A Case Study Intervention on the Effects of Perceived Pain and Functional Ability on Postpartum Women Presenting with Pelvic Girdle Pain and Symptoms of Symphysis Pubis Dysfunction

A RESEARCH PROJECT BY
MICHELLE MULLARD

Word Count: 8037
Student ID: 21401079

Supervisor: Maria Konstantaki

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Abstract

The primary purpose of this study was to evaluate the symptoms and functional movement patterns in women with continuing symptoms of postnatal Pelvic Girdle Pain (PGP) and/or Symphysis Pubis Dysfunction (SPD) before and after an exercise intervention, with the aim of reducing perceived symptoms and improving functional movement.

Taking a positivist, objective approach, (Gratton, 2010), we conducted a pre and post intervention trial to evaluate the effects of exercise targeting specific muscles during a case study of four women. The findings were in favour of exercise as a treatment in both reducing perceived symptoms and improving functional movement. We did however identify some limitations of the study.
Acknowledgments

Abstract

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INTRODUCTION

Statement of Purpose
The primary purpose of this study was to evaluate the symptoms and functional movement patterns in women with continuing symptoms of postnatal Pelvic Girdle Pain (PGP) and/or Symphysis Pubis Dysfunction (SPD) before and after an exercise intervention, with the aim of reducing the symptoms and improving functional movement. Previous studies have investigated the efficacy of exercise interventions on the symptoms of pelvic girdle pain [Mens (2000), Stuge (2004), Depledge (2005)] with some positive results. If exercise that strengthens the pelvic structure can alleviate symptoms it would provide a long-term solution at minimal cost. As injury or misalignment in one area can lead to adverse effects in other areas via the kinetic chain [Minick (2010), Watkins (1999)], there could also be a reduction in the risk of developing additional problems.

Aim and Objective
The objective was to devise and teach a simple and concise exercise routine based on current research that could be practiced at home with little or no equipment so that it could be accessible to postpartum women in a cost and time effective way. This will be assessed by case studies of a small group of women in a pre-post intervention trial design. Taking a positivist, objective approach as recommended by Gratton (2010) our aim was to quantitatively investigate the symptoms and impact of pain caused by Symphysis Pubis Dysfunction in order to establish whether a specifically designed exercise intervention could alleviate symptoms, allowing better quality of life and the option of increased activity levels in daily living.
Background

Pelvic Girdle Pain (PGP) is the umbrella term presently used to describe pelvic pain commonly occurring in women, during and post pregnancy, and includes such conditions as Symphysis Pubis Dysfunction (SPD) and Diastasis Symphysis Pubis (DSP). Osteitis Pubis (OP) is often classified under PGP but, although a similar condition to SPD, OP commonly occurs as an overuse injury in athletes [O’Connell (2002), Goitz (2015)]. SPD is a known instability and dysfunction in the joint of the symphysis pubis, sometimes in conjunction with the sacroiliac joint [Aldabe (2012)]. Current estimates of the prevalence of the condition vary from 1 in 300 to 1 in 30,000 [Scriven (1995)]. It is thought to be more prevalent in Scandinavian women [MacLennan, (1991)], with Norway reportedly having a 37.5% incidence, although this regional difference could relate to a varied recognition of the condition between countries [Aslan (2007)]. PGP causes severe pain in one third of women who are affected [Ostgaard (1996)]. Research, however, is very limited and the condition appears to be underdiagnosed [Depledge (2005), Henry (2015)]. When separation of the pubic symphysis is greater than 10-13mm this is diagnostic of SPD. When diastasis is greater than 14mm it is indicative of DSP and possible consequent damage to the sacroiliac joint [Bahlmann (1993)]. DSP is a separate but related condition occurring when there is abnormal displacement, either vertical or horizontal, of the symphysis pubis [Bjorklund (2000), Aldabe (2012), POGP (2015)]. This is more likely to occur during delivery and can be attributed to a forceps delivery [Henry (2015), Aslan (2007)]. Gestation week 30 has been associated with the onset of pain intensity and disability with 60-80% of diagnosed women reporting pain in late pregnancy. This is thought to be due to increased levels of the hormone relaxin in the body which has an influence on collagen and elastin content [Yamamuro (1999)]. Other possible causes that have been cited are altered pelvic load, weak musculature leading to spino-pelvic instability, genetic susceptibility to joint dysfunction. Associations have been noted with increased maternal age, back pain during pregnancy, high body mass index (BMI), previous history of PGP, strenuous working conditions and increased anterior weight. To date, however, there is no widely accepted cause [Robinson (2010), Owens (2002), Wellock (2008), Bothamley (2009), Tseng (2015)].
Past studies have found that women often do not receive treatment and may feel that they are not listened to when describing their symptoms [Elden (2005)]. Other possible barriers to treatment may be lack of time, giving priority to caring for a new baby along with managing family life, possibly combined with a return to work.

**Symptoms and Treatment**

Symptoms can include mild to severe pain in the pubic region (Ostgaard, 1996). Pain can also occur at the sacroiliac joint (SIJ), lower back and the medial aspect of the thigh, unilaterally or bilaterally. Pain is aggravated by activities such as walking, weight bearing, or lifting one leg and may be accompanied by clicking or grinding sensations in the joint [Aslan (2007)]. It was also found that if pain occurred in multiple sites, such as both the SIJ and the symphysis pubis, that women were less likely to recover postpartum [Robinson (2010)]. Treatment for such symptoms include physiotherapy, exercise, a sacroiliac support belt, anti-inflammatory drugs or steroids, and, in some cases, surgery [Scriven (1995), Depledge (2005)]. There appears to be limited research on the effectiveness of these treatments, however, and due to the scarcity of publications, the available results yield only a little information in the way of clarification [Depledge (2005), Henry (2015), Mulhall (2002)]. There is some suggestion that a combination of a pelvic belt and muscle training can enhance pelvic stability [Vleeming (1992)]. Wingerden's (2004) more recent study found that “sacroiliac joint (SIJ) shear is prevented by friction, dynamically influenced by muscle force and ligament tension.” This supports the hypothesis that strengthening the muscles in the pelvic area could lead to reduced symptoms.

Severe cases of SPD and DSP have been treated with surgery to insert plates and screws to support the pelvic structure and would leave the patient requiring a Caesarean section in the event of any future pregnancy. Surgery necessitates analgesics, antibiotics and thromboembolic prophylaxis to reduce risk of developing deep vein thrombosis [Pedrazzini (2005)]. Such medications would interfere with breastfeeding. [POGP (2015)].
Further Implications of SPD

Women who present with pregnancy-related PGP are three times more likely to develop postpartum depressive symptoms and often have reduced capacity for functional activities [Aldabe (2012)]; this could interfere with family and work life as well as impair ability to care for a child/children and oneself. SPD during pregnancy has been associated with obstetric morbidity [Aslan (2007), Owens (2002)]. Owens further found medical and midwifery staff lacked knowledge of the condition when providing care during delivery and postnatally. Most patients report a resolution of symptoms within 6 months postpartum [Owens, (2002)] but symptoms may persist for many years [Aslan (2007)]. Mens (2000) conducted a survey of 141 women who had symptoms and found that 1 in 4 were still symptomatic 6 months postpartum but often felt ignored when they complained of pain. In retrospective studies 10% - 28% of young and middle aged women with chronic low back pain (LBP) stated their first occurrence was during pregnancy (Mens, 2000).

Pathogenesis and Pelvic Anatomy

Aetiology of PGP and related conditions is unknown but studies suggest that it is linked to increased pelvic mobility leading to joint instability and pain [Aldabe (2012), Mens (2000)]. Relaxation of the pelvic ligaments during pregnancy is believed to be a consequence of hormonal changes occurring around the twelfth week. This is a normal physical change during pregnancy that facilitates delivery (Aldabe, 2012). It is generally believed that the laxity in the pelvic ligaments is a response to the hormone relaxin Aldabe (2012) although some studies show no correlation between joint laxity and serum relaxin levels Schaubberger (1996). Increased fluid retention during the later stages of pregnancy also allows the pubic rami to glide at greater degree so the joint has less resistance to torsional forces resulting in instability [Pool-Goudzwaard (2004)].

This instability can lead to separation in the symphysis pubis known as DSP, causing acute pain in the pelvic region [Scriven (1995), Parker (2009)]. Excessive movement and misalignment can occur causing anterior or posterior pain that can be debilitating [Wellock
Separation can occur during late or post pregnancy or from a rapid or forceps delivery [Henry (2015), Aslan (2007)] and may lead to long term complications [Scriven (1995)]. Siddall (2015) states that the gap in the symphysis joint can increase from 4-5mm in the non-pregnant state to more than 9mm in women with SPD. In the case of DSP the gap would be 10mm plus and may not decrease to normal post birth [Siddall (2015)]. Figure 1 below shows a normal symphysis joint on the left and on the right one with a 9mm gap typical of that occurring in the condition of SPD. Anything wider than 9mm would be classified as DSP.

![Figure 1: Normal and SPD Pelvic Anatomy](https://www.lafeenoire.com)

The pelvis is joined by two sacroiliac joints (SIJ) posteriorly and the pubic symphysis (PS) anteriorly [Moore & Agur (1995)]. The mechanisms of force and form closure, often referred to as the self-bracing or self-locking mechanisms of the SIJ (Vleeming, 1990) provide support while allowing slight movement (Thompson & Floyd, 1998). Form and force closure play an important role in protecting the SIJ from shear forces (Stuge, 2004). During nutation of the sacrum, such as loading situations when transferring from lying to sitting or standing, tension in the ligaments intensifies creating more friction leading to increased SIJ stability (Sturesson, 1989). The articular cartilage of the SIJ is irregular and covered in ridges and grooves to
LITERATURE REVIEW
The aim of this review is to discover what exercise programmes have already been tried in the treatment of patients presenting with PGP or SPD. Although the condition was recognised by Hippocrates (Aslan, 2007), research into the cause, effect and treatment of PGP and SPD is limited. A search of databases including Ovid, SportDiscuss and Pubmed, for SPD and DSP revealed some literature on the conditions, however much of that literature is on the anatomy and physiology as opposed to investigations of treatment modes. We identified five relevant studies with sufficient detail to allow an assessment of what might be effective. Two of these showed positive results in favour of exercise intervention; two found no significant difference between experimental and control groups and one study focussed on a single patient with inconclusive results. Limitations of the two studies that did not have positive results are identified and discussed below.

**Diagonal Trunk Muscle Exercises in Peripartum Pelvic Pain**
Mens et al (2000) conducted a study to investigate the value of graded exercises of the diagonal trunk muscle systems in reducing symptoms of pelvic pain. In a randomised clinical
trial 44 women with persistent post pregnancy PGP were divided into groups: 1) exercise to increase force in diagonal trunk muscles 2) increase force in the longitudinal trunk muscles 3) refrain from exercise but use a pelvic support belt.

Mens classified the diagonal trunk muscles as the internal and external obliques, latissimus dorsi, transversospinal parts of erector spinae (especially multifidus) and gluteus maximus. This set of exercise was theorised to have a positive outcome. The longitudinal trunk muscle group focused on rectus abdomini, longitudinal parts of erector spinae and quadratus lumborum. This is the placebo group because the exercises were not expected to be of benefit. The control group during the study were advised to refrain from exercise while gradually increasing daily living activities. There was no indication of what constituted daily living activities however, or the variability of these between participants.

Results showed the exercise interventions had no additional value over the non-exercise group that used a support belt. Mens (2000) had theorised that although exercise would increase muscle force and reduce symptoms, exercise could also exacerbate symptoms by loading of the spinal and pelvic structures. Therefore it could not be determined whether an exercise programme was ineffective in increasing muscle force or if the benefits were outweighed by increased spinal and pelvic loading. In addition they speculated that the exercise being implemented by video instruction, could have influenced the results. This is a valid consideration as there is a risk that participants with little body awareness or exercise experience may not be targeting correct muscle groups and may over-compensate in other areas without direct supervision and specific cues.

**The Efficacy of Specific Stabilisation Exercises for Treatment of Pelvic Girdle Pain**

Stuge (2004), in a randomised controlled trial using a stratified block design, compared two treatment groups to evaluate the efficacy of specific stabilisation exercises in reducing pain and improving functional status and the quality of life for women with pelvic pain. The aim of the study had been to assess whether improvements in local and global stability systems
would bring a positive effect on dysfunction of the muscle-tendon-fascia system that provides force closure of the pelvis, as mentioned above.

Group 1, the treatment group, received specific stabilisation exercises (SSEG). Group 2, the control group (CG), did not take part in the exercises. Both groups received physical therapy treatment on ethical grounds. The groups were stratified by pain location: pure symphysis pubis pain, all 3 pelvic joints and either, or both, of the SI regions, in order to have comparable groups. Stuge viewed these variables to be of possible prognostic importance based on Albert (2001) who discovered differences in recovery between women with pelvic girdle syndrome (pain in all 3 joints), the majority of whom had continued pain at 2yr follow up, and women with symphysiolysis (pain at 1 site), who predominantly had no pain at 6m follow up. Baseline assessments found no significant differences for measures of pain, functional status and quality of life between the two groups. Physical tests were performed prior to intervention for participation criteria: posterior pelvic pain provocation (P4) test, ASLR, pain provocation of the long dorsal SI ligament, pain provocation of the symphysis by palpitation and the Trendelenburg test to assess the gait pattern of gluteus medius.

The targeted muscle groups in the treatment programme consisted of transversely orientated abdominals with coactivation of multifidus, gluteus maximus, latisimus dorsi, oblique abdominals, erector spinae, quadratus lumborum and the hip adductors and abductors. Participants exercised 3 times per week for 18-20 weeks with weekly or bi-weekly guidance and adjustments by a physical therapist. Exercise was measured with a training diary and subjects were also encouraged to regularly activate transverse abdominals during daily activity. To facilitate the exercise a TerapiMaster was installed at each participant’s home. This equipment consists of a suspension system attached to the ceiling which is often used with a treatment couch by physiotherapists but can also be used on the floor. Examples of some of the exercises are shown in Figure 3.
Group 2 (CG) received bi-weekly treatment of massage, joint mobilisation, manipulation, electrotherapy and hot packs as individually recommended by a physiotherapist as well as advice on performing daily activities in an ergonomically efficient way. No stabilisation exercises were performed by group 2.

The measured outcomes included general health, vitality, social functioning and emotional and mental health. Pain and functional status were measured using the Oswestry LBP Disability Questionnaire and health related quality of life with the SF-36 Health Survey. For the purpose of our study we are focussed on the results for physical functioning and bodily pain, illustrated in Table 1.

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>After Intervention</th>
<th>1 Year follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SSEG</td>
<td>CG</td>
<td>P</td>
</tr>
<tr>
<td></td>
<td>(n=40)</td>
<td>(n=41)</td>
<td></td>
</tr>
<tr>
<td>Physical Functioning</td>
<td>52.8</td>
<td>46.3</td>
<td>.15</td>
</tr>
<tr>
<td>Bodily Pain</td>
<td>35.8</td>
<td>32.8</td>
<td>.42</td>
</tr>
</tbody>
</table>

Table 1 Intervention Results Adapted from (Stuge, 2004)
There was improvement in physical functioning and bodily pain both post intervention (20wks) and at 1 year postpartum for both groups. The SSEG group showed significantly more improvement after intervention and at the 1-year follow up. Stuge concluded that specific stabilisation exercises were a more effective treatment than physical therapy without stabilisation exercises.

**Depledge (2005)**

Depledge (2005), in a randomised, masked, prospective experimental clinical trial of pregnant women presenting with SPD, investigated the effects of specific strengthening exercises and whether the use of pelvic support belts would add any value. Women were divided into 3 groups: exercise only (n=30), exercise with rigid support belt (n=28) and exercise with non-rigid support belt (n=29). Additionally all 3 groups were advised on how to perform daily activities correctly. The exercises were based on research by Vleeming (1995) and Lee (1996) and were aimed at increasing stability in the pelvis. The exercises were demonstrated and checked for correct performance by a physiotherapist and completed 3x daily by participants. There was no further information provided in the paper regarding what the exercises consisted of or targeted muscles. Data was gathered using an adapted version of the Roland-Morris Disability Questionnaire, the Patient Specific Functional Scale and a Pain Intensity Questionnaire (Westaway, 1998) to ascertain which functional activities participants found difficult and to what extent.

The results summarised as pain reduction in Figure 4 revealed a significant improvement in symptoms of SPD across all groups but with no additional benefit in the use of either rigid or non-rigid support belts. In discussion, the long term benefits of strengthening muscles to support and stabilise the skeletal structure were emphasised. From a physiological perspective, it does appear that exercise is beneficial in supporting the pelvic structure which is prone to weakening via hormonal changes during pregnancy at a time when there is the additional strain of anterior weight gain.
Depledge (2005) concluded that the use of support belts did not add to the effect of the muscle strengthening exercises and advice given. It was also suggested the long term benefits of exercise in strengthening muscles to stabilise the pelvis would be significantly greater than a support belt.

**Stabilising Home Exercises for Persistent Pelvic Girdle Pain**

Gutke (2010) later conducted a prospective, randomised, single-blinded, clinically controlled study (n=88) on postnatal women with pelvic pain at 3 months postpartum. The aim was to determine whether home based, specific stabilising exercise, focusing on the local stabilising muscles was sufficient as a treatment for women with persistent pelvic pain, PGP or a combination of both. Participants were identified by medical staff and had not sought help for their condition, so the selection process may have included women with only minor symptoms. Additionally there had been no reported lumbar pain during pregnancy among these participants and the results of the Active Straight Leg Raise (ASLR) showed that not all women had problems with load transfer in the lumbo-pelvic region.

Baseline tests were taken using the Oswestry Disability Index (ODI) to measure disability, pain intensity was measured using a Visual Analogue Scale and back extensors were tested for
isometric endurance. Baseline testing showed no significant difference between groups for disability, pain or symptoms.

Participants were divided into either a treatment group receiving specific stabilisation exercise (n=34) or a reference group (n=54). The treatment group intervention consisted of exercise targeting transverse abdominals, lumbar multifidus and pelvic floor along with stabilisation training to include the principles of motor learning theory. The exercise regime was divided into 3 phases: phase 1 focused on local segmental control, phase 2 closed chain segmental control and phase 3 open chain segmental control. The exercise was progressive throughout with the goal being to reach phase 3. The training was mostly done at home with guidance and adjustment every 2nd week with a physio. Electromyography EMG activity was measured to evaluate whether treatment had targeted muscle function.

The exercises were subscribed individually by a physiotherapist and participants varied in the amount of time they trained. The target level 2 was reached by 78% of the women although some training diaries were not handed in. Some women received additional treatment such as ultrasound or use of a pelvic support belt. Results showed no significant difference at 3 and 6 month follow up for disability, pain or symptoms. A within group comparison showed some improvement in disability, pain and decrease in symptoms along with improvement in muscles function compared to baseline. There was however a difference in pain frequency between groups at 3 and 6 month follow up, with a significant reduction in the treatment group.

It was noted by Gutke (2010) that participants in both groups had quite adequate skills at baseline giving less scope for improvement; it was also noted that subsets of women, such as those with different pain locations, would benefit from other exercise or treatment modes. It was concluded that there was no significant difference between treatment and the natural healing process. More than half the women continued to have pain 9 months on from the study in both groups suggesting that the stabilisation exercises were not effective. It was recommended that there is a need for greater significance to be placed on understanding the
effect of local and global muscles on lower back pain (LBP) and PGP to ascertain which is more suitable for stabilisation exercise.

**Management of Postpartum Pubic Symphysis Diastasis**

Henry (2015), dissimilar to previous studies, conducted a single case study on a 30 year old female with severe postpartum pelvic pain resulting from Pubic Symphysis Diastasis. Treatment consisted of chiropractic adjustments, trigger point release, electrical stimulation, moist heat, and sacroiliac support belt and stabilisation exercises. The exercises included, Kegels, pelvic tilt and bridge, progressing to use of a stability ball to strengthen core. It is stated that the exercises given were for specific stabilisation but there is no more mention of type, or targeted muscles. Fourteen weeks post treatment the patients’ pain was reduced to 1 on a scale of 1-10, separation of the pubis symphysis was reduced from 17mm at pre-treatment to just under 10mm. Due to the multimodal intervention however, it is not possible to know which intervention worked more than another and to what level, leaving us with inconclusive results regarding the efficacy of the stabilisation exercises. Henry (2015) noted that PSD is deemed to be rare and lacks enough literature to establish appropriate treatment for the condition, suggesting also the need for collaboration between chiropractors, midwives and obstetricians amid further investigation.

**Summary**

With respect to Mens (2000) study, other researchers, [Pool-Goudswaard (2003) Wingerden (2004) Stuge (2004) Hodges (1996)], had concluded that rectus abdomini, transverse abdominals and quadratus lumborum also contribute to pelvic stability. The separation of the muscle groups also seemed unproductive as some muscles included in both the study group and the CG had a role in pelvic stability. Combining the longitudinal and diagonal trunk muscles during the intervention may have seen improvement over that of the pelvic support belt as in Depledge (2005), however, whether overloading muscles would outweigh any possible benefits of exercise did not become apparent in the study.
Stuge (2004) found exercise to be a beneficial treatment in contrast to Mens (2000) and Gutke (2010). Stuge noted some key muscles were not included during Mens (2000) study which focused on local stabilising muscles only. Stuge (2004) also argued that the integrity of performing the exercise is as important as the quality of the exercise.

Depledge (2005) found positive results with exercise, based on research by [Vleeming (1995) Lee (1996)] over the use of either rigid or non-rigid pelvic support belts. We were not able to access the full study by Vleeming and Lee however and there was no further information on this in the study.

Gutke (2010) found no benefits to exercise over the natural healing process, however the selection process may have left little room for improvement in either group. Participants were also at a stage postpartum (under 6m) where statistically the natural healing process is still likely to occur.

Henry (2015) later found inconclusive results during his single case as there was no way to determine which treatment worked due to the multi modal nature of the intervention.

**METHODOLOGY**

**Research Design**

Taking a positivist, objective approach, (Gratton, 2010), we conducted a pre and post intervention trial to evaluate the effects of exercise targeting specific muscles during a case study of four women. It was deemed case studies would be the most appropriate study method, as each case will be so unique in terms of the history of symptoms as well as other factors relating to pregnancy, birth and lifestyle.

**Research Question**

Can an Exercise Programme Aimed at Strengthening the Pelvic Structure Reduce Perceived Symptoms of Pelvic Girdle Pain and Symphysis Pubis Dysfunction?
Objectives
To quantitatively investigate the symptoms and impact of pain caused by symphysis pubis disorder (SPD) in order to establish whether an exercise intervention could alleviate symptoms, allowing better quality of life and the option of increased activity levels in daily living

• Build a profile of each participant i.e. exercise/activity levels, pre pregnancy pain, whether they are multiparous, birth weights of babies
• Evaluate participants functional ability in performing day to day tasks pre and post intervention
• Investigate the level of pain pre and post intervention
• Apply an exercise intervention

Sampling Strategy
As previously mentioned (Aslan, 2007), most women reporting pelvic pain are symptom free within 6 months but those with continued pain find that pain can persist for several years. We therefore we looked for women who are at least 6m postpartum, so there is less likelihood of symptom resolution occurring naturally and for the practicality of being able to leave their child to attend the programme. A stratified sampling method was applied (Gratton, 2010) where participants were sought using online networking pages relating to pregnancy and or birth. This recruitment process was used to obtain a cross section of mums in the local community. Participants were required to be postnatal from 6months onwards but with no upper limit of postnatal stage if symptoms still persisted, providing symptoms related to a past pregnancy.

Inclusion Criteria:

• Pain/tenderness in the symphysis pubis region relating to current or past pregnancy, not as a result of injury or other condition
• Pain or difficulty raising one leg from the floor, either straight or bent, from standing, seated or lying.
• Diagnosis or symptoms of SPD that related to a past pregnancy

Exclusion Criteria:

• Advised against exercising by a professional
• Musculoskeletal disorders or pain in lower back or hips unrelated to pregnancy
• Pain unrelated to the condition(s) perceived to be worse than pelvic pain
• Postpartum earlier than the specified 6 months
• Any other condition deemed to be contraindicative for the exercises prescribed.
Selection process is illustrated in Figure 5.

Figure 2 Flowchart of Study Selection Process

Participants

Case studies were conducted on 4 females presenting with symptoms of PGP and/or SPD relating to a past pregnancy, which had continued more than 6m after the initial period that they are normally expected to dissipate (Owens, 2002). A profile was created for each participant (Table 2) and all participants were assessed for functional ability and level of pain before commencement and immediately after the intervention using the Roland Morris Disability questionnaire (RMD), designed to assess physical disability; and the Patient Specific Functional Scale (PSFS) to assess perceived pain. Additionally physical functional movement tests based on the functional movement screen (FMS) were completed.

<table>
<thead>
<tr>
<th></th>
<th>Participant 1</th>
<th>Participant 2</th>
<th>Participant 3</th>
<th>Participant 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>35</td>
<td>32</td>
<td>31</td>
<td>42</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>162</td>
<td>179</td>
<td>167</td>
<td>169</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>51</td>
<td>88</td>
<td>59</td>
<td>60</td>
</tr>
<tr>
<td>Postpartum (months)</td>
<td>24</td>
<td>10</td>
<td>7</td>
<td>18</td>
</tr>
<tr>
<td>No. Full Term Pregnancies</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Symptoms Related to Pregnancy No.</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>Both</td>
</tr>
<tr>
<td>Birth Weights (lb)</td>
<td>6.9 / 6.4</td>
<td>9.14</td>
<td>8</td>
<td>6.1 / 7.7</td>
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### Table 2 Participant Profiles

<table>
<thead>
<tr>
<th>Previous Treatment Relating to PGP/SPD</th>
<th>Participant 1</th>
<th>Participant 2</th>
<th>Participant 3</th>
<th>Participant 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physiotherapist, Chiropractor, acupuncture, Referral to Pain Management Clinic</td>
<td>Physiotherapist</td>
<td>N/A</td>
<td>Osteopath</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Previous Exercise Habits During Adulthood</th>
<th>Participant 1</th>
<th>Participant 2</th>
<th>Participant 3</th>
<th>Participant 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walking (school run and local park with children)</td>
<td>Yoga, long walks, occasional gym</td>
<td>Walking between tube trains on commute &amp; occasional weekend walk</td>
<td>Regular Pilates after first child, intermittently after second</td>
<td></td>
</tr>
</tbody>
</table>

### Ethical Considerations

Par-q and participant consent forms were completed and signed prior to the first session.

Participants had all previously received and read the participant information sheet regarding the study and requirements. Participants were informed of the risk of aching muscles after exercise and were advised on stretches that may help alleviate aches and applying cold and heat. We attempted to avoid this risk with low numbered repetitions and advising participants to only increase resistance when they felt the exercise required less effort. During the FMS testing participants were advised to not complete the test if pain was felt. The words pass, fail and test were omitted from the FMS as this terminology was thought to be inappropriate and may encourage participants to “work through pain.” The exercise was taught by a qualified Yoga and Pilates Teacher with additional qualifications in Pregnancy and Postnatal Yoga and Pilates. Participants were informed they could drop out of the study at any point but their data would still be used if they had completed the post intervention forms and testing.

### Data Collection Method

The measured outcomes were pain, disability and functional movement. The Roland Morris Disability questionnaire (RMD) and Patient Specific Functional Scale (PSFS) were completed by participants prior to and post intervention. The RMD and PSFS have been assessed in trials to be an efficient, reliable and valid means with which to assess disability and change in disability [(Westaway (1998), Chatman (1997), Nicholas (2012)]. The RMD is designed for patients to self-rate their physical disability; it was originally designed for lower back pain (LBP).
but can be adapted for other conditions by replacing the phrase “because of my back.” We used the phrase “because of my pelvic pain.” While some of the studies used the Oswestry Low Back Disability Questionnaire that is recommended for severe disability (Grotle, 2000). The RMD is purportedly more suited to mild disability such as seen in PGP or SPD. The RMD is widely considered to be an accurate measure of pain, reliable in distinguishing a specific pain from other areas of pain and, with less incomplete or ambiguous answers than similarly used questionnaires (Roland, 2000) while also being more efficient in terms of completion time compared to others (Nicholas, 2012). Participants select from a list of 24 items covering aspects of daily living that may be impaired by pain. Each tick equates to a point so we would see a reduction in points post intervention if disability is reduced.

The Patient-Specific Functional Scale (PSFS) allows participants to choose 3 tasks they perceive themselves to have difficulty with. Each is scored on a scale of 0-10 with 10 indicating the most difficulty and 0 no issues at all. Patient generated relevant activities have been found to be more adaptable to quantifying and evaluating a range of conditions than generic questions (Westaway, 1998). The PSFS was validated for test-retest reliability and sensitivity to change on patients with LBP (Chatman, 1997), although Chatman (1997) also suggests further investigation. More recently, supporting the extent to which it can be applied to other conditions, the PSFS was reported to be a valid and reliable outcome measure in individuals with a limited number of acute, subacute and chronic conditions and in populations with dysfunction, including acute and mechanical LBP (Horn, 2012). A reduction in scoring post intervention equates to improvement.

An adapted version of the Functional Movement Screen (FMS) [(Cook (2003), Cook (2006)] was used to assess functional movement patterns prior to and on completion of the intervention. The FMS test involves 5 physical tasks that require correct movement patterns to score a pass, if not correctly completed a fail is registered (Cook, 2006). The test is often used to detect athletes at risk of injury or test their susceptibility to re-injury before returning
to sport (Cook, 2006). In consideration of the physical condition of the participants this was reduced to include only 3 physical tasks that are less challenging:

- An adapted hurdle step involving lifting one heel to the tibial tuberosity height of the standing leg. This movement is often reported to be difficult with symptoms of PGP and/or SPD.
- The active straight leg raise (ASLR)
- The inline lunge to 90° angle instead of the full version with knee to the floor.

The inline lunge was deemed the most challenging and would only be attempted if both task 1 and 2 were successful. Examples are shown in Table 4.

Testing resulted with a pass or fail for each one depending on whether the test could be performed correctly without over compensation in other areas of the body and without pain or discomfort. The third test was only attempted if the previous 2 were successful. The purpose of the ASLR is to examine the ability to transfer weight between the spine and legs, inability to perform can indicate reduced muscular activity and resulting dysfunction in the pelvic joint (Robinson, 2010). The ASLR mentioned in (Cook, 2003) is designed to test hamstring flexibility, we used the ASLR to test functioning as described in (Robinson, 2010).

<table>
<thead>
<tr>
<th>Adapted Hurdle Step</th>
<th>ASLR</th>
<th>Inline Lunge (knee to 90°)</th>
</tr>
</thead>
</table>

Figure 6 Illustration of Adapted FMS Test
**Study Design**

The aim of the exercise intervention was to strengthen the muscles involved in the hip and pelvic movement (Thompson, 1998). It was previously thought that focusing on isolated muscles would reduce injury, but following more recent research (Minick, 2010), health professionals are focused on the more holistic approach of improving movement patterns as opposed to working with a joint or muscle in isolation (Cook, 2006). Therefore, and based on previous studies by Vleeming (1992), our exercise intervention was aimed at developing strength in the muscles surrounding the whole pelvic structure. Unlike some studies that did not show benefits from exercise, we are taking care to include all of the muscle slings that create force closure. The muscles targeted are listed in Table 3.

<table>
<thead>
<tr>
<th>LOCATION AND FUNCTION</th>
<th>MUSCLES</th>
</tr>
</thead>
</table>
| **Pelvic Diaphragm**  | Levator Ani, Levator Protatae  
Along with the tendinous arch, counters abdominal pressure, assists in micturition, defecation and childbirth and a significant support mechanism for the uterus in resisting prolapse  
Puborectalis, Pubococcygeus  
Iliococcygeus, Coccygeus (will be collectively referred to as Pelvic Diaphragm throughout) |
| **Pelvic Wall**       | Obturator Internus (adducts hip)  
Piriformis (abducts, extends, stabilizes)  
Sacrotuberous Ligament  
Sacrospinous Ligament |
| **Lower Body Anterior** | Tendinous Arch  
Iliopsoas  
Pectineus  
Rectus Femoris  
Sartorius  
Psoas Major (stabilizes lumbar spine)  
Iliacus (laterally rotates hip) |
| **Lower Body Posterior Muscles** | Gluteus Maximus  
Bicep Femoris  
Semitendinosus  
Semimembranosus  
External Rotators |
| **Lower Body Lateral Muscles** | Gluteus Medius  
Gluteus Minimus  
External Rotators  
Tensor Fasciae Latae (TFL) |
**Lower Body Medial Muscles**
- Primarily involved in hip adduction
  - Adductor Brevis
  - Adductor Longus
  - Adductor Magnus
  - Gracilis

**Abdominals & Lower Back**
- Stabilizes and tilts pelvis backward (retroversion)
- Contributes to stabilization and movement of pelvis
  - Rectus Abdomini
  - Quadratus Lumborum

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Intensity</th>
<th>Target</th>
<th>Progression</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semi Supine - isometric contraction (Kegel exercise)</td>
<td>5 deep breaths</td>
<td>Pelvic Diaphragm Transverse Abdominals</td>
<td>Deeper breaths</td>
</tr>
<tr>
<td>Pelvic Tilts – palms on lower belly/upper pelvis</td>
<td>5 deep breaths</td>
<td></td>
<td>As above</td>
</tr>
<tr>
<td>Bridge while squeezing block/ball</td>
<td>1-3 breaths</td>
<td></td>
<td>4-5 breaths</td>
</tr>
</tbody>
</table>

Table 3 (Thompson 1998, Moore 1995 Long 2010)

**Training Protocol**
Participants were required to complete the exercise routine (shown in Table 4) of approximately 30mins, twice per week over a period of six weeks. This was deemed to be a sufficient period for adaptation to occur (Spurway, 2006). Participants were advised to practice Kegel and isometric transverse abdominal exercises daily when possible. The training protocol was developed with reference to (Delavier, 2003) and (Long, 2010). Advice was given on progression in line with (ACSM, 2014) guidelines. During side-lying hip abduction, participants were instructed to isometrically contract the transverse abdominals and lumbar multifidus to create lumbar stabilisation. This was shown in a study to increase electromyographic activity in the target muscles; gluteus medius and internal oblique’s (Cynn, 2006).
<table>
<thead>
<tr>
<th>Exercise</th>
<th>Reps/Likes</th>
<th>Muscles Involved</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bridge – single leg extension</td>
<td>1-2 rounds</td>
<td>Glute Max, Bicep Femoris</td>
<td>3-4 rounds</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Glute Medius, Glute Max, Tensor Fascia Lata</td>
<td></td>
</tr>
<tr>
<td>Side lying heel kicks</td>
<td>20 reps</td>
<td>Gluteus Maximus</td>
<td>Increase reps</td>
</tr>
<tr>
<td>Side Lying Hip Abductions</td>
<td>16 reps</td>
<td>Glute Medius, Glute Minimus</td>
<td>Add weight i.e. Pilates ball/dumbbell behind knee</td>
</tr>
<tr>
<td>Side Lying Thigh Circles</td>
<td>8 reps</td>
<td>Glute Maximus</td>
<td></td>
</tr>
<tr>
<td>Side Lying Lateral Thigh Lifts</td>
<td>20 reps</td>
<td>Adductor Brevis</td>
<td></td>
</tr>
<tr>
<td>Side Lying Lateral Thigh Circles</td>
<td>10 each direction</td>
<td>Adductor Longus Adductor Magnus Gracilis Pectineus</td>
<td></td>
</tr>
<tr>
<td>Rib Cage Arms (wide, overhead, circles)</td>
<td>10 reps each</td>
<td>Rectus Abdomini</td>
<td></td>
</tr>
<tr>
<td>Heel Slides L1</td>
<td>8 reps each</td>
<td>Rectus Femoris</td>
<td></td>
</tr>
<tr>
<td>Knee Floats L1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crunches - &amp; feet on floor L2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Torso Raises off floor L2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Half Crunches L2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single leg shin lift – all fours</td>
<td>3 reps</td>
<td>Multifidus</td>
<td></td>
</tr>
<tr>
<td>Back extensions</td>
<td>2 reps held 1-3 breaths</td>
<td>Quadratus Lumborum</td>
<td></td>
</tr>
<tr>
<td>Stretches for pelvic diaphragm, hips, thighs and waist</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1 Exercise Plan

Exercises were done in a group supervised by the instructor for the first 3 weeks (6 sessions) at a local gym in reasonable proximity of all participants. Participants all stated they felt confident to continue the exercise routine at home. Prompts with teaching points, number of repetitions and stick drawing illustrations, along with a video of the exercises were provided to each participant for home use. Regular contact was maintained with participants via social media messaging twice weekly as a reminder to ensure exercise was adhered to and to answer any queries or offer advice on progression. Women had previously reported being motivated by gradual increase in resistance (Stuge, 2004). Although twice weekly exercise was required participants could increase this if they wished to, advice was given based on ACSM (2014) guidelines.
**Data Analysis**

The RMD and PSFS provided quantitative data in regards to the level of pain and functional movement pre and post intervention and to what extent. To be of clinical importance we would need a 2 or 3 point reduction in the RMD (Deyo, 1998). In the PSFS questionnaire a 2 point difference in scores is considered to be the minimum detectable change (Westaway, 1998). With regards to the FMS test, we are looking for a pass where there was previously a fail, or the test was not applicable such as test 3 where the test might not have been attempted. We will also discuss the variables between each participant, investigating any parity between symptoms for example age or birth weight.

**RESULTS**

To ensure a consistent basis, initial and post data collection was completed at the same time of day, between 1.30pm and 2.30pm. We found significant differences in all 4 participants between baseline and post intervention.

**RMD Results**

The RMD results (Figure 7) display the points scored at baseline and completion for each client. We can see similar levels of post intervention score for participants each showing an improvement. The improvement in every case is greater than the 3 points required for clinical significance. The reduction for participant 1 who had the worst baseline level was particularly substantial.
PSFS Results

The self-generated tasks for each participant’s PSFS are shown in Table 5. While there is some commonality with three participants mention walking, there were no tasks that appeared in all lists. This illustrates the point made by Westaway that generic tests are less likely to capture the uniqueness of individual’s issues. The lower numbers at completion show improvement, less perceived difficulty or pain. Where the score is 0 this equals no remaining issue with the task.
Average results across all three tasks for each participant are shown in Table 6. Every participant showed an improvement on average scores, between baseline and completion.
The 3 FMS tests were scored as a pass or fail. Overall data was collated according to whether there was regression i.e. pass at baseline, but fail on completion (-1), no change (0), or improvement (1). Scores are shown in Table 7.

<table>
<thead>
<tr>
<th></th>
<th>P1</th>
<th>P2</th>
<th>P3</th>
<th>P4</th>
</tr>
</thead>
<tbody>
<tr>
<td>BL</td>
<td></td>
<td>BL</td>
<td>BL</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
<td>C</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td><strong>Adapted Hurdle Step</strong></td>
<td>F</td>
<td>P</td>
<td>P</td>
<td>p</td>
</tr>
<tr>
<td><strong>ASLR</strong></td>
<td>F</td>
<td>P</td>
<td>F</td>
<td>p</td>
</tr>
<tr>
<td><strong>Inline Lunge to 90°</strong></td>
<td>N/A</td>
<td>F</td>
<td>N/A</td>
<td>F</td>
</tr>
<tr>
<td><strong>Score</strong></td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 6 PSFS Average Baseline and Completion

Table 7 Functional Movement Screen Tests

To summarise, all of the outcome results for each participant are shown in Table 8 all of them indicating improvement.
Discussion
The results are consistent with the hypothesis that exercise can be effective in the reduction of symptoms of SPD and PGP. Participants all reported feeling a positive change after the first week. Participant 1 missed 2 sessions between weeks 2 and 3 due to illness, and reported a return of discomfort which was alleviated on returning to the exercise. No official data was recorded on how much of the exercise was performed by participants beyond the required amount, but all participants reported daily pelvic floor and abdominal work.

Participant 1 reported daily adherence to at least 2 or 3 of the exercises on a rotational basis. She had tried several treatment modes preceding the intervention -- physiotherapy, chiropractic, acupuncture -- and was waiting upon referral to a pain management clinic throughout the duration of the study. No previous history of formal exercise was reported by participant 1 this could affect adherence to any prescribed exercise, or cause insufficiency in understanding of performing exercise correctly. Participant 1 had required additional demonstrations and teaching cues above others in the group. However this participant appeared to become the most dedicated and had the best overall change, with RMD reduction of 11, PSFS average change 4.3, FMS score 2.

Participants 2, 3 and 4 showed very similar results. Participant 2 had a reduction of 4 on the RMD, PSFS was 4.2 and FMS 1. Participant 3, RMD 5, PSFS 4.0 and FMS 1. Participant 4
had a reduction of 6 on the RMD, 2.0 and FMS 1. Variables between participants; seen in Table 3; such as age, height, weight, number of pregnancies and birth weights of babies were uninformative. Participants 1-3 were of similar age, participant 4 was older but showed little difference in overall results. Due to the postpartum condition of the participants we are not placing too much emphasis on BMI; 1, 3, and 4 were within healthy range while participant 2 would be classified as overweight as classified by NHS Choices (2015). However this was not a scientific test and does not appear to have any bearing on our results. The distinguishing factors could be the increased frequency of exercise undertaken by participant 1 and having not exercised significantly in the past. More overloading in muscles may have occurred therefore increasing hypertrophy (Fahey, 1998), which also suggests a potential for improved results in participants 2-4 had time, type and intensity in exercise been increased sufficiently. We also have no way to determine predominant muscle fibre types in each participant, type ii fibres adapt faster to strength training (Fahey, 1998) which could also affect results.

The resulting benefits seen in the study could have been exaggerated due to feelings of social obligation by participants towards the instructor who also carried out the assessments. It was explained on initial introduction that complete honest answers were essential for the study, in order to gain an understanding on what exercise intervention may be effective and that a negative outcome would not be detrimental to the study at all. Ideally assessments would be conducted as a blind trial with baseline and completion testing done by persons unknown to the participants.

As this test was an adapted version of the FMS which is usually used on athletes we weren’t sure if this would provide useful information. The results were consistent with the other two assessments although we have no benchmark on the level of change required to be clinically significant.

Varying results are seen in studies relating to exercise intervention, Stuge (2004) and Depledge (2005) had positive results with stabilisation exercises whereas Mens (2000) and
Gutke (2010) found no significant benefit to exercise, however as previously stated Mens (2000) had not included key muscles that play a role in stabilisation. Gutke (2010) stated there may have been less scope for improvement in participants due to quite adequate skills at baseline, this could tally with our results seen in participant 1. In addition, participants in Gutke (2010) were less than 6 months postpartum, the stage during which natural recovery is more likely to occur (Aslan, 2007) which may affect results. Stuge (2004) and Henry (2015) studies both showed positive results. Our intervention targeted the muscles of the pelvic slings, as seen in Stuge (2004) who had positive results; but with the addition of all other muscles that pass through the pelvis. Stuge (2004) required equipment that could be difficult to implement, our aim was to develop exercise that could be more easily accessible. Additional testing such as electromyogram activity may have provided more conclusive data however with time constraints of the participants this would have been beyond the scope of this study, furthermore where the aim is to improve functional status of daily living activities, physical measurements such as muscle strength and ROM have been shown to have a weak correlation to patient symptoms or behaviour (Deyo, 1988).

As we had a small number of participants we treated each one individually and it was not possible to have a control group that did not exercise. We cannot definitively say that the exercises caused the improvement although the data is consistent with that, particularly as it is otherwise unusual to see improvement after six months postpartum. Because all participants did the same exercises we have no basis for discriminating between any particular aspects of the exercise regime that were essential and those that were not necessary. However as less complete routines were not found to be beneficial we can have some confidence that this range of exercises is appropriate.

**Recommendations**

This research shows that exercise can be effective in the reduction of symptoms if this was more accessible to this community. Physiotherapy is not always accessible, it can be costly, especially if needed long term and accessing NHS treatment requires initial referral and
waiting time. A survey of NHS waiting times showed almost a quarter of patients awaiting musculoskeletal treatments had a 6-8 week waiting time and 15% had waiting times between 4 and 5 weeks, this is an increase on 2010 figures (JJ Consulting, 2011). Physio clinics appear to be moving towards offering Pilate’s classes suited to patients with back pain or postnatal women, but again this may not be accessible to all. A well-documented home-based exercise routine could be a cost effective way of reaching a wider proportion of this community.

More extensive clinical trials investigating differentiation between pain locations and specific exercise would be helpful in generating targeted routines with minimal time requirements that would help adherence. Investigation into preventative measures and early intervention measures might generate relevant clinical information to improve outcomes for the women who are at risk of Pelvic Girdle Pain, Symphysis Pubis Dysfunction or Diastasis Symphysis Pubis.

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