58] were excluded because they assessed treatment rather than prevention of urinary incontinence. Another one was excluded because it did not test the effects of PFEs, but rather the effect of a postpartum reminding system.[51] Studies recruited postpartum women of all parity, regardless of their continent status, within the first 2 months after delivery.

In the included studies, intervention used a vaginal device (perineometer, vaginal cones, or specific resistance device) providing some degree of feedback and/or resistance,[52-54] except for one.[57] No RCT assessed the effect of electrical stimulation in this population. The endpoint for 3 "resistance" trials was generally pelvic floor strength,[52-54] with only 1 trial evaluating urinary incontinence.[57] Due to the difference in methodology and outcome measure, these trials could not be combined to provide a summary statistic.

Postpartum Pelvic Floor Exercises and Urinary Incontinence: RCT

One study[57] that evaluated the effect of postpartum PFE on urinary incontinence in women who had undergone instrumental delivery or delivered a macrosomic baby found 10% to be incontinent at study recruitment (on postpartum ward), although 18% reported incontinence before pregnancy. In this large trial, the treatment group showed less urinary incontinence (31% vs. 38%, $P < 0.05$) than controls.

Postpartum Pelvic Floor Exercises and Pelvic Floor Muscle Strength: RCT

Two trials found greater pelvic floor muscle strength in the treatment group (Table 2).[53,54] The first[53] was a study on urinary incontinent postpartum women with a 12-weeks follow-up. The second[54] one was a pilot study reported as an abstract and having an assessment only at 4 weeks in 60 women.

Several trials using surveys evaluated the effect of a system in which women have frequent contact with trained health care staff who remind them to perform PFEs for the prevention or treatment of urinary incontinence and provide support to the women.[51,56-58] These suggested less incontinence in women who were frequently reminded to perform their PFEs, although the differences between study groups were inconsistent and of marginal clinical significance.

Postpartum Pelvic Floor Exercises and Pelvic Floor Muscle Strength or Urinary Incontinence: Non-RCT Studies

Among the non-randomized controlled trials, consistency was found in the improvement of the surrogate outcome (pelvic muscle floor strength) in groups of women undergoing intensive PFE, but the benefit on urinary incontinence was inconsistent, although it seemed to point toward less urinary incontinence.[49,50]

Pelvic Floor Exercises for the Prevention of Postpartum Anal Incontinence

Four reports of RCTs[51,55,56,58] and one non-randomized controlled trial[50] evaluated the role of pelvic floor exercises on anal incontinence, generally as a secondary outcome. One trial[58] was a long-term follow-up on a previous report,[56] and another was excluded because the authors did not test the effects of PFEs, but rather the effect of a system reminding postpartum women to perform PFEs (without device) at home,[51] thus leaving 2 RCTs for evaluation (Table 3).[55,56] Due to differences in methodology and outcome measures, however, these 2 studies[55,56] could not be combined to provide a summary statistic.

Pelvic Floor Exercises and Anal Incontinence: RCT

The smaller trial[55] reported a null effect of PFE on postpartum anal incontinence, whereas the larger trial[56] showed PFE was beneficial. However, long-term follow-up[58] of the positive trial failed to demonstrate a durable preventative effect.

The reminder system did not prove to be of benefit in preventing anal incontinence.[51]

Pelvic Floor Exercises and Anal Incontinence: Non-RCT

Meyer *et al.*[50] failed to detect a difference in anal incontinence 10 months postpartum between experimental (biofeedback and electrical stimulation) and control groups.

Pelvic Floor Exercises for the Prevention of Pelvic Organ Prolapse

No studies were found.

DISCUSSION

This study reflects recent publications in the field of prevention of urinary incontinence in the peripartum. Overlap exists with a prior Cochrane meta-analysis,[45] however, data presented here include full publications, which are at variance with the Cochrane analysis. This has allowed for the inclusion of studies into a formal meta-analysis, as the details provided supported a satisfactory level of similitude between the trials included. A random model was used to account for some of the heterogeneity encountered, and to obtain a conservative effect size. This approach allows offsetting of the heterogeneity in situations where trials are felt to be similar enough in methodology to be combined.

This study is methodologically limited by the absence of a co-reviewer to cross-reference the article selections and provide a control against selection bias. However, efforts were taken to limit such bias by adhering to strict inclusion criteria.

TABLE 2

POSTPARTUM PELVIC FLOOR EXERCISES IN PREVENTION OF URINARY INCONTINENCE: SUMMARY OF RANDOMIZED CONTROLLED TRIALS*

Authors	Methods	Population	Intervention	Outcome	Results	Quality Rating†
Dougherty 1989[52]	• 3 arms RCT (exercise against resistance, exercises without resistance, control) • Method of randomization not specified • Number of subjects in each group not specified	• N = 45 (TG, CG) • 6–17 weeks PP • No mention of continence status at recruitment	• Use of an intravaginal resistance device TG: • A: daily PFEs with device providing resistance • B: daily PFEs without intravaginal device CG: • No PFE • Reading with device in situ for similar length of time without contraction	• PFM strength pressure recorded via the device • 6 weeks	• *Report on only 15 patients* • No difference between study groups and between baseline and end-of-study measurements	I
Jonasson 1989[53]	• 2 arms RCT • Method of randomization not provided • Blinding status of assessor not specified	• N = 83 (TG 42, CG 41) • PP • Primipara: 46 • Multipara: 37	TG: • PFEs with vaginal cones All: • PFEs with written instruction	• PFM strength (defined by the weight of the heaviest cone retained) • 12 weeks	• TG had greater increase in weight of cone retained • PFM: 20 g vs. 6 g, $P < 0.001$	I
Norton 1990[54] (Abstract only)	• 3 arms RCT (controls, Kegel, cones) • Method of randomization not specified • Number of subjects in each group not specified • Blinding status of assessor not specified	• 60 women • 6 weeks PP (after vaginal delivery) • 33% of subjects incontinent at recruitment	TG-A: • 1 session of PFM training • 100 Kegel at home daily TG-B: • Same as TG-A • Daily cone use for 4 weeks Controls: • Body mechanics lecture	• Vaginal pressure (mm Hg) • 4 weeks • 6 months	• 4 weeks: Improved PFM strength in TG over CG • 6 months (preliminary): no data given	I
Chiarelli 2002[57]	• 2 arms RCT • Method of randomization not provided • Masked assessor	• N = 720 (TG 370, CG 350) • High-risk PP women on ward (delivery by forceps or vacuum, or if baby weight >4 kg) • Only 10% of subjects were incontinent at baseline	TG: • Individualized instructions • PFE supervision by physiotherapist • Kegel exercises prescription • Compliance aids CG: • Brochure, recommending PFEs daily	• Telephone survey for UI • 3 months	• Less UI in TG (31% vs. 38%, $P = 0.044$)	I

*CG: control group; PF: pelvic floor; PFE: pelvic floor exercise; PFM: pelvic floor muscle; PP: postpartum; RCT: randomized controlled trial; TG: treatment group; UI: urinary incontinence.
†Quality rating as per Jadad scale[34]: poor (0), good (3), excellent (5).

TABLE 3

PELVIC FLOOR EXERCISES FOR THE TREATMENT OR PREVENTION OF ANAL INCONTINENCE: SUMMARY OF RANDOMIZED CONTROLLED TRIALS*

Authors	Population	Intervention	Outcome	Results	Quality Rating†
Wilson 1998[55]	• N = 230 (TG 113, CG 117) • 3 months PP • *Urinary incontinent women* NOTE: randomization by strata (parity, number of UI episodes and type of delivery)	TG: • A: Instruction by a physiotherapist 4 times while on PP ward and at 3, 4, 6, and 9 months PP • Perineometer used to teach • B: cones • C: PFEs and cones CG: • Standard PFEs as taught in antenatal classes and daily instruction on PFEs in postpartum ward	• Anal incontinence question • 12 months • Blinded assessor	• No difference	3
Glazener 2001[56]	• 747 (TG 371, CG 376) • 5 months PP • *Urinary incontinent women* • Stratified by parity (<4, ≥4), method of delivery, and frequency of UI	TG: • Structured home interview with teaching (verbal) on PFE • 3 home visits in a period of 4 months • Kegel 80–100 contractions/day CG: • Peripartum standard information	• Anal incontinence question • 12 months	• Less anal incontinence in TG (4.4% vs. 10.5%, $P = 0.012$) • 6 years' follow-up[58]: no difference	2

*CG: control group; PF: pelvic floor; PFE: pelvic floor exercise; PFM: pelvic floor muscle; PP: postpartum; RCT: randomized controlled trial; TG: treatment group; UI: urinary incontinence.
†Quality rating as per Jadad scale[34]: poor (0), good (3), excellent (5).

The studies published had inherent limitations that impacted on the application of PFEs antepartum and postpartum. None of the studies had limited entry criteria to women continent at baseline. Outcome measures were not standardized, in particular with the subjective self-report of urinary incontinence. Very little data were available regarding the preventive role of PFE in fecal incontinence, whereas data were totally absent with respect to pelvic organ prolapse.

CONCLUSIONS

The quality of evidence for the statements below has been determined using the Evaluation of Evidence criteria of the Canadian Task Force on the Periodic Health Exam.[59]

1. Antepartum PFEs, when taught by trained personnel with biofeedback, do not significantly decrease the incidence of postpartum urinary incontinence or improve PFM strength in the short term (3 months). (I-C)
2. Postpartum PFEs, when performed with biofeedback or with a vaginal device providing resistance or feedback, decrease postpartum urinary incontinence in high-risk women. (I-A)
3. Postpartum PFEs, when performed with a vaginal device providing resistance or feedback, result in increased PFM strength. (I-B)
4. Evidence shows that a reminder and motivational system without expert instruction is ineffective in preventing urinary incontinence postpartum. (I-D)
5. No studies evaluating the role of antepartum PFE in the reduction of anal incontinence were found.
6. Postpartum PFEs do not consistently reduce anal incontinence. (I-D)
7. The data is scant regarding the preventative role of antepartum and postpartum PFE in continent postpartum women, and better-designed large RCTs are necessary.
8. No studies evaluating the role of ante- or postpartum PFE in prevention of pelvic organ prolapse were found.

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