Therapeutic Exercise Regarding Musculoskeletal Health of the Pregnant Exerciser and Athlete

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Abstract

Physical activity during pregnancy is recommended and has been shown to benefit most women. However, some modifications to exercise routines may be necessary due to normal anatomic and physiologic changes and fetal requirements. Therefore, knowledge about the systemic changes of pregnancy should be con-

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sidered when counseling women who wish to exercise through their pregnancy and should be complemented by the knowledge about the potential effect of exercise (therapeutic exercise) for the prevention and resolution of some common pregnancy-related musculoskeletal conditions. Therapeutic exercise is the systematic and planned performance of exercises that aims to improve and restore physical function.

This chapter presents the scientific evidence foundation on the effect of therapeutic exercises on the prevention and resolution of three commonly pregnancy-related musculoskeletal conditions: pelvic floor dysfunction, diastasis recti abdominis, and low back and pelvic girdle pain. The chapter emphasizes the potential effect of exercise on the prevention and resolution of these musculoskeletal conditions and provides useful information when tailoring therapeutic exercise programs for pregnant women.

Keywords

Pregnancy · Diastasis recti abdominis · Low back pain · Pelvic girdle pain · Pelvic floor muscles · Urinary incontinence

12.1 Introduction

Physical activity during pregnancy is recommended and has been shown to benefit most women. However, some modifications to exercise routines may be necessary due to normal anatomic and physiologic changes and fetal requirements [1]. Pregnant women, therefore, represent a particular gender-based clinical challenge for the therapist and exercise promotor. During pregnancy, the female body undergoes many morphological and physiological changes that affect the musculoskeletal system. The most obvious change in pregnancy is related to the growth of the fetus and the stretching of the abdominal muscles, which may influence the mother's posture and balance. These factors in combination with hormones and weight gain may contribute to a variety of musculoskeletal impairments, trigger the development of musculoskeletal dysfunction, or alter the course of preexisting conditions. The most common pregnancy-related musculoskeletal impairments are pelvic floor dysfunctions, diastasis recti abdominis, and low back and pelvic girdle pain.

Therapeutic exercise is the systematic and planned performance of exercises that aims to improve and restore physical function. Additional goals of therapeutic exercises include pain relief, increased strength, and increased range of motion.

This chapter presents the scientific evidence foundation on the effect of therapeutic exercises on the prevention and resolution of three common pregnancy-related musculoskeletal conditions: pelvic floor dysfunction, diastasis recti abdominis, and low back and pelvic girdle pain. A generic description of each condition is followed by information that could be useful for the development of therapeutic exercise programs for pregnant women.

12.2 Pelvic Floor Muscle Training

In general, it is possible to affirm that all women can benefit from education regarding the role of Pelvic Floor Muscles (PFM) during pregnancy on pelvic floor dysfunctions. The specific treatment of the pelvic floor muscles is critical for the quality of life of women suffering from urinary and anal incontinence, pelvic organ prolapse, and a variety of pelvic pain syndromes. Therapeutic exercises focusing on education and pelvic floor muscle training should be incorporated as a key component for pregnant exercisers and pregnant athlete women.

Several hypotheses have suggested that a trained PFM might reduce the risk of UI during pregnancy and after childbirth [2]. For example, a trained PFM may counteract the hormonally mediated increased laxity of the pelvic floor and the increased intra-abdominal pressure during pregnancy. In addition, it may encompass a greater functional reserve so that childbirth does not cause loss of muscle function to develop urinary leakage. Further, a trained PFM may recover better after childbirth as the appropriate neuromuscular motor patterns have already been learned [2].

PFM Training (PFMT) and the importance of PFMT in restoring function after childbirth were introduced as early as 1948 by Kegel [3]. In an uncontrolled clinical trial from 1952, he reported that 84% of his patients with UI were cured after performing PFMT [4]. According to Bø [5], there are two main rationales for why PFMT works:

- Women learn how to consciously precontract the PFM before and during situations causing increased abdominal pressure (e.g., coughing);
- Increased PFM strength and enhanced hypertrophy take place, building up long-lasting muscle volume to provide structural support, closing the levator hiatus, and lifting the anatomical position of the pelvic floor.

12.2.1 Pre-Contraction

During situations with increased abdominal pressure, the supportive action of the PFM is believed to be important [6–9]. Miller et al. [10] found that older women with SUI could acquire the skill of a well-timed PFM contraction just ahead of and during a cough ("The Knack"), and by this maneuver significantly reduce leakage. The positive effect of the Knack maneuver in reducing leakage during coughing has later been confirmed both among nonpregnant and pregnant women [11]. The rationale to acquire such a skill is to prevent the urethra and bladder base from descending during increased abdominal pressure and thereby prevent leakage. An actual stabilization of the bladder neck by performing pre-contraction just ahead of and during a cough has subsequently been shown in observational studies, using perineal ultrasound, both among both nulliparous continent women [12, 13], and older incontinent parous women [12].

12.2.2 Strength Training

Strength training of the PFM increases PFM strength, provides increased urethral closure pressure, and prevents urethral descent [5, 14]. The PFM, like other skeletal muscles, responds to strength training by improved neuromuscular function, increased cross-sectional area, increased number of activated motor neurons, increased frequency of excitation, and improved muscle "tone" [5, 14, 15]. Specificity and overload are two fundamental principles that carefully must be addressed for effective strength training [14, 16].

To improve a specific skill, that specific skill must be performed. To become a good skier, you need to ski. To effectively improve PFM strength, specific PFM contraction performed in a correct manner needs to be carried out [14]. This means an inward lift and squeezing around the urethra, vagina, and rectum [4, 17, 18]. Avoiding co-contraction of other muscles should be emphasized, as this may mask the actual strength of the PFM contraction being performed [14]. The principle of specificity also draws attention to the fact that a correct PFM contraction may be difficult to perform for some women. Studies on women with UI have shown that >30% were unable to perform a correct PFM contraction [4, 19–21], even after a thorough verbal instruction on how to contract. Assessment of the ability to contract the PFM can easily be performed by visual observation and vaginal palpation [22, 23]. Proper assessment, instruction, and teaching on how to contract correctly are considered crucial to gain benefit from PFMT [24].

To achieve increased cross-sectional area and increased contractile force, the muscles need to be exposed to an overload that is larger than the common load encountered during everyday life [16]. Overload in PFMT can be achieved by performing close to maximal contractions, lengthening the holding periods for each contraction, increasing the number of repetitions and number of sets completed, and reducing the rest intervals [14]. Strength training recommendations for skeletal muscles are 8–12 maximal contractions, 3–4 series, 3–4 times per week [15, 25, 26]. It takes time to achieve increased PFM strength, endurance, and muscle volume [14], and The American College of Sports Medicine recommends the exercise duration period to be at least 15–20 weeks [25]. Strength training with contractions close to maximum and short rest intervals between the contractions usually also increase local muscle endurance [27, 28].

12.2.3 Evidence for Pelvic Floor Muscle Training to Prevent and Treat Urinary Incontinence during Pregnancy

Based on the current evidence presented in a recent Cochrane review by Dumoulin [29], PFMT is better than no treatment, placebo drug, or inactive control treatments for women with UI (any type). The current evidence supports the widespread recommendation (Grade A) for offering supervised PFMT as the first-line treatment for female stress, urgency, or mixed UI [29, 30].

Boyle et al. [31] performed a Cochrane review during pregnancy and 22 trials involving 8485 women (4231 PFMT, 4254 controls) were included in the analysis.

Pregnant women without prior UI (prevention) who were randomized to intensive antenatal PFMT were about 30% less likely to report UI up to 6 months after delivery when compared to women randomized to no PFMT or usual antenatal care (risk ratio (RR) 0.71, 95% CI 0.54–0.95, the combined result of five trials). The results of seven studies showed a statistically significant result favoring PFMT in a mixed population (women with and without incontinence symptoms) in late pregnancy (RR 0.74, 95% CI 0.58–0.94, random-effects model). The fifth International Consultation on Incontinence [30] recommends that pregnant women having their first child should be offered supervised PFMT (Grade A recommendation). To date, there is not enough evidence to conclude on the long-term effect and there are no randomized controlled trials in pregnant recreational or elite athletes.

12.2.4 Can Pelvic Floor Muscle Training Compromise Vaginal Birth?

There has been some concern that a tight and strong pelvic floor might obstruct labor and result in instrumental delivery, perineal trauma and/or injury of peripheral nerves, connective tissue, and muscles [32]. A recent systematic review including 12 RCTs/quasi-RCTs involving 2243 primigravida women concluded that PFM training significantly shortened 1st (mean 28 min) and second stage (mean 10 min) of labor. In addition, antenatal PFM training did not increase the risk of episiotomy, instrumental vaginal delivery, and perineal laceration [33].

12.3 Diastasis Recti Abdominis

Pregnancy and childbirth bring along several changes to a woman's body, especially to the musculoskeletal system [34]. The most obvious change is related to the growth of the fetus and the stretching of the abdominal muscles, which may influence the mother's posture and balance [34].

Today there is a strong focus on the pregnant woman's appearance, especially through social media. Web pages and apps recommend how women should stay thin and get back into shape and regain "a flat tummy" at an early stage of the postpartum period.

Diastasis Recti Abdominis (DRA) or the increased inter-rectus distance is a common condition in women during pregnancy and postpartum [35]. As the fetus grows, the two muscle bellies of the rectus abdominis, connected by the linea alba, elongate, and curve round as the abdominal wall expands, with most separation occurring at the umbilicus [36–38]. The augmented inter-rectus distance is described as a change in the abdominal musculature, specifically in the linea alba and the rectus abdominis sheath, with onset in the last trimester of pregnancy and whose peak of incidence occurs immediately after birth and the first weeks following childbirth [36, 39, 40].

Using the search terms "diastasis recti" and "exercise," 278,000 hits were obtained on Google. In addition, there is easily available advice on how to get rid of what is named "the mum's belly" (e.g., www.mammamage.se; www.

breakingmuscle.com; www.befitmom.com; www.babybellybelt.com; www.tummyzip.com). A systematic review of the scientific literature has found no or very weak evidence behind any of these pieces of advice [41].

12.3.1 Prevention and Treatment

Exercise and surgery are the two available methods to treat diastasis recti abdominis. Akram and Matzen [42] identified 15 studies on surgery and found only one Randomized Controlled Trial (RCT). The RCT compared the results of using two different sutures. The authors concluded that both groups had an adequate correction of DRA 6 months after surgery. This was supported by a recent RCT [43]. However, there are no RCTs comparing surgery with no treatment or exercise, no long-term effect studies, and sparse reports of complications after surgery.

The huge activity in social media recommending a variation of abdominal exercise programs to prevent and treat DRA is in strong contrast to the lack of evidence for any positive effect shown in RCTs. In a systematic review by Benjamin et al. [41], eight studies in the treatment of DRA using abdominal exercises were found: four case studies, two retrospective observational studies, one quasi-experimental posttest study, and one small RCT of a brief training intervention [44]. A new search on Pubmed of August 2017 found only three additional RCTs [43, 45, 46]. These studies score low on the PEDro rating scale of methodological quality (5, 6, and 6 of 10 possible scores of internal validities, respectively), and both exercise protocols, assessment methods, cut-off points for diastasis and results differ (Table 12.1). None of the studies included exercise during pregnancy, and to date, there is, therefore, no knowledge whether the condition can be prevented or reduced with abdominal training or other exercises programs during pregnancy.

It has been suggested that antepartum activity levels may have a protective effect on DRA and exercise may improve post-partum symptoms of DRA [42]. Physiotherapists and exercise instructors prescribe exercises to this population every day, but given the limited research data, there is currently no consensus on which abdominal exercises to recommend narrowing the diastasis [47–50]. Recent research has questioned the use of the commonly used and recommended in-drawing exercises as these appear to widen, rather than narrow the gap measured with ultrasound [35, 51, 52]. Furthermore, one research group recommended contracting the pelvic floor muscles to activate the transverse abdominal muscles to stabilize the linea alba before performing curl-ups [53]. The results of the latter study conferred those contractions of the pelvic floor muscles increased the gap. There are currently no data from RCTs to support the new theory that activation of the transverse abdominal muscles via a pelvic floor muscle contraction can stabilize the linea alba, the validity of the formula used, and what this may mean for the diastasis. Furthermore, the effect of different abdominal exercises to treat low back pain has also recently been questioned. In a systematic review, Smith et al. [54] concluded that stabilization exercise is not more effective than any other form of active exercise in the long term. Based on the current published high-quality RCTs of

Table 12.1 Randomized trials on different exercises on diastasis recti abdominis (DRA)

	Participants	Intervention	Outcome and cut off value for DRA	Results
Mesquita et al. (1999)	50 women (18–40 years) After vaginal delivery Intervention: $N = 25$ Control: $N = 25$	Intervention: 2 supervised sessions with physical therapists 6 h (10 repetitions) and 18 h (20 repetitions) postpartum Abdominal and pelvic floor muscle contractions. Diaphragmatic breathing, pelvic tilt with transverse abdominal and oblique's contraction. Co-contraction of pelvic floor muscles during all exercises Control: no follow-up	IRD measured using a caliper 4.5 cm above the umbilicus 4.5 cm below the umbilicus Diastasis: IRD > 3 cm	0 dropouts Significant larger reduction in IRD in intervention (mean 3.45 cm (SD 0.43) to 2.64 cm (SD 0.45) compared to control (3.16 cm (SD 0.26) to 2.99 cm (SD 0.28)
Walton et al. (2016)	9 women (18–45 years) Cesarean section and vaginal delivery Experimental group: $N = 5$ Control group: $N = 4$	6 weeks intervention (3 times/week of 3 × 10 repetitions). Increasing progression in repetitions. External support by a towel. Both groups: pelvic tilt, pelvic floor muscle exercises, and oblique's contraction Experimental: Plank 10 s with knees on the floor. Control: modified sit-up	IRD measured by ultrasound 4.5 cm above the umbilicus 4.5 cm below the umbilicus Oswestry disability index Pelvic floor distress index Diastasis: Cut-off value not defined	1 drop-out Experimental: IRD: mean 8.75 mm (SD 0.87) to 7.58 mm (SD 2.01) Control: mean 10.97 mm (SD 1.96) to 6.63 mm (SD 1.65) No significant difference between groups, $p = 0.2$ and $p = 0.6$ above and below the umbilicus, respectively
Emanuelsson et al. (2016)	89 participants (27–67 years) 87 women, 2 men Surgery with mesh: $N = 29$ Surgery with Quill: $N = 28$ Abdominal exercise: $N = 32$	3 months (3 times/week with a physical therapist). Exercise for rectus abdominis, obliques, and transversus abdominis	IRD measured by a ruler (halfway between xipoideus and navel and navel and pubic symphysis) SF-36. Ventral hernia pain questionnaire. Abdominal strength: VAS scale and Biodex system 4. Diastasis: IRD: ≥3 cm	3 dropouts No significant improvement on VAS in the exercise group compared to the surgery groups

(continued)

Table 12.1 (continued)

	Participants	Intervention	Outcome and cut off value for DRA	Results
Kamel and Yousif (2017)	60 women (25–35 years) After normal vaginal delivery 2 months postpartum Inclusion: Diastasis >2.5 cm at any point of linea alba	Neuromuscular electrical stimulation + abdominal exercise group: $N = 29$ Abdominal exercise group: $N = 28$ Abdominal exercise: sit up, reverse sit up, trunk twist, U-seat exercise Both groups had a scarf around the abdomen for support. Each exercise has 20 repetitions +4 extra repetitions per week Diaphragmatic breathing	Body mass index. Waist/hip ratio IRD abdominal strength: Isokinetic (Biodex multi-joint system pro, model 850-000; Biodex medical systems Inc.) Peak torque, maximum repetition total work, average power	3 dropouts Inter-rectus distance: Neuromuscular electrical stimulation + abdominal training: 50% reduction Abdominal training: 25.9% reduction, $p < 0.001$ Abdominal strength: Neuromuscular electrical stimulation + abdominals: 75.9%, 95.5%, 76.3% Abdominals: 53.5%, 40.3%, 32.9% increase in peak torque, maximum repetition total work, and average power, respectively. $p < 0.05$ for all comparisons

IRD inter-rectus distance, *VAS* Visual Analog Scale, *SD* standard deviation

abdominal training for low back pain, they stated that further research is unlikely to considerably change this conclusion. Nevertheless, abdominal training and especially core training with a focus on the transverse abdominis muscle continues to be highly recommended for both DRA and low back pain [53].

According to the IOC 2016 evidence summary [34, 55], there is no knowledge of the prevalence, risk factors, and prevention and treatment of diastasis in recreational exercisers and elite athletes. However, athletes of most sports are dependent on well-functioning abdominals for sports performance, and therefore may be more vulnerable to the presence of a diastasis than other women. This and the effect of exercise interventions on this specific group of women needs further investigation. Benjamin et al. [41] concluded that there is an urgent need for more studies on the effect of conservative treatment for DRA.

12.4 Low Back and Pelvic Girdle Pain

Although exercise is recommended during pregnancy, some women are inclined to reduce their levels of physical activity [56, 57]. Women with complicated pregnancies or women suffering LBP and/or PGP may have been advised not to participate in exercise activities. The effect of exercise on the prevention of low back and pelvic girdle pain during pregnancy is uncertain. Few trials have been reported to examine the prevention of LBP and/or PGP, and they mainly lacked evidence of a positive effect [58]. Recently, a randomized controlled trial found that group fitness classes for pregnant women, exercising twice a week with a focus on cardiovascular endurance training and strength training, did not affect the prevalence of LBP and PGP during pregnancy or postpartum [59]. Whereas more years of regular physical activity before pregnancy reduced the risk of LBP and/or PGP during pregnancy in one follow-up study [60], a retrospective study comparing athletes who performed plenty of exercise prepregnancy with non-athletic controls found no difference in the prevalence of LBP and/or PGP [61]. In a longitudinal cohort study, a greater loss of physical condition seems to be not a cause but rather a consequence of LBP and/or PGP in pregnancy [62].

12.4.1 Therapeutic Exercise for Pregnancy-Related Low Back and Pelvic Girdle Pain

Several reviews have examined physical therapy interventions for LBP and PGP during pregnancy [63–72]. A recent systematic review showed that exercise reduced the risk of LBP in pregnancy by 9% whereas it had no protective effect on PGP [73]. One systematic review of the Cochrane Collaboration included 26 randomized controlled trials that examined the effects of a variety of interventions for LBP and PGP during pregnancy [58]. Eleven trials examined LBP, four examined PGP and a further 11 trials examined a combination of LBP and PGP (lumbopelvic pain). Evidence of moderate quality suggests that exercise or acupuncture significantly

reduced evening PGP or lumbopelvic pain more than normal care alone. A more recent systematic review, including 22 randomized controlled trials, supported the conclusion of the moderate evidence for a positive effect of exercise therapy on pain, disability, and/or sick leave for the treatment of lumbopelvic pain during pregnancy [74]. According to this review, also patient information seems to be a useful intervention, especially when combined with exercises. However, when the authors analyzed LBP and PGP separately, the results were more robust for LBP than for PGP. The European guideline for PGP recommends individualized exercises in pregnancy [72] and a systematic review investigating the effectiveness of complementary and alternative medicine for the management of LBP and/or PGP in pregnancy, found limited evidence to support the use of these interventions [75]. A review of yoga interventions during pregnancy indicates positive outcomes but leads to conclusions that more studies are needed [76].

Whereas individualized exercise and appropriate information to reduce fear and anxiety are recommended for pregnant women, the European guideline for PGP postpartum recommends giving appropriate information and reassuring the patients as part of an individualized multifactorial treatment focusing on specific exercises for motor control and stability [77]. The level of evidence for interventions for PGP postpartum is, however, limited, because few randomized controlled trials have been performed. One systematic review has investigated the effectiveness of physical therapy for the treatment of LBP and PGP related to pregnancy postpartum [78] and included four randomized controlled trials [79–82]. All used exercises for motor control and stability of the lumbopelvic region, but with different interventions. The studies showed high methodological quality. However, only the study by Stuge et al. [79] demonstrated statistically and clinically significant positive and long-lasting effects, where disability was reduced by more than 50% for the exercise group compared to negligible changes in the control group. One more recent randomized study [83], concludes that core stabilization exercises and postural correction are effective in the management of postpartum lumbopelvic pain, however, the methodological quality was low. No studies examining a treatment program for LBP or PGP in elite athletes have been found [34, 55].

The lack of clear evidence supporting the diagnosis, prevention, and treatment of musculoskeletal conditions in the pregnancy and the postpartum period is challenging. Despite the desire of women to stay physically active during pregnancy [84], only a low proportion of pregnant women seem to follow current guidelines for exercise during pregnancy [77]. Even though group exercises during pregnancy have not been shown to influence the prevalence of LBP and/or PGP [59, 85–87], women who exercised seemed to handle their pain disorder better, with reduced need for sick leave [87]. Adhering to an exercise regime is a challenge [59] and it is important that exercises should not provoke pain during or after exercising. It might be that group exercise classes, even supervised, with a focus on cardiovascular endurance training and strength training, are not addressing the pain-provoking factors in individual women. Including heterogeneous samples with and without pain, unspecified LBP, and/or PGP, as well as combining prevention and treatment is

likely to be a weak study design and potentially allows for a washout effect caused by the heterogeneity of the patient populations included [88].

The only randomized controlled study showing significant and long-lasting effects included a homogeneous group of patients based on clinical examination and criteria for PGP [79]. The treatment program studied was also individualized and focused on exercises for motor control and stability of the pelvic girdle. The focus of the exercises was to improve force closure with coordination of the local and overall muscle system, especially addressing the dynamic control of a neutral position of the lumbopelvic, subsequently to develop strength and endurance to manage the physical demands facing each individual. Additionally, essential points addressed were sacroiliac joint restrictions, posture, breathing, and cognitive-behavioral perspectives. Cognitive aspects were an important part of the intervention, in addition to the exercises. The women were ordered to perform their 30–60 min exercise program 3 days a week and they adhered closely to this regime. A qualitative study elucidating this treatment program found that by being active agents in managing their PGP the women learned to set themselves proximal goals [89]. Perceived hope and self-efficacy appeared to be essential for developing capacity for self-management and an enhanced ability to benefit from appropriate learning experiences. To improve the quality of treatment, physiotherapists ought to have evidence-based skills, listen attentively, and individualize treatment. The women found the discussion and individualized guidance as positive factors in helping them to cope with their daily lives.

Even though no single exercise therapy has proven to be superior [90], core stabilization exercises have grown in popularity [91] and two different core stabilization strategies exist, with controversy about which is the optimal strategy [92, 93]. The motor control exercise approach emphasizes specific exercises for local muscles, whereas the general exercise approach focuses on exercises on global muscles [94, 95]. A recent review has suggested that therapeutic exercises purporting to restore motor control of specific selected local muscles are unnecessary [92]. However, it has also been emphasized that generic approaches using stabilizing exercises do not address the individual motor control deficits identified in the patients [88]. Increased co-contraction of trunk stabilizing muscles during tasks that provoke pain and an inability to relax muscles are reported in both LBP and PGP [88, 96]. Consequently, interventions should focus less on specific stabilizing muscles and more on daily activities and optimal dynamic control of movements. Inherent underlying maladaptive movements might act as potential ongoing peripheral nociception rather than a strategy to avoid pain [88]. The examination of daily activities can determine whether the movement and pain behaviors are adaptive or maladaptive. With this in mind, individually designed treatment programs of supervised home exercise with regular therapist follow-up sessions to encourage adherence and achieve optimal dosage are recommended for patients with pregnancy-related LBP and/or PGP [79, 97]. Contradictory evidence exists on whether motor control or stabilizing exercises are better than general exercises [98, 99], with one systematic review showing strong evidence that stabilization exercises are not more effective than any other form of active exercise in the long term [54].

Nevertheless, positive changes in motor control have been found to be associated with relief of pain and disability for PGP [79, 100].

In conclusion, pregnant and postpartum women, even those with LBP and/or PGP, should be encouraged to be physically active and health care providers should help the women to find the kind of exercise or physical activity that is optimal for each individual, in her environment.

To assess activity limitations and symptoms there is a need for suitable outcome measures that are reliable and valid for patients with PGP in research and clinical practice [101]. The condition-specific measure, the Pelvic Girdle Questionnaire was developed for pregnant and nonpregnant women [102]. The questionnaire consists of 20 activity items and 5 symptom items on a four-point response scale. The Pelvic Girdle Questionnaire is reliable and valid for both pregnant and postpartum women with PGP; it is simple to administer and feasible for use in research and clinical practice. The Pelvic Girdle Questionnaire has also shown acceptable responsiveness and been shown to discriminate significantly both between pregnant and non-pregnant patients as well as between different locations of pain [103, 104].

12.5 Further Research

This chapter presents the current scientific evidence on the effect of exercise on the prevention and treatment of three commonly pregnancy-related musculoskeletal conditions: pelvic floor dysfunctions, diastasis recti abdominis, and low back and pelvic girdle pain.

To date, there is not enough evidence to conclude the long-term effect of PFMT. To our knowledge, there are no available studies specifically addressing the effect of PFMT among pregnant recreational or elite athletes. These two topics should be explored in further studies.

A lack of evidence exists about the consequences of the diastasis recti abdominis on abdominal wall integrity. Further research should focus on the effect of abdominal strengthening exercises in the reduction of diastasis recti abdominis.

Regarding low back and pelvic girdle pain during pregnancy, high-quality randomized studies are needed to clarify the preventive and/or resolution effect of core stabilization exercises and postural correction. Further, the effect of therapeutic exercise programs for low back or pelvic girdle pain in pregnant elite athletes is unexplored and needs further attention.

12.6 Conclusions

This chapter presents the current evidence on the effect of therapeutic exercise programs in the prevention and resolution of three commonly pregnancy-related musculoskeletal conditions: pelvic floor dysfunction, diastasis recti abdominis, and low back and pelvic girdle pain.

The section on "*Pelvic Floor Muscle Training*" (PFMT) underlines the importance of PFMT during pregnancy. A trained PFM may counteract the hormonally

mediated increased laxity of the pelvic floor and the increased intra-abdominal pressure during pregnancy. Further, a trained PFM may encompass a greater functional reserve so that childbirth does not cause the sufficient loss of muscle function to develop urinary leakage. Additionally, a trained PFM may recover better after childbirth as the appropriate neuromuscular motor patterns have already been learned. The current evidence supports the widespread recommendation (Grade A) for offering supervised PFMT as the first-line treatment for female stress, urgency, or mixed UI. The current evidence support PFMT as this is shown to prevent and treat UI during pregnancy and prevent UI postpartum. The fifth International Consultation on Incontinence recommends that pregnant women having their first child should be offered supervised PFMT (Grade A recommendation).

The section on "*Diastasis Recti Abdominis*" explores the effect of exercise on diastasis recti abdominis (DRA) prevention or correction. The potential effect of the abdominal exercise programs on DRA prevention and treatment in pregnant women has been discussed as well as the consequences of this condition on abdominal wall integrity. To date, there is no knowledge whether DRA can be prevented or reduced with abdominal training or other exercise programs during pregnancy.

The topic "*Low Back and Pelvic Girdle Pain*" discuss the existing scientific evidence about the effect of exercise on the prevention and treatment of Low-Back Pain (LBP) and Pelvic Girdle Pain (PGP) during pregnancy. Pregnant women, even those with LBP and/or PGP, should be encouraged to be physically active. Health care providers should help women to find the most appropriate exercise or physical activity for each individual, in her environment. Identification of women's activity limitations and symptoms should be done before engaging in the exercise. For this purpose, there is a need for suitable outcome measures that are reliable and valid for patients with PGP. The condition-specific measure, the Pelvic Girdle Questionnaire was developed for pregnant and nonpregnant women. The questionnaire consists of 20 activity items and 5 symptom items on a four-point response scale. The Pelvic Girdle Questionnaire is reliable and valid for both pregnant and postpartum women with PGP; it is simple to administer and feasible for use in research and clinical practice. The Pelvic Girdle Questionnaire has also shown acceptable responsiveness and been shown to discriminate significantly both between pregnant and nonpregnant patients as well as between different locations of pain.

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