Journal of Pelvic, Obstetric and Gynaecological Physiotherapy, Spring 2021, **128,** 46–53

CASE REPORT

Movement-based intervention to resolve severe pelvic and hip pain in a female Iron-distance triathlete

J. W. Wiebe
Private Practice, Woodland Hills, CA, USA

Abstract

A 40-year-old professional female Iron-distance triathlete presented with an 11-month history of left hip, iliotibial band and pelvic pain. She had fallen from her bicycle onto a railway track, and injured the soft tissue of her left buttock. The patient reported persistent hip pain. Furthermore, her attempts to return to training had led to pelvic pain symptoms that were made acute by walking, rolling over in bed and activities of daily living. Her continuing pain resulted in a fear of movement. A lack of progress with a sports medicine physiotherapist and five pelvic health physiotherapists led the patient to seek a more comprehensive approach to care. She was provided with a biopsychosocial programme that drew from the fields of pelvic, musculoskeletal and sports performance physiotherapy. The intervention strategy reduced her fears about movement, and altered her gluteal–pelvic floor muscle synergy by linking the dynamic interrelationship of the diaphragm, abdomen and pelvic floor to sport-specific movements that were meaningful to the patient. This increased her tolerance for challenges over time. Collaboration with the patient's strength, running and swimming coaches led to her return to training and short-distance racing within 2 and 6 months, respectively. Integrated pelvic health, musculoskeletal and sports performance concepts led to the resolution of the patient's symptoms, and her subsequent return to competition.

Keywords: athletics, hip pain, injury, pelvic floor dysfunction, pelvic pain.

Introduction

Pelvic pain in athletic women is not well understood by either the sports medicine or pelvic health communities. It is defined as non-cyclical pain in the lower abdomen or pelvis that is not attributable to menstruation or infection. The interactions of interdependent body systems can contribute to its symptomatology, including urogynaecological, gastrointestinal, musculoskeletal, neurological and psychological conditions, and pelvic floor muscle (PFM) overactivity (Bergeron *et al.* 2011; Neville *et al.* 2012; Dufour *et al.* 2018).

Researchers have investigated the role of physical activity in pelvic health dysfunction, but have drawn no firm conclusions. Conflicting study results, and the challenges posed by accurately evaluating the PFMs during dynamic activity, have highlighted large gaps in the knowledge base. In addition, very few studies have explored pelvic health considerations in elite or high-intensity athletes (Nygaard & Shaw 2016; Shaw & Nygaard 2017; Bø & Nygaard 2020).

Thus, clinicians find it difficult to draw meaningful conclusions and create programmes for athletic women with pelvic health dysfunction, and often err on the side of caution. Counselling women against continued high-intensity activity is a common approach. This can be attributed to the deleterious effects on pelvic health that are associated with training; for example, higher rates of incontinence are exhibited by athletes who participate in sports that are known to involve higher impact forces (de Mattos Lourenco *et al.* 2018; Moser *et al.* 2018). In addition, clinicians may lack relevant treatment options if these have not been part of their training.

Similarly, musculoskeletal (MSK) and sports medicine professionals have a limited understanding of and little training in the pelvic, pregnancy and postpartum needs of women, or the

Correspondence: Julie W. Wiebe PT DPT, c/o Andrew J. Wilson Publishing Services, 15 Bughtlin Loan, Edinburgh EH12 8UZ, UK (e-mail: Julie@juliewiebept.com).

impact that these considerations may have on a patient's clinical presentation. Historically, these issues have been considered to be the purview of pelvic health providers, while MSK issues and a return to performance tend to fall within their scope of practice (Deering *et al.* 2020).

Nevertheless, pelvic health and MSK comorbidities are interconnected. In a large study involving 38 050 women, Smith *et al.* (2006) found that incontinence and respiratory dysfunction were more strongly correlated with low back pain than physical activity and body mass index. Dufour *et al.* (2018) reported pelvic floor dysfunction (PFD) in 95.3% of patients referred to Canadian outpatient orthopaedic physiotherapy clinics for lumbopelvic pain, and 83.5% of the participants in their study self-reported a symptom of PFD (e.g. incontinence, pelvic pain and/or painful sex). These authors noted that 70.6% of the participants in their study exhibited pelvic floor tenderness on digital examination, and that this was often associated with PFM overactivity (Bergeron *et al.* 2011). Neville *et al.* (2012) stated that women with pelvic pain were more likely than pain-free control subjects to have abnormal MSK results. A positive forced FABER [Flexion, ABduction and External Rotation] test, a provocative hip, sacroiliac joint and lumbar screening instrument, correctly predicted pelvic pain in 89.5% of their participants.

The demonstrable relationship between low back and hip pain, pelvic girdle dysfunction and pelvic health issues raises an important question: why are these conditions understood and treated as separate entities clinically? Nearly 4 million women give birth each year in the USA (NCHS 2019). Many of these new mothers will experience pelvic health challenges, but they will also want to return to a robust engagement in fitness and sport. It behoves us to examine the silo mentality prevalent in physiotherapy that separates pelvic, MSK and sports performance specialties, and alternatively, seek to equip providers with new tools to enable them to provide a comprehensive model of athletic care.

The aim of the present case report is to bridge these divisions with clinical reasoning and biopsychosocial intervention strategies that simultaneously draw from the fields of pelvic health, MSK and sports medicine.

Case report

Subjective history

A 40-year-old professional female Iron-distance triathlete presented with an 11-month history of left hip, iliotibial band (ITB) and pelvic pain. In September 2017, she had fallen from her bicycle onto a railway track, and injured the soft tissue of her left buttock. The patient was referred to a sports medicine physiotherapist with an initial diagnosis of trochanteric bursitis, hip pain and ITB syndrome. During 3 months of care between December 2017 and February 2018, she received dry needling and hip strengthening exercises, but there was minimal improvement in her condition. When the subject attempted to return to training, her left hip and ITB remained painful, and she began to experience external perineal and pelvic pain. Gradually, her pelvic pain, which was worse on her right side, began to escalate and overshadow her hip pain. These symptoms became severe, and were easily provoked by walking, rolling over in bed and activities of daily living.

The patient was referred for pelvic health physiotherapy. Pelvic floor downtraining exercises were coupled with manual release of the PFMs to reduce overactivity. The subject reported that internal interventions were intensely painful, and although she experienced occasional periods of mild, temporary relief, there was no lasting improvement. Over the subsequent 5 months from March to July 2018, she sought help from a series of four additional pelvic health physiotherapists, who performed similar interventions without achieving any resolution. Her continuing pain entrenched the subject's fear of movement, and she was repeatedly told by her pelvic health providers that her athletic career was over. Her lack of progress, severe symptoms and need to complete a race in 2018 to maintain her endorsements led her to discontinue the traditional care model, and seek a more comprehensive approach to care.

In August 2018, the subject crossed the country for a series of three in-person visits with the present author. Each trip included two sessions, which were separated by a few days. The visits took place in August, September and October 2018. Communication continued between visits via e-mail, and in collaboration with her strength, running and swimming coaches.

The subject's past medical history included nulliparity, pain during sexual intercourse, endometrial ablation with perineal pain, gut disturbance (i.e. irritable bowel syndrome) and a self-described anxious personality. The validated Queensland Female Pelvic Floor Questionnaire revealed no urinary, bowel or prolapse symptomatology. However, the sexual function domain

indicated a pre-injury history of painful sex (Baessler *et al.* 2010).

At the initial evaluation, the subject likened her internal pain to "being torn in half" when it peaked. Her hip and buttock pain were described as sore to sharp, and were both triggered by movement. Her hip and pelvic pain were both lessened by following self-imposed restrictions on movement. She described an unresolved sense of "instability" in her left pelvis and hip complex that had begun after her accident.

Objective history

Strength and movement testing. The subject presented with symmetrical hip girdle strength, which was scored as 4/5 on the manual muscle test, and a Trendelenburg gait pattern. Bilateral movement testing revealed that she had confident and controlled full range of motion for squats and squat jumps without increasing any of her baseline symptoms. However, unilateral activities were symptomatic and poorly controlled. The subject demonstrated trunk and arm compensations, and was unable to maintain a balanced single-leg stance for 5 s. She also displayed poor proximal lumbopelvic–hip control, with greater femoral adduction and internal rotation on her left side, and limited depth in single-leg squats. Five repetitions of a left hop demonstrated proximal hip control deficits and triggered pelvic pain. A single right hop immediately elicited severe symptoms that she compare with "being ripped in half".

Synergistic gluteal–PFM activation has been demonstrated in the literature, and vaginal squeeze pressures are improved by gluteal strengthening (Tuttle *et al.* 2016, 2020). Altered gluteal patterns following the initial injury may have elicited PFM compensation.

Observation. The subject slowly and deliberately prepared to participate in single-leg activities, displaying fear-avoidance behaviour (de Oliveira Silva *et al.* 2019). Involuntary PFM contraction has been noted in women who were exposed to threatening film clips (van der Velde & Everaerd 2001). In addition to the contribution of the pelvic floor to control of the lumbopelvic–hip complex, this anticipated threat may have exaggerated PFM overactivation.

The subject held her breath and used abdominal over-recruitment as a stabilizing strategy for all movement tasks. This stiff, high-pressure strategy interrupted the interrelationship of her diaphragm, transversus abdominis (TA) and PFMs with intra-abdominal pressure (IAP) to create dynamic central control. On inhalation, IAP increases, and the abdomen and pelvic floor lengthen and descend; on exhalation, IAP decreases, and the abdomen and pelvic floor reflexively shorten and ascend (Hodges *et al.* 2007; Talasz *et al.* 2011; Barbato *et al.* 2014; Wiebe 2020). Transversus abdominis and PFM coactivation is well understood: the pelvic floor will match forces and pressures from above (Sapsford & Hodges 2001; Smith *et al.* 2007; Pereira *et al.* 2012). Thus, the subject's abdominal over-recruitment heightened activation of her already overactive PFMs, and hampered the natural rest–work excursion cycle of these muscles that is associated with respiration.

Palpation. Internal pelvic floor interventions had been painful for the subject, and failed to bring about any improvement in her condition. However, external palpation of the PFMs provides an opportunity for qualitative assessment. Stensgaard *et al.* (2014) demonstrated that palpation of seated coccyx movement in response to PFM contractions could be employed as a screening tool. Clinically, the present author integrates concepts derived from pelvic health and sports medicine using external PFM evaluation; she does not provide internal interventions. A brief and more direct external palpation was performed adjacent to the anus while the subject was clothed and standing (Wiebe 2020). She was able to perform symmetrical, voluntary superior and inferior PFM movements without provoking any additional symptoms. However, an involuntary PFM response to respiration demonstrated an uncoordinated and low-quality response on her right side.

Running form assessment. A video of the subject running had been taken in early 2017, prior to the accident that had caused the presenting injury. This revealed left lower extremity (LE) adduction and internal rotation at midstance, and a concomitant lack of right-trunk reciprocation. This was interpreted as being the result of the subject's unconscious lack of confidence in the landing leg, which may have been longstanding because of two previous falls involving the same left buttock and hip in 2015 and 2016. In addition, she ran in a more upright trunk position, limiting hip extension and gluteal participation (Teng & Powers 2013).

Clinical hypothesis

The subject's left gluteal complex was not well coordinated during dynamic movement patterns,

which resulted in compensatory over-recruitment of the contralateral PFMs. Altered gluteal–PFM synergy and errant central control over-recruitment strategies reinforced and heightened PFM overactivity within movement patterns. In addition, prolonged unresolved symptoms, career-ending narratives and pain reinforced by movement compounded this biopsychosocial presentation (Caneiro *et al.* 2021).

Patient goals and outcome measures

In the short term, the subject wanted to make a return to competing at any distance by December 2018 in order to retain her professional endorsements. Her long-term goal was to return to full competition and regain maximum function without limitation. The overarching biopsychosocial comprehensive intervention pathway is shown in Box 1. An in-depth evaluation of the reasoning process behind the initiation of treatment is presented in Tables 1 and 2.

Intervention

August 2018. During the first appointment, the present author initiated the intervention with left-side staggered squats coupled with inhalation on descent, which triggered reflexive abdominal and PFM elongation during gluteal excursion. Trunk reciprocation and arm swings were added to reduce the subject's excessive use of her abdominal muscles and subsequent co-activation of the PFMs. Movements with breath cues began to modulate her symptoms, allowing gradual left LE loading while right swing was introduced. Successful movement in meaningful running patterns began to reduce the patient's pain, her sense of perceived threat and fear-avoidance behaviour.

At the conclusion of the first session, she reported feeling only fatigue and no pain in her PFMs. The automaticity of her new dynamic central control strategies and improved gluteal–PFM synergistic activation were objectively demonstrated by the subject's ability to assume a single-leg stance for 15 s without hesitation, and with no arm or trunk compensations. In addition, she performed deeper and more controlled single-leg squats without provoking any symptoms.

During her second appointment, the patient reported that she had walked for 90 min with minimal pelvic pain. Her previous maximum tolerance had been 30 min. While encouraged, she still had concerns about running, which historically triggered an immediate escalation of pelvic pain and left ITB pain when cycling.

Box 1. Biopsychosocial comprehensive intervention pathway: (PFMs) pelvic floor muscles

- Predispose left gluteal activation in functional movement patterns in order to enhance gluteal participation and access, and reduce reliance on PFM compensation.
- Rebalance the inter-relationships of the dynamic central control system, i.e. the diaphragm, transversus abdominis and PFMs, in order to supplant stiff and dysfunctional over-recruitment patterns, and reduce PFM overactivity and spasm within movement patterns.
- Use sport-specific movement patterns that hold meaning for the patient's neuromuscular and emotional systems in order to re-establish and embed functional and efficient gluteal–PFM synergy in movement. The renewal of these familiar inputs is intended to induce neuroplasticity.
- Gradually layer load, impact, speed and volume onto renewed central control and gluteal–PFM synergistic strategies. The focus on the gluteal muscles will also address hip and iliotibial band symptoms.
- Valued, sport-relatable movements that modulate symptoms will reduce fear-avoidance behaviour, and build a therapeutic alliance by showing that the physiotherapist is listening and understands the patient's goals.
- Monitor the patient's responses and modify activities rather than eliminating these. Teach the patient modification strategies for self-management within her training.
- Provide the patient with a movement-based symptom modulator (i.e. breathing and reciprocation) in order to manage flare-ups. Flip the script: movement is the solution, not just the aggravator.

Running form modifications were initiated to reduce impact forces to within the tolerance range of her PFM tissue. To accomplish this, the subject was prompted to lean into the leading leg, shifting her centre of mass over each foot strike. Concomitantly, leaning would result in increased hip extensor activation and trunk reciprocation (Bly *et al.* 2013; Teng & Powers 2013; Napier *et al.* 2019). Reciprocation was encouraged in order to interrupt abdominal over-recruitment and central stiffness during running. Abdominal "bracing" increases ground reaction forces when jumping from a height (Campbell *et al.* 2016).

Table 1. Hypotheses and differential diagnosis made after the subjective and objective examinations, respectively: (PFMs) pelvic floor muscles

Hypothesis	Differential diagnosis
Left gluteal weakness/pain avoidance resulting in over-recruitment of the PFMs as compensation Altered gluteal/PFMs and core team synergy	Manual muscle test score of 4/5 and symmetrical (subject had been doing gluteal strengthening with her previous physiotherapists) Antalgic gait pattern with Trendelenburg gait over the left hip confirming gluteal avoidance (likely to prevent pain) versus significant weakness Symmetrical, bilateral tenderness to palpation along the length of the iliotibial band and at the trochanteric bursa; no reproduction of primary pain (ruling out original diagnosis) Limited depth and loss of control of midline during single-leg squats (hip adduction and internal rotation) Single-leg squat: (left) moderate loss of control; and (right) minimal loss of control Hop test: (left) five repetitions with increasing internal pelvic pain; (right) one repetition only because of the immediate escalation of symptoms and a sense of being "ripped in half" Subject relies on holding her breath and heavily recruiting her abdomen for central control, and experiences heightened pelvic pain symptoms with single-leg and gluteal exercise, indicating heightened engagement of the PFMs to help create central control
Avoidance of movement because of fear becoming cyclical when movements reinforce pain, thus reducing the benefits of movement in the modulation of pain The threat of pain associated with movement may elicit an involuntary PFM contraction, adding to existing overactivity or triggering a spasm Anxious personality previously managed by exercise/fitness	Bilateral squat and squat jump: subject moved without hesitation through her functional range with control, and reported no increase in her symptoms Single-leg activities: subject demonstrated slow and deliberate preparation to accept unilateral weight, and participate in single-leg movements Biomechanical triggers are consistent and repeatable; however, a fear of movement is evident, and probably compounding both the biomechanical and psychosocial components of the presentation
Pain with previous internal release, limited duration of relief with previous manual intervention and a description of the severity of her pain ("torn in half") indicative of increased tone or spasm in the PFMs According to the subject, previous pelvic health physiotherapists had confirmed hypertonicity in her PFMs Longstanding history of painful sex	External involuntary pelvic floor exam: subject demonstrated poor-quality and asymmetrical involuntary movement (in response to breath cycling); her right side was less coordinated than her left External voluntary pelvic floor exam: movement was symmetrical and did not increase the symptoms (subject had been taught lifting and lowering by a previous pelvic health physiotherapist in order to learn how to relax, and was well trained) Overuse of her abdominal muscles and holding her breath in stability strategies triggered the subject's already heightened PFM spasm
Sense of left hip instability may be related to either poor sensory feedback from the injured hip girdle complex, poor coordination of the gluteal muscles in movement patterns, and/or loss of balanced synergy between the gluteal muscles and PFMs Possible reinforcement as a result of a fear-avoidance cycle caused by the severity of the pain	Subject is unable to maintain single-leg balance on either leg for more than 5 s without significant arm and free-leg movement Subject uses a posterior pelvic tilting strategy to assist with control and balance in single-leg stance, which results in less access to the gluteal muscles to help with balance and pelvic–hip complex control; she was instructed to do this by a previous physiotherapist Subject experiences heightened pelvic pain symptoms with single-leg work, indicating heightened PFM engagement to create lumbopelvic and pelvic–hip control
Gut disturbance/irritable bowel syndrome contributing to pelvic floor spasm (visceral referral); the subject noted that her symptoms increased when she ate certain foods (e.g. sugar)	Subject is perceptibly bloated, but her symptoms are recreated via musculoskeletal testing during examinations (neither ruled out as a possible contributor, nor accepted as a primary source generator during sessions)

Thus, reciprocation concurrently reduced central stiffness and excessive coactivation of the PFMs and ground reaction forces. In order to reduce the burden of over-cueing, she was simply asked to lean, breathe and rotate.

To reinforce the neuromuscular reciprocation pattern involved in running, and also create a transition from walking to the pace and impact of running, the subject was instructed to ramp up to running by skipping with leaning and

Table 2. Hypotheses made about the primary focus of the initial treatment after the objective examination (data interpretation), and the movement-based interventions used to test these and the differential diagnosis: (PFMs) pelvic floor muscles

Hypothesis	Intervention
Left gluteal weakness/pain avoidance resulting in over-recruitment of the PFMs as compensation and then spasm	Use a bilateral position of confidence and sufficiency for the left gluteal muscles, and preferentially load to encourage use of these muscles rather than the PFMs Add rotational patterns to break up the stiffness and over-recruitment of the trunk musculature and mimic running
Avoidance of movement because of fear Reduced benefit of movements to modulate pain becoming cyclic when these reinforce pain	Use rotation and running patterns (gradually increase range, load and speed) to help the conscious and unconscious mind to find successful movements
Anxious personality previously managed by exercise/fitness	Decrease the fear of movement to reduce the psychosocial issues contributing to the presentation

breathing cues. With this new approach, she tolerated walk–run intervals of 2 min–30 s every 10 min, and reported only minimal to moderate pelvic pain and no severe spasms.

Once home, the patient was instructed to continue to implement these strategies in her movements, function and training below her symptomatic threshold. Now that a path forward had been found, she was told that this had to be widened with graded exposure to elements of her sport.

September 2018. Between appointments, the subject increased her running tolerance to seven repetitions of 5 min each. Her symptoms of ITB pain remained negligible, and she now described her pelvic pain as more like "fatigue and ache". During this time, she had made another appointment with a pelvic health physiotherapist who had treated her previously in order to reassess the status of her PFMs in response to this movement-based approach. The subject reported that the internal examination was no longer painful, and previous myofascial trigger points were no longer present. She could now bike for 1 h, and swim approximately 2 km (1.2 miles) with minimal ITB or pelvic pain.

The subject objectively demonstrated a significant improvement in freedom of movement without symptoms. The September sessions focused on restoring control over these movements and improving precision without recreating the previous over-recruitment patterns. Motor control practice with different load scenarios encouraged her to develop a central control strategy that matched variable demands. Skipping practice was now made to be quicker and tighter in order to restore the movement efficiency required in an endurance athlete.

Updated running videos demonstrated that the patient continued to exhibit left hip adduction and internal rotation, and right trunk reciprocation deficits at midstance. Another video revealed excessive left hip adduction and internal rotation as she cycled, which is a potential ITB irritant. A targeted, standing exercise programme designed to address these consistent deficits was layered onto the newly established neuromuscular central control strategy.

The subject was able to engage with the new exercises and more controlled movement patterns without experiencing a significant increase in her pelvic pain symptoms. If these occurred, the activity was either modified, or paused for breathing and a reciprocal movement in order to modulate pain prior to its resumption.

October 2018. In order to address any gut problems and food allergies that could possibly be contributing to the subject's pelvic pain, a naturopath prescribed a dietary cleanse. This resulted in bloating and gut pain, and left single-leg support and right swing in running now recreated her pelvic pain, although this was less intense than before.

Biomechanical movement screens were unremarkable and did not provoke pelvic pain. A video of the subject swimming revealed that her left LE dropped into hip flexion on right-arm pulls during freestyle, the same movement pattern deficit that was evident when she ran. A video collaboration with her swimming coach led to drills to enhance these diagonal muscular relationships in the water and promote synergistic activation.

The final in-person running assessment revealed that, although there had been some improvement, the subject's left hip adduction and internal rotation, and right trunk reciprocation deficit at midstance continued. In addition to the swimming drills, closed-chain hip external rotator work and Spider-Man plank-walks were initiated to further link her left hip complex with reciprocal trunk work.

The activities did not aggravate the subject's pelvic pain during sessions. It was reasoned that the recent cleansing of her gut was the precipitating factor that was responsible for the increase in her symptoms. While this return of her symptoms was disconcerting for the subject, it was encouraging that these had a non-mechanical source. Running and movement were no longer the fear-inducing "bad guys". Her path was widening.

With her pelvic pain and hip symptoms under control, the subject was able to return to unrestricted training by the end of October. Her running, swimming and strength coaches continued to address her left hip complex and right reciprocation deficit. According to the patient, changes to her diet and chiropractic treatment helped to resolve her gut problems.

Unfortunately, the subject was unable return to competition by December. However, she was able to successfully complete a short-distance duathlon in February 2019, and achieve a personal best in a half-Iron-distance triathlon in December 2019.

Discussion

The present case report illustrates a biopsychosocial thought process, and a clinical approach that blends concepts derived from the fields of sports medicine, and pelvic and MSK health. This integrated intervention linked the dynamic interrelationship between the subject's diaphragm, transversus abdominus and PFMs with the gluteal–PFM synergistic interaction. The recreation of this interdependent muscular balance within sport-specific movement patterns that held meaning for her was critical to the success of the programme. This approach gradually reduced both the mechanical and emotional inputs that triggered her PFM spasms

Implications for practice

The functional and movement-based intervention described in the present case report is relevant to and reproducible in the fields of pelvic and MSK health, and sports medicine. Pelvic health physiotherapy is often wrongly thought to consist only of internal manual therapy and Kegel exercises, which limits its broader application and collaborative engagement with other areas of care. However, it is not outside the realm of a sports medicine physiotherapist to implement breathing strategies within sport-specific movements to influence the behaviour of the PFMs. In addition, it is not outside the realm of a pelvic health provider to integrate the PFMs into fitness movements that are meaningful to a patient.

It has been noted that a physiotherapist with expertise in both sports medicine and pelvic health "is quite rare" (Deering *et al.* 2020, p. 283). Although the present case report only represents a starting point, the aim is to begin to change that reality by familiarizing readers with a thought process and patient care example that will allow them to build a dual skill set. A new clinical model must emerge, and further study is warranted.

Acknowledgements

The present case study was self-funded. The author would like to thank the patient for sharing her story, and Biljana Kennaway for her encouragement.

Conflicts of interest

The present author teaches professional development courses on this and similar topics.

References

Baessler K., O'Neill S. M., Maher C. F. & Battistutta D. (2010) A validated self-administered female pelvic floor questionnaire. *International Urogynecology Journal* **21** (2), 163–172.

Barbato K. A., Wiebe J. W., Cline T. W. & Hellier S. D. (2014) Web-based treatment for women with stress urinary incontinence. *Urologic Nursing* **34** (5), 252–257.

Bergeron S., Rosen N. O. & Morin M. (2011) Genital pain in women: beyond interference with intercourse. *Pain* **152** (6), 1223–1225.

Bø K. & Nygaard I. E. (2020) Is physical activity good or bad for the female pelvic floor? A narrative review. *Sports Medicine* **50** (3), 471–484.

Byl N., Davis I., Heiderscheit B. & Powers C. (2013) The science of running. Symposium conducted by the California Physical Therapy Association, Los Angeles, CA, USA, 9–10 November 2013.

Campbell A., Kemp-Smith K., O'Sullivan P. & Straker L. (2016) Abdominal bracing increases ground reaction forces and reduces knee and hip flexion during landing. *Journal of Orthopaedic & Sports Physical Therapy* **46** (4), 286–292.

Caneiro J. P., Alaiti R. K., Fukusawa L., *et al.* (2021) There is more to pain than tissue damage: eight principles to guide care of acute non-traumatic pain in sport. [Editorial.] *British Journal of Sports Medicine* **55** (2), 75–77.

Deering R. E., Christopher S. M. & Heiderscheit B. C. (2020) From childbirth to the starting blocks: are we providing the best care to our postpartum athletes? *Journal of Orthopaedic & Sports Physical Therapy* **50** (6), 281–284.

De Mattos Lourenco T. R., Matsuoka P. K., Baracat E. C. & Haddad J. M. (2018) Urinary incontinence in female athletes: a systematic review. *International Urogynecology Journal* **29** (12), 1757–1763.

De Oliveira Silva D., Barton C. J., Briani R. V., *et al.* (2019) Kinesiophobia, but not strength is associated with altered movement in women with patellofemoral pain. *Gait & Posture* **68** (February), 1–5.

Dufour S., Vandyken B., Forget M.-J. & Vandyken C. (2018) Association between lumbopelvic pain and pelvic floor dysfunction in women: a cross sectional study. *Musculoskeletal Science and Practice* **34** (April), 47–53.

Hodges P., Sapsford R. & Pengel L. H. M. (2007) Postural and respiratory functions of the pelvic floor muscles. *Neurourology and Urodynamics* **26** (3), 362–371.

Moser H., Leitner M., Baeyens J.-P. & Radlinger L. (2018) Pelvic floor muscle activity during impact activities in continent and incontinent women: a systematic review. *International Urogynecology Journal* **29** (2), 179–196.

Napier C., MacLean C. L., Maurer J., Taunton J. E. & Hunt M. A. (2019) Kinematic correlates of kinetic outcomes associated with running-related injury. *Journal of Applied Biomechanics* **35** (2), 123–130.

National Center for Health Statistics (NCHS) (2019) *Births and Natality.* [WWW document.] URL https://www.cdc.gov/nchs/fastats/births.htm

Neville C. E., Fitzgerald C. M., Mallinson T., *et al.* (2012) A preliminary report of musculoskeletal dysfunction in female chronic pelvic pain: a blinded study of examination findings. *Journal of Bodywork and Movement Therapies* **16** (1), 50–56.

Nygaard I. E. & Shaw J. M. (2016) Physical activity and the pelvic floor. *American Journal of Obstetrics and Gynecology* **214** (2), 164–171.

Pereira L. C., Botelho S., Marques J., *et al.* (2012) Are transversus abdominis/oblique internal and pelvic floor muscles coactivated during pregnancy and postpartum? *Neurourology and Urodynamics* **32** (5), 416–419.

Sapsford R. R. & Hodges P. W. (2001) Contraction of the pelvic floor muscles during abdominal maneuvers. *Archives of Physical Medicine and Rehabilitation* **82** (8), 1081–1088.

Shaw J. M. & Nygaard I. E. (2017) Role of chronic exercise on pelvic floor support and function. *Current Opinion in Urology* **27** (3), 257–261.

Smith M. D., Russell A. & Hodges P. W. (2006) Disorders of breathing and continence have a stronger association with back pain than obesity and physical activity. *Australian Journal Physiotherapy* **52** (1), 11–16.

Smith M. D., Coppieters M. W. & Hodges P. W. (2007) Postural response of the pelvic floor and abdominal muscles in women with and without incontinence. *Neurourology and Urodynamics* **26** (3), 377–385.

Stensgaard S. H., Moeller Bek K. & Ismail K. M. K. (2014) Coccygeal movement test: an objective, non-invasive test for localization of the pelvic floor muscles in healthy women. *Medical Principles and Practice* **23** (4), 318–322.

Talasz H., Kremser C., Kofler M., *et al.* (2011) Phase-locked parallel movement of diaphragm and pelvic floor during breathing and coughing – a dynamic MRI investigation in healthy females. *International Urogynecology Journal* **22** (1), 61–68.

Teng H. L. & Powers C. M. (2013) Diminished hip extensor strength is associated with a more upright trunk posture and higher patellofemoral joint stress during running. Poster presented at the 3rd International Patellofemoral Pain Research Retreat, Vancouver, Canada, 18–21 September 2013.

Tuttle L. J., DeLozier E. R., Harter K. A., *et al.* (2016) The role of the obturator internus muscle in pelvic floor function. *Journal of Women's Health Physical Therapy* **40** (1), 15–19.

Tuttle L. J., Autry T., Kemp C., *et al.* (2020) Hip exercises improve intravaginal squeeze pressure in older women. *Physiotherapy Theory and Practice* **36** (12), 1340–1347.

Van der Velde J. & Everaerd W. (2001) The relationship between involuntary pelvic floor muscle activity, muscle awareness and experienced threat in women with and without vaginismus. *Behaviour Research and Therapy* **39** (4), 395–408.

Wiebe J. W. (2020) Pelvic floor: integration versus isolation. In: *Rehabilitation of the Spine: A Patient-Centered Approach*, 3rd edn (ed. C. Liebenson), pp. 790–806. Wolters Kluwer, Philadelphia, PA.

Julie Wiebe PT DPT is a clinician and educator who specializes in sports medicine and pelvic health. She is much sought after as a speaker and collaborator on movement and fitness-based solutions for pelvic, abdominal, pregnancy and postpartum issues in fit and athletic females.