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LITERATURE REVIEW

Antenatal pelvic floor muscle exercises for the prevention and treatment of urinary incontinence in the antenatal and early postnatal period: a critical appraisal of the evidence

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Abstract

Pregnancy and childbirth are implicated in the development of urinary incontinence (UI). This literature review analyses the current evidence relating to the use of antenatal pelvic floor muscle exercises (PFMEs) to prevent and treat UI in women during pregnancy and the postnatal period. Relevant studies are considered and then discussed in relation to their similarities and differences. The evidence for the use of antenatal PFMEs to treat UI in pregnancy and the postnatal period is inconclusive, although a small body of literature supports the adoption of this approach as a preventative strategy. Conclusions are drawn from the current evidence and suggestions are made for clinical practice.

Keywords: antenatal, pelvic floor muscle exercises, postnatal, pregnancy, urinary incontinence.

Introduction

Pregnancy and childbirth are implicated in the development of urinary incontinence (UI) (Kapoor & Freeman 2007), and are known to have the potential to cause weakness in the pelvic floor muscles (PFMs) (Chiarelli & Campbell 1997). The reported prevalence of UI in the pregnant population varies: Mørkved & Bø (1999) stated that it is 42%, while Chiarelli & Campbell (1997) found that 64% of pregnant women experience some degree of UI. Furthermore, women who suffer from stress UI (SUI) during their first pregnancy are more likely to experience incontinence 5 years later when compared to those who do not (Viktrup 2002).

The reasons why women develop UI in pregnancy are not fully understood and are likely to be multi-factorial in nature. During pregnancy, there is an increase in intra-abdominal pressure caused by the enlarged uterus, and changes in hormone levels may affect connective tissue strength and urethral resistance (Kapoor & Freeman 2007). Increased bladder neck mobility in pregnancy has been investigated by a number of researchers, and King & Freeman (1998) found a positive relationship between increased bladder neck mobility and the development of SUI in pregnancy.

The use of PFM exercises (PFMEs) for the treatment of UI has been investigated by a number of researchers. A recent Cochrane Review by Hay-Smith & Dumoulin (2006) systematically evaluated the use of PFMEs in the treatment of UI in non-pregnant women. Six trials involving 403 subjects were included in this analysis. The authors found support for the recommendation that PFMEs should be used as a first-line conservative treatment for UI.

The relationship between PFM strength and thickness in continent and incontinent pregnant women was investigated by Mørkved *et al.* (2004). Nulliparous women were studied at week 20 of their pregnancy, and continent pregnant women were found to have stronger and thicker PFMs than those who were incontinent. National Institute for Health and Clinical Excellence (NICE) guidelines recommend that

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Table 1. Search strategy: (PEDro) Physiotherapy Evidence Database; (MEDLINE) Medical Literature Analysis and Retrieval System Online; (AMED) Allied and Complementary Medicine Database; (EMBASE) Excerpta Medica Database; and (CINAHL) Cumulative Index to Nursing and Allied Health Literature

Variable	Details
Keywords	Pregnancy or antenatal or childbirth combined with urinary incontinence combined with pelvic floor exercise or pelvic floor training or physiotherapy
Limits	Human beings, English language
Databases	PEDro, MEDLINE, AMED, EMBASE, CINAHL, Ovid
Search engines	Google Scholar
Hand searches	Reference lists from all relevant articles were searched by hand

all women exercise their PFMs during their first pregnancy in order to prevent the development of UI (NICE 2006).

The aim of the present literature review is to critically appraise the current evidence regarding the effectiveness of antenatal PFMEs in the prevention and treatment of UI in the antenatal and early postnatal period. It focuses solely on the performance of PFMEs in the antenatal period, and therefore, differs from two recent systematic reviews on similar topics (Hay-Smith *et al*. 2008; Lemos *et al*. 2008). The present authors also include research that has been made public since the publication of the two previous reviews of this subject (Agur *et al*. 2008; Dinc *et al*. 2009).

Databases were searched using the keywords listed in Table 1.

Studies were included if these were available as full texts and written in English. Reference lists of useful articles were then hand searched to find previously unidentified sources. Since the aim was to review recent evidence, only articles printed in the past 10 years were included, although one older article (Sampselle *et al*. 1998) was also included because it was considered to be a key reference.

Studies were excluded if these did not contain a control group and also if, despite investigating antenatal PFMEs, UI was not one of the outcomes measured. Four systematic reviews (Harvey 2003; Haddow *et al*. 2005; Hay-Smith *et al*. 2008; Lemos *et al*. 2008) and five randomized controlled trials (RCTs) (Sampselle *et al*. 1998; Reilly *et al*. 2002; Mørkved *et al*. 2003; Woldringh *et al*. 2007; Dinc *et al*. 2009) were identified as relevant. An 8-year follow-up study of one of the RCTs (Agur *et al*. 2008) was also included. The systematic reviews and the RCTs are considered in different sections of this review.

Literature review

Randomized controlled trials

Two RCTs investigated the treatment of antenatal UI using PFMEs (Woldringh *et al*. 2007; Dinc *et al*. 2009).

Woldringh *et al*. (2007) studied 264 women who had experienced more than two episodes of either SUI, urge UI (UUI) or mixed UI (MUI) in the preceding month, and found that 53% of the treatment group and 52% of the control group had suffered from continence problems prior to pregnancy. The sample included both nulliparous and multiparous women, and the participants were appropriately randomized to either a treatment or control group. The main outcomes were frequency and severity of UI, as measured by the subjects in a bladder diary. The treatment group had four sessions with a physiotherapist throughout pregnancy and the early postnatal period, and were advised on a home programme of PFMEs, the content of which was not reported. The control group received routine care from their midwife, which was not fully described, although the authors noted that almost two-thirds of the control group received instruction on PFMEs. The women were followed up from week 22 of pregnancy to 12 months postpartum.

No significant difference was found between the treatment and control groups in terms of the incidence of incontinence at week 35 of pregnancy ($P=0.329$), 8 weeks postpartum ($P=0.442$), 6 months postpartum ($P=0.633$) and one year postpartum ($P=0.610$), although Woldringh *et al*. (2007) noted that there was a trend for less incontinence in the treatment group. They stated that intention to treat was adhered to when analysing their results, but recognized that the high number of dropouts (approximately 40%) would have inevitably affected the power of the study. The tabulated results show that the confidence intervals were wide and the authors noted that there was low compliance with the treatment protocol. As such, the results of this study, and the conclusions drawn from them, must be viewed with caution: there could well have been an underestimation of treatment effect. Furthermore, without details of the exercise regime, it is not possible to make a judgement as to whether it would have been of sufficient intensity to have affected the subjects' symptoms.

Dinc *et al*. (2009) studied 92 women during pregnancy and the early postpartum period. All their subjects had reported SUI or MUI, and the sample contained nulliparous and multiparous women. The main outcomes investigated were the number of leakage episodes, the amount leaked on pad test, the number of day- and night-time voids, urgency, and PFM strength, as measured by a perineometer. This approach differs from clinical practice in the UK, where a perineometer in the antenatal period would not be used routinely. Randomization was appropriate, and there were no significant demographic differences between the study group and the control group at the start of the trial. The mean values for the pad test and perineometer readings were also not significantly different at the outset ($P=0.47$ and $P=0.73$, respectively).

Both groups of subjects were taught the correct way to contract their pelvic floor at the beginning of the trial, prior to the initial perineometry readings being taken. The treatment group was also given an exercise programme to follow that was based on a series of maximal contractions, and therefore, assumed to be a strength-training protocol. This programme was adequately described. The treatment group's exercise technique was monitored one week after the commencement of the study, and further instruction and reviews were undertaken as necessary. These participants were also followed up at every antenatal appointment. All subjects were questioned as to the ongoing nature of their incontinence, and further perineometry readings were taken between weeks 36 and 38 of pregnancy, and again at 6–8 weeks postpartum.

The study group showed a significant improvement over the control group in a number of areas: a reduction in the number of incontinence episodes at weeks 36–38 of pregnancy ($P=0.008$) and at 6–8 weeks postpartum ($P=0.014$); a reduction in leakage, as measured by pad test, at weeks 36–38 of pregnancy ($P=0.00$) and at 6–8 weeks postpartum ($P=0.002$); and improved perineometry readings at weeks 36–38 of pregnancy ($P=0.00$) and at 6–8 weeks postpartum ($P=0.00$).

Dinc *et al*.'s (2009) results appear to show that PFMEs can significantly improve women's pelvic floor strength, and reduce the quantity of leaks and the number of leakage episodes if these are practised during pregnancy. However, flaws in their study reduce the credibility of the results. First, the subjects do not appear to have been blindly assessed, which could have introduced bias. Secondly, these authors do not state that they used intention to treat when analysing their results. Thirdly, 92 women were randomized initially, but because only 68 subjects completed the study, this would also have affected the accuracy of the results, which means that the benefits of treatment may have been overstated.

Three RCTs (Sampselle *et al*. 1998; Reilly *et al*. 2002; Mørkved *et al*. 2003) have investigated the prevention of incontinence using antenatal PFMEs.

Reilly *et al*. (2002) assessed the ability of PFMEs to prevent the development of SUI in women with increased bladder neck mobility. These authors gave a detailed description of how bladder neck mobility was determined using perineal ultrasound. Two hundred and sixty-eight primiparous women who were all continent at baseline assessment were appropriately randomized to a treatment or control group. Those in the treatment group attended individual monthly appointments for supervised PFMEs from week 20 of pregnancy to delivery. The exercise protocol was well documented. Subjects were also encouraged to perform a home exercise programme and to use a pre-timed contraction ('The Knack') prior to coughing and sneezing. The control group received 'usual care' from their midwife, which was not fully described. However, the authors did state that, 'Both groups were likely to have received verbal advice on pelvic floor exercises from their midwives at antenatal classes' (Reilly *et al*. 2002, p. 69). Outcomes were measured by self-reported SUI episodes, and these were classed as mild, moderate or severe depending on their frequency. A standardized pad test was undertaken by all the participants and their bladder neck mobility was measured again. Treatment group compliance was recorded in an exercise diary.

According to Reilly *et al*.'s (2002) calculations, enough women completed their study to give it a power of 80%. The results showed a significant difference between the treatment and control groups: at 3 months postpartum, the women in the treatment group had a 19.2% incidence of SUI compared to the 32.75% incidence reported in the control group (relative risk = 0.59; 95% confidence interval = 0.37–0.92). The pad test results correlated with the severity of self-reported incontinence. There was no difference between the groups in terms of change to bladder neck mobility, although this is likely to be of less interest to the clinician and patient

than the reduction in the incidence and amount of incontinence. This study was thought to be at relatively low risk of bias because, although the subjects and therapists were not blind to group allocation, the assessors were. Therefore, the results are of interest to the clinician since there was a demonstrable benefit 3 months postpartum for the women who performed a regular, supervised exercise programme. Reilly *et al.* (2002) aimed to target a population thought to be at high risk of developing SUI, but it is unrealistic to think that all women would be able to undergo assessment for increased bladder neck mobility because of constraints in both staffing and resources. However, their results do reinforce the current NICE (2006) recommendations for practice, i.e. that all pregnant women should be advised to undertake PFMEs as a preventative strategy.

Agur *et al.* (2008) followed up the women who were originally randomized in the study by Reilly *et al.* (2002), and 61% of the original subjects participated. They were questioned about their PFME behaviour and continence status 8 years after the original study ended. There was no significant difference ($P=0.7$) between the two groups at the 8-year point in terms of number suffering from SUI. Agur *et al.* (2008) were able to demonstrate that the most important predictor of continence 8 years after the first delivery was continence status at 3 months postpartum. In their conclusions, the authors recognized that the 39% attrition rate of subjects reduced the power of the follow-up study, although the results were comparable to other investigations of the long-term benefit of PFMEs.

Mørkved *et al.* (2003) investigated the effectiveness of a 12-week intensive PFME programme for the prevention of UI. Because some of the women were incontinent before the investigation began at week 20 of pregnancy, despite the stated aim of the study, this could be more accurately described as a treatment and prevention study. At the onset of the research, 31% and 32% of the treatment and control groups, respectively, were classed as incontinent, with women who reported more than one episode of leaking each week during the preceding month being defined as incontinent. No distinction was made between the types of incontinence. Three hundred and one nulliparous women were randomized to either a treatment or control group, with the treatment group undertaking a 60-min exercise class weekly for 12 weeks and being strongly encouraged to perform home exercises. The content of the exercise class was adequately described. The control group received 'usual care' from their midwife, the content of which was unspecified. The primary outcome measured was self-reported UI.

According to the authors' calculations, the low dropout rate meant that a sufficient number of women finished the study to allow for 80% power. The data were analysed on an intention-to-treat basis, and showed that the subjects undergoing the intensive exercise programme were 33% less likely to report UI at week 36 of pregnancy and 39% less likely to report UI at 3 months postpartum when compared to the control group. Since Mørkved *et al.* (2003) took reasonable steps to minimize bias by employing appropriate randomization and blinding of assessors, the results of their study are noteworthy. However, in current practice, it is unlikely that all pregnant women would be able to access an intensive exercise class such as the one used in this trial because of staff and resource limitations. The present authors believe that it is reasonable to assume that the repeated contact with a healthcare professional and the influence of being part of a group could have had a significant motivating influence on the women in the treatment group, making them more likely to exercise regularly on their own. As such, while Mørkved *et al.* (2003) do demonstrate the potential of antenatal PFMEs to reduce the incidence of UI, their results might not have been as significant if the women had not had the group contacts and were expected to maintain this level of exercise in an unsupervised home programme.

Sampselle *et al.* (1998) studied the effect of PFMEs on the continence status of primiparous women from week 20 of pregnancy until 12 months postpartum. Both continent and incontinent women were among the participants at enrolment, but the authors did not define how many: like the study by Mørkved *et al.* (2003), this was a prevention and treatment study. The type of incontinence was not specified at baseline. Seventy-one women were randomized at the start of the trial to either a treatment or control group. The treatment group followed an exercise programme that, although not fully described by Sampselle *et al.* (1998), was reported to be tailored to each woman's individual capacity. The programme involved 30 contractions, the intensity of which was to be maximum or near maximum, so this can be assumed to be a

strength training programme. The main outcome was self-reported SUI, which the authors rated from (0) no leaking to (3) soaking. Complete data were only available for 64% of the women involved, which markedly reduced the power of the results since only a small sample was used initially. However, the findings show significantly less self-reported incontinence in the treatment group at week 35 of pregnancy ($P=0.043$), 6 weeks postpartum ($P=0.032$) and 6 months postpartum ($P=0.044$). The difference was no longer significant at 12 months postpartum. Despite the flaws of this study, primarily the high dropout rate from an initially small group, Sampselle *et al.* (1998) took steps to reduce bias. Appropriate randomization resulted in no significant differences between the treatment and control groups at the outset of the trial, and the authors adhered to intention-to-treat analysis. As such, the results are of clinical interest: performing an individualized home exercise programme of PFMEs may reduce the risk of developing incontinence in late pregnancy and the early postnatal period.

Systematic reviews

Four systematic reviews (Harvey 2003; Haddow *et al.* 2005; Hay-Smith *et al.* 2008; Lemos *et al.* 2008) were found, at least in part, to examine the role of PFMEs in the prevention and/or treatment of UI. There was a large degree of overlap between the systematic reviews in terms of the literature used in the analyses. Some of the papers discussed above by the present authors were included in the systematic reviews as follows: Harvey (2003) and Lemos *et al.* (2008) included the work of Reilly *et al.* (2002) and Mørkved *et al.* (2003); Haddow *et al.* (2005) included the above trials and also that of Sampselle *et al.* (1998); and Hay-Smith *et al.* (2008) included the above trials and also that of Woldringh *et al.* (2007).

Lemos *et al.* (2008) systematically reviewed RCTs in order to determine the efficacy of PFMEs in the prevention of UI. They also hoped to determine the optimum exercise regime. The authors performed a meta-analysis of three studies involving 515 subjects, the results of which suggested that antenatal PFMEs had a preventative effect on the development of incontinence in women from 6 weeks to 3 months postpartum. A heterogeneity test showed that it was appropriate to combine the results of the three trials, although Lemos *et al.* (2008) were unable to make recommendations regarding the optimum frequency and intensity of PFMEs because the exercise protocols were heterogeneous.

A systematic review by Harvey (2003) investigated whether antenatal and postnatal PFMEs could prevent postpartum UI. Three RCTs investigating antenatal PFMEs involving 1688 subjects were included in a meta-analysis. Two of these were full reports and one trial was reported as a conference abstract. Despite the three studies showing significant heterogeneity on testing, the above author combined these, stating that employing a random effects model would overcome the heterogeneity, but recognizing that it would also provide a very conservative estimate of effect. A decrease of 25% in the relative risk of developing UI was found in the treatment group in the period from 3 to 6 months postpartum. Harvey (2003) stated that this was not significant. She then analysed the results of the trials reported on in full, excluding the conference abstract, and found that these showed a significant difference (35% decrease in relative risk) in favour of the treatment group. In her discussion, Harvey (2003) recognized the limits of this study, but stated that all efforts had been made to overcome any potential bias. However, the conclusion that antenatal PFMEs do not produce a significant reduction in the development of postnatal UI is at odds with the result of the second meta-analysis. It is possible that the first meta-analysis produced too conservative an estimate of effect as a result of the use of a random effects model to mitigate for the heterogeneity of the trials.

Haddow *et al.* (2005) conducted a systematic review that was partly designed to determine the effectiveness of antenatal PFMEs for the prevention and treatment of UI. A thorough search was conducted and abstracts were reviewed when full texts were not available. Three RCTs involving 641 subjects were included in the analysis, and although all the RCTs differed with regard to the treatment protocol and the time-scale of data collection, a heterogeneity test showed that it was appropriate to analyse the results together. Haddow *et al.* (2005) concluded that antenatal PFMEs are effective in preventing and treating UI after childbirth. However, they failed to clarify the time-scale within which the exercises are effective.

Hay-Smith *et al.* (2008) produced a Cochrane Review that was partly devoted to the effect of antenatal PFMEs on the prevention and treatment of UI. Five trials involving 802 subjects

were considered. Through personal communications with the authors of several studies, Hay-Smith *et al*. (2008) were able to gather data relating to subgroups in original studies that had analysed continent and incontinent women together. After appropriately combining the results of various RCTs, Hay-Smith *et al*. (2008) concluded that antenatal PFMEs reduce the likelihood of incontinence from late pregnancy (56% less likely) to 3–6 months postpartum (30% less likely). However, they were unable to comment on the possible benefits of PFMEs as a treatment for UI in pregnancy because of the lack of available quality research.

Discussion

The present literature review critically analyses the evidence with regard to the effectiveness of performing antenatal PFMEs to treat and prevent UI in the antenatal and early postnatal period. Currently, NICE (2006) recommends that PFMEs be performed during a first pregnancy in order to prevent the development of UI, although it does not make any suggestions regarding the frequency or intensity of an exercise programme for the pelvic floor.

It is not possible to compare the two RCTs concerned with the treatment of UI in pregnancy and the postnatal period directly (Woldringh *et al*. 2007; Dinc *et al*. 2009) because of the heterogeneous nature of several areas of these studies. Both Woldringh *et al*. (2007) and Dinc *et al*. (2009) recruited a mix of nulliparous and multiparous subjects to their trials. However, the number of participants who had experienced incontinence before pregnancy differed, with 52.5% of subjects in the study by Woldringh *et al*. (2007) and only 25% of those in that of Dinc *et al*. (2009) having had previous episodes of incontinence. The definition of incontinence also differed between the studies, with the subjects in Woldringh *et al*. (2007) required to report two or more episodes of incontinence in the previous month to be defined as incontinent, whereas those in Dinc *et al*. (2009) self-reported incontinence, but no time-scale or number of episodes was specified.

The outcome measures used varied between the two studies, with Woldringh *et al*. (2007) combining a diary and questionnaire to determine severity of incontinence, and Dinc *et al*. (2009) using self-report and a pad test to determine degree of incontinence.

In terms of the treatment group protocol, it is impossible to compare the studies because Woldringh *et al*. (2007) did not report sufficient detail on the exercise regime, an omission that lessens the value of their work. Dinc *et al*. (2009) adequately described a three-level strength training programme, but were not explicit with regard to how the women progressed through these stages. The activities of the control group were not described by Dinc *et al*. (2009), although Woldringh *et al*. (2007) did report on the percentage of control group subjects who undertook PFMEs during their pregnancy.

The time-scales of the studies also differed. Dinc *et al*. (2009) recruited women between the weeks 20 and 34 of pregnancy, and followed up the groups until 8 weeks postpartum, whereas the subjects used by Woldringh *et al*. (2007) were recruited at week 23 of pregnancy and followed up until 12 months postpartum.

The results of these studies were contradictory, with Dinc *et al*. (2009) finding support for the use of PFMEs performed antenatally to treat UI and Woldringh *et al*. (2007) finding no evidence that PFMEs were beneficial. As previously described in the present literature review, both studies contained flaws and omissions that, regardless of the differences outlined above, decrease the utility of the results in clinical practice.

Three RCTs investigated the use of antenatal PFMEs for the prevention of UI (Sampselle *et al*. 1998; Reilly *et al*. 2002; Mørkved *et al*. 2003). The subject groups differed between the trials: Reilly *et al*. (2002) recruited nulliparous, asymptomatic women who had increased bladder neck mobility, and therefore, were assumed to be at increased risk of SUI, whereas Mørkved *et al*. (2003) and Sampselle *et al*. (1998) recruited nulliparous subjects, a percentage of whom were incontinent at the beginning of the studies. As such, while Reilly *et al*. (2002) were investigating a specific 'at risk' group, Mørkved *et al*. (2003) and Sampselle *et al*. (1998) used subjects more representative of the general pregnant population, i.e. both continent and incontinent women, and their investigations should be thought of as treatment and prevention studies.

The outcome measures used by the three studies were heterogeneous, and therefore, it is impossible to compare the results directly. Reilly *et al*. (2002) used self-reported episodes of SUI as their primary outcome measure. Mørkved *et al*. (2003) also used self-reported episodes of incontinence as a measure, although they did not specify the type of incontinence, and therefore,

their study differed from that of Reilly *et al.* (2002) in that it could have included UUI and MUI. In contrast, Sampselle *et al.* (1998) were primarily interested in episodes of SUI and used a questionnaire to record the symptoms.

The treatment protocols employed all differed in terms of exercise content and number of contacts with a healthcare professional. Mørkved *et al.* (2003) used the most intense exercise programme, with the treatment group attending an hour-long exercise class for 12 weeks during the second and third trimesters; their subjects were also advised to undertake a strength training programme at home. Sampselle *et al.* (1998) described a strength training home exercise programme with contacts with a healthcare professional being limited to the assessment appointments. The treatment group in Reilly *et al.* (2002) had a home exercise programme to increase pelvic floor strength and also a one-to-one appointment with a physiotherapist from week 20 of pregnancy to delivery. In contrast to all the other studies, Reilly *et al.* (2002) also advised their treatment group to perform a pelvic floor contraction prior to activities that would raise their intra-abdominal pressure (also known as 'The Knack'). Since this manoeuvre is known to decrease the severity of stress urinary leakage, it was wholly appropriate to include this for the study population targeted and seems a strange omission from the exercise protocols of the other studies.

All three studies recruited women at week 20 of pregnancy, although the lengths of trials varied, with Reilly *et al.* (2002) and Mørkved *et al.* (2003) following up their subjects until 3 months postpartum, and Sampselle *et al.* (1998) continuing their follow-up until 12 months postpartum. Therefore, while Mørkved *et al.* (2003) described some promising results for the use of antenatal PFMEs to prevent UI, the benefits cannot be extrapolated beyond a relatively short time-scale. Agur *et al.* (2008) provided follow-up data for the subjects studied by Reilly *et al.* (2002), but as previously discussed, their work was flawed by a high rate of attrition. The benefits found by Sampselle *et al.* (1998) were no longer significant after 6 months postpartum.

Pelvic floor muscle exercises were found to be beneficial by all three studies. None of the authors discouraged their control groups from exercising, but because midwives often discuss PFMEs with their patients, it is possible that the benefits did not appear to be as significant as they would have if the controls had not exercised. As previously described in the present literature review, all of the studies were reasonably well conducted, and therefore, while not without flaws, these do represent a small body of evidence in support of the use of antenatal PFMEs. However, because of the heterogeneity between the studies in a number of areas, it is not possible to make any firm recommendation regarding the optimum exercise protocol.

None of the studies reported any significant detrimental or adverse effects from the performance of PFMEs during pregnancy; however, there has been a historical belief that a strong pelvic floor may inhibit the progress of labour. Salvesen & Mørkved (2004) conducted an RCT to investigate this and found that there was actually a trend for a shorter second stage of labour in women who had undertaken a PFME programme during pregnancy.

Conclusions

There is not a great deal of recent, high-quality evidence regarding the role of antenatal PFMEs in the prevention and treatment of UI. The studies reviewed above varied in terms of how incontinence was defined, the outcome measures employed, and the number and characteristics of the subjects recruited. All but two (Woldringh *et al.* 2007; Dinc *et al.* 2009) included only nulliparous subjects. There was great variation between the PFME regimes under investigation, which varied from four individual contacts and a home exercise programme (Woldringh *et al.* 2007) to 12 weekly 60-min exercise classes (Mørkved *et al.* 2003). There is a need for further research to determine an optimal regime for antenatal PFMEs and study further the effects of these exercises in multiparous women.

While the majority of studies reviewed support the use of antenatal PFMEs for the prevention of UI, this is not universally the case, with one systematic review finding there to be no significant benefit (Harvey 2003). Nevertheless, PFMEs generally reduced the incidence of UI in pregnant women, and since these have few if any side effects, such exercises should be recommended as a preventative strategy.

Two RCTs (Woldringh *et al.* 2007; Dinc *et al.* 2009) investigated antenatal PFMEs for the treatment of UI. Woldringh *et al.* (2007) found no significant benefit from exercising, while Dinc *et al.* (2009) reported that antenatal PFMEs were of benefit in the treatment of UI. Since both

studies were flawed, it is impossible to make a firm recommendation as to whether PFMEs are a useful treatment for antenatal incontinence. However, in light of the benefit of PFMEs in the treatment of UI in non-pregnant women, it is suggested that, despite the lack of evidence for this patient group, women suffering incontinence in pregnancy should continue to be offered PFMEs as a treatment.

The prevention studies reviewed were all positive about the benefits of performing PFMEs antenatally, and since none of the authors discouraged their control groups from exercising and all recognized that it was likely that the control group had been made aware of the exercises by their midwives, it is possible that the apparent size of the benefit from being in the treatment groups would be lessened. However, it also seems likely from the available evidence that the benefits of performing PFMEs in pregnancy do not extend beyond 3–6 months postpartum. This may be because of a lack of compliance with exercises postpartum, or a result of birth trauma damaging the muscle and surrounding structures.

Currently, women in the UK are unlikely to be seen by physiotherapists during their pregnancy unless either musculoskeletal or continence problems arise, or they attend a physiotherapy-led antenatal class. As such, it is the midwifery staff who have the greatest opportunity to educate the women about PFMEs. Finance, time and staffing constraints make it unrealistic to imagine that all pregnant women could be assessed and taught PFMEs by a suitably qualified women's health physiotherapist. Therefore, physiotherapists should be aware of the opportunities to inform as many women as possible about PFMEs (e.g. as part of an antenatal class) and to educate them in how to seek a referral should they experience continence problems. Furthermore, in light of the current research evidence proving the benefit of PFMEs for pregnant women, the present authors suggest that women's health physiotherapists should liaise with their midwifery colleagues regarding the information provided to such women, and also encourage midwives to refer their patients for specialist assessment and treatment should they complain of continence problems.

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