Rehabilitation of the Postpartum Runner: A 4-Phase Approach

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ABSTRACT

Running after childbirth, specifically how or when to return, is a hot topic in the field of physical therapy and on social media; however, there are significant gaps in the literature supporting when and how to safely initiate running postpartum. During pregnancy and following childbirth (both vaginal and cesarean), the body undergoes changes that may impact strength, neuromuscular control, endurance, and the ability to withstand the high-impact forces and repetitive nature of running. Many mothers experience new or worsened symptoms of musculoskeletal or pelvic floor dysfunction following pregnancy and childbirth and require physical therapy to normalize function. After most major injuries, it is common to participate in formalized rehabilitation; however, this is not the norm for athletes returning to running postchildbirth. Because of lack of evidence, many runners and clinicians struggle to develop appropriate rehabilitation progressions for return to running after childbirth. Pelvic and sports physical therapists must understand biomechanical features of running gait and safely progress strength, endurance, and neuromuscular control of the kinetic chain when guiding a runner back to running. This clinical commentary builds on existing guidelines, research, and expert opinion to propose a 4-phase rehabilitation framework to help runners initiate and progress running after childbirth. The result is an in-depth exercise prescription (intensity, frequency, type), examples of exercises (hip, abdominal, pelvic floor, and foot), running progression, and progression goals to prepare runners for symptom-free running after childbirth (see Video, Supplemental Digital Content 1, available at: http://links.lww.com/JWHPT/A58, where authors provide more insight on this return to running framework).

Key Words: athlete, childbirth, incontinence, running, strength

BACKGROUND

Running is becoming more popular during and after pregnancy. About 70% of runners who become pregnant continue to run during pregnancy.[1] After childbirth, runners commonly resume running between 2 weeks and 2 months postpartum.[1,2] Runners who

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This clinical commentary is dedicated to Kimberly (Kim) Seymour, PT, DPT, who was the inaugural and current director for the Pregnancy & Postpartum Special Interest Group of Academy of Pelvic Health Physical Therapy. Kim's passion to improve maternal care is the reason this commentary exists. To honor Kim and her leadership in this field, we hope that each reader can use this document to improve health and wellness in the perinatal population.

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are postpartum have reported pelvic floor dysfunction and musculoskeletal pain[2–5]; however, running also produces psychological and physiological health benefits, including reduced risk of premature mortality and cardiovascular disease, improved endurance, and weight management.[6,7] Because of these benefits, and the ease of access to running, it is important to facilitate return to running after childbirth. Health care providers and people who are postpartum increasingly seek guidance on resuming running after childbirth. While high rates of running-related injury (RRI) have been reported in the general population,[8] scientific evidence on resuming high-impact exercise after childbirth is lacking.[9,10]

Pregnancy and childbirth produce unique changes in the muscles and ligaments of the pelvic floor, trunk, hip, and foot, which could affect running form.[11] Childbirth itself can result in major musculoskeletal changes that should require rehabilitation to return to sport like other major injuries.[12] However, people are initiating or returning to running after childbirth without guidance. Despite the sparsity of literature in running after childbirth, a few expert opinions have proposed return to running screens and generalized progressions based on musculoskeletal changes in the general and postpartum population.[9,13–15] Little guidance exists on progressions addressing muscular strength and endurance as well as running mileage progression for people who have recently given birth. This clinical commentary builds on the return to running screens[13–15] to provide pelvic health and sports clinicians with a 4-phase rehabilitation framework for initiating or returning to running in the postpartum period. Our premise is that each individual runner should be empowered to decide when to initiate running, in consultation with their health care providers, especially if symptoms such as incontinence are present.

SCREENING FOR READINESS TO RUN AFTER CHILDBIRTH

In addition to the normal physical therapy review of systems, the first step in determining readiness to run after childbirth should include a thorough physical therapy evaluation (review of systems,[16] musculoskeletal examination,[17-19] and questions on pelvic health[20,21]) as well as screening for impact readiness (musculoskeletal tolerance to impact), pelvic health symptoms, physiological variables (sleep, fatigue, nutrition, and systems review[22-26]), and performing a running gait analysis (see Supplemental Digital Content Appendix A, available at: http://links.lww.com/JWHPT/A76, and Supplemental Digital Content Figure 1, available at: http://links.lww.com/JWHPT/A77). A runner with musculoskeletal or pelvic health symptoms may be able to gradually initiate running in tandem with medical management. The expectation is to minimize these symptoms through exercise prescription, gait retraining, manual therapy, and support of the pelvic organs (eg, pessary). The screening or rehabilitation framework should be stopped immediately if the client has any absolute contraindications,[24,27,28] and clinical judgment exercised with any client who presents with relative contraindications[28,29] (see Supplemental Digital Content Table A, available at: http://links.lww.com/JWHPT/A78). Symptom screens (incontinence, pain, etc) should continue to be routinely performed as exercises are progressed and running distance increases, and training adjusted on the basis of symptoms (see Supplemental Digital Content Appendix A, available at: http://links.lww.com/JWHPT/A76, for more in-depth information on screening).

Screening for Pelvic Health

Running is an impact activity that increases intra-abdominal pressure.[30] This increase in pressure challenges the pelvic floor to maintain continence and pelvic organ support.[30] Stress urinary incontinence is prevalent in women performing high-impact activities[31] and is observed in 19% of runners up to 2 years postpartum.[2] Childbirth is also a risk factor for pelvic organ prolapse.[32] Therefore, it is imperative to screen for incontinence and pelvic organ prolapse symptoms before running. Screening can be accomplished with the Pelvic Floor Disability Inventory short form (PFDI-20)[21] or by asking screening questions[20] (Figure 1 and see Supplemental Digital Content Appendix A, available at: http://links.lww.com/JWHPT/A76). A response of "yes" to any of the pelvic health screening questions warrants a referral to a pelvic health physical therapist or urogynecologist but does not necessarily prohibit initiation of the running portion of the framework.[33] A pelvic floor muscle (PFM) examination is highly advised to determine degree of impairment and whether the impairment influences participation in the running portion of the framework.[34-36]

Screening for Impact Readiness

Two screens have been proposed to determine whether a person is ready to run.[13,14] The screen proposed by Goom et al[15] consisted of a series of movements to determine whether musculoskeletal pain or pelvic health symptoms are present with impact or increased load. The Run Readiness Scale proposed by Payne et al[14] also evaluated musculoskeletal pain through a series of movements (see Supplemental Digital Content Appendix A, available at: http://links.lww.com/JWHPT/A76). Before beginning the return to running framework outlined in this document, we recommend screening for running impact readiness. It should be noted that neither of these screens have been validated in runners postchildbirth.

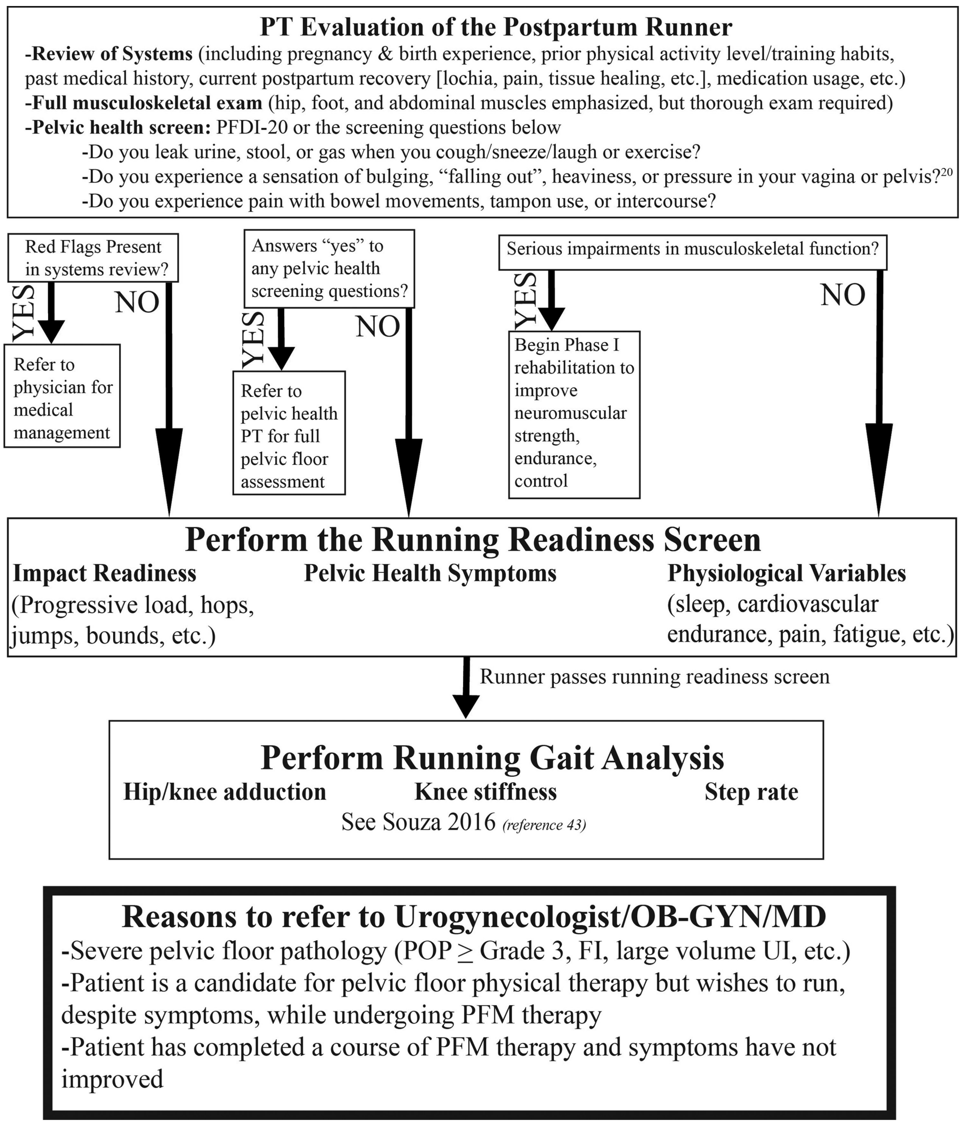

Figure 1. Decision tree to guide PT evaluation and screening of runners after childbirth. Care of runners after childbirth begins with a full physical therapist examination, which determines the phase of the framework to initiate. As with any runner, a full systems review—with particular emphasis on cardiovascular and bone health after childbirth—should be performed to determine appropriateness for physical therapy intervention and need for referral to other health care providers. If no major concerns (physiological red flags, need for further pelvic health examination, or severe musculoskeletal impairments) are present, the runner may undergo the Running Readiness Screen. If the runner passes the Running Readiness Screen, analysis of running gait should be performed to identify whether kinematic risk factors for running-related injury are present. FI indicates fecal incontinence; MD, medical doctor; OB-GYN, obstetrician-gynecologist; PFDI-20, Pelvic Floor Disability Inventory short form; PT, physical therapist; UI, urinary incontinence.

Screening for Running Gait

Many kinematic and kinetic factors have been investigated for the relationship between running gait and injury,[37–39] including peak hip and knee adduction,[38,40] knee stiffness,[41] and step rate.[42] We recommend a running gait analysis to assess biomechanical risk factors for RRI.[9] For clinicians unfamiliar with running gait analysis, Souza[43] provides a guide to 2D analysis.

Screening for Physiologic Variables

Decreased sleep,[44,45] increased fatigue,[46–49] and inadequate nutrition[50,51] may contribute to RRI in postpartum persons.[5,52–54] These variables should be screened when returning to running[55–57] (see Supplemental Digital Content Appendix A, available at: http://links.lww.com/JWHPT/A76).

PROPOSED REHABILITATION FRAMEWORK

The American College of Obstetricians and Gynecologists advises postpartum exercise as soon as medically safe, sometimes within days of delivery.[27] Postpartum recovery involves musculoskeletal,[58] biomechanical,[59–64] and physiological variables.[65] The widening of the levator hiatus that occurs in vaginal birth may contribute to incontinence and prolapse; thus, runners with this risk factor may need to progress more slowly.[66,67] Healing from birth injuries, such as perineal tearing or cesarean incision, may require additional recovery time.[10,68–70] We recommend approaching recovery from pregnancy-related changes and delivery-related injuries in an individualized manner, similar to recovery from other injury or surgery, while respecting the unique postpartum physiological factors. For example, return-to-sport frameworks for anterior cruciate ligament injury involve formal rehabilitation protocols with functional progressions based on sport-specific goals.[71] This proposed framework mirrors these return-to-sport protocols by proposing a phased approach targeting key muscle groups that influence running gait and those that are commonly impaired after childbirth: the PFM, abdominals, posterolateral hip muscles, calf, and foot intrinsic muscles. A progression through isometric, isotonic, and plyometric exercises is recommended to assist a runner to participate in running after childbirth and prevent RRI. This framework encompasses the entire kinetic chain to prepare the runner for effective load management.[72]

How to Use the Framework

The runner may begin running at any time postpartum if they have been medically cleared and screened for running readiness (Figure 1), as recent literature suggests that early return to exercise does not negatively impact pelvic health outcomes or increase injury risk in athletes.[73,74] Symptoms should be continuously monitored and addressed by the health care team. As each individual may have unique pregnancy and postpartum experiences, this framework should be used to assist each runner in achieving their running goals. The physical examination will determine which phase of the framework to initiate (Figure 2). We highly recommend returning to a previous phase if musculoskeletal symptoms worsen. In addition, an extremely fatigued, sleep-deprived runner may need to stay in the current phase of rehabilitation, or regress in some parts of the framework (ie, running) until they are recovered. We recommend runners and health care providers monitor training, recovery, and symptoms throughout the phases of this framework to ensure appropriate physiological and musculoskeletal adaptation to training load.[75] Clinical judgment should be used to progress or regress each component of this framework as indicated by the runner's tolerance and symptom profile (Figure 2).

Key Elements of the Framework

Exercise Prescription

The proposed framework is based on the principles of exercise prescription established by the American College of Sports Medicine,[28] providing the specific parameters of frequency, intensity, type, and rest (see Supplemental Digital Content Table B, available at: http://links.lww.com/JWHPT/A79). Exercise types discussed are isometric, isotonic, and plyometric. Isometric exercise has been shown to increase tendon stiffness and muscle hypertrophy.[76] Midrange joint positions are commonly used, and duration of isometric holds ranges from 10 to 45 seconds with 20 to 90 seconds of rest. Isometric exercises can also evoke exercise-induced hypoalgesia.[77,78] Isotonic exercises improve muscle strength and hypertrophy.[79,80] Eccentric exercises have added neural benefits[81] and exercise-induced hypoalgesia[82] but increased risk of delayed-onset muscle soreness; however, neural adaptations seem to help muscle recruitment and override inhibitory signals from pain and swelling.[81] Plyometric training in female athletes may decrease knee injuries[83] and improve running performance[84] by augmenting tendon extensibility and active muscle stiffness.[85]

The 4 targeted muscle groups in this framework (Table) are the abdominals, pelvic floor, gluteus medius, and foot muscles. Example exercises for each phase were chosen on the basis of evidence—with specific attention to electromyography (EMG) studies to help determine exercise intensity, and running-specific research regarding injury risk and rehabilitation—and expert opinion. We recommend exercises with low EMG activity initially to build strength and neuromuscular control, progressing to exercises with higher EMG activity. [86,125] Example exercises are to guide clinicians, not to act as an exhaustive list. Clinicians are encouraged to use clinical judgment in identifying appropriate exercises for their clients. On scheduled run days, strengthening exercises should be performed after running to avoid muscle fatigue that could alter running mechanics. Clinicians should work with runners to identify barriers (eg, lack of time) and create an individualized version of this framework to ensure success.[126] For example, a limit of 4 exercises has been recommended in a home exercise program to ensure compliance.[127] Phase goals for when to advance have also been provided (see Supplemental Digital Content Table C, available at: http://links.lww.com/JWHPT/A80).

Frequency: The strength exercises suggested in each phase of the framework should be performed 2 to 3 nonconsecutive days a week; however, isometric exercises and very low-intensity exercises, such as those in phase I, may be performed 3 to 7 days per week.[28]

Intensity: To build strength, the American College of Sports Medicine recommends low repetitions

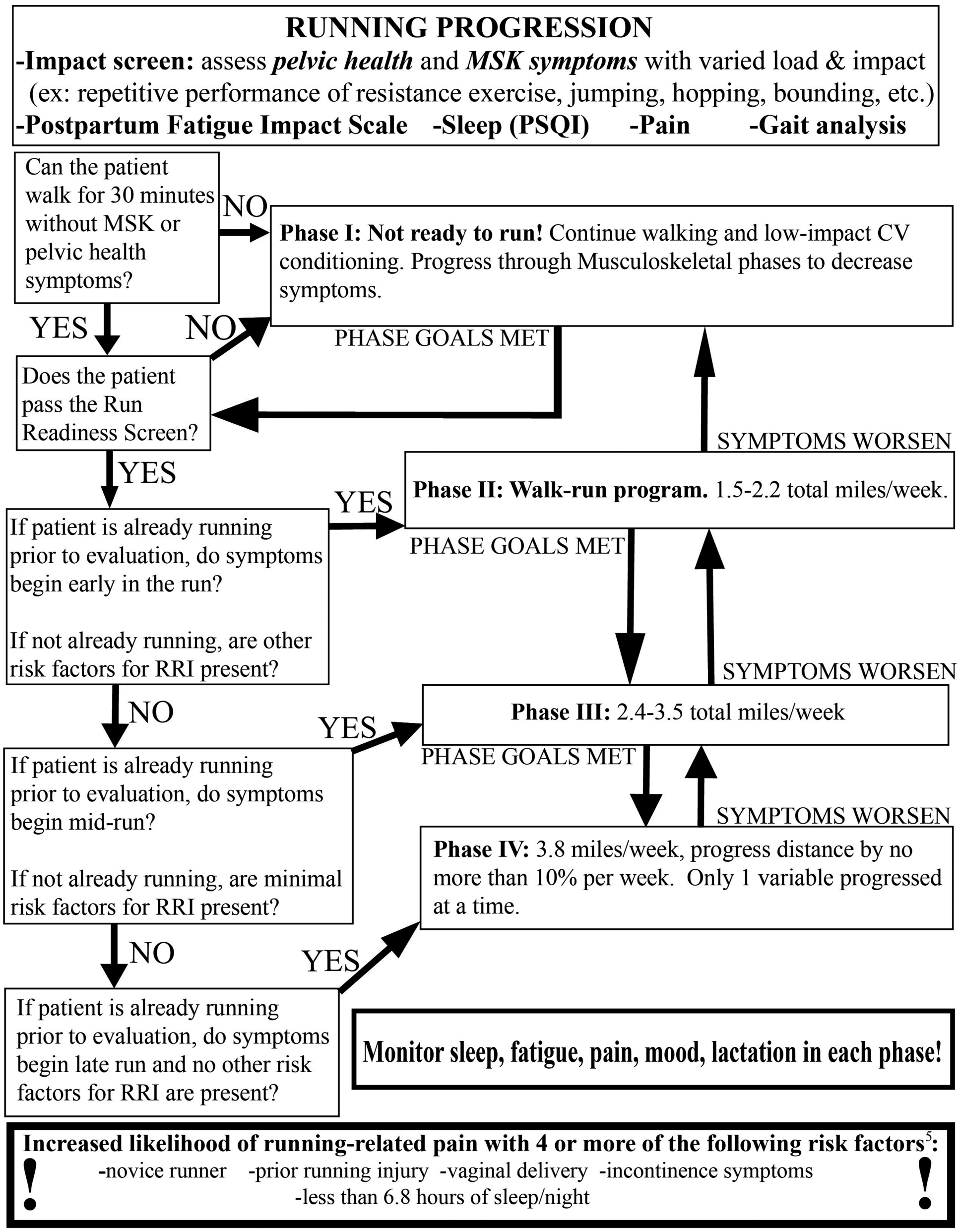

Figure 2. Running progression decision tree. Determining the phase in which to begin the running progression is based on the runner's ability to pass the screening criteria, running habits and symptoms prior to evaluation, and the presence of running-related injury risk factors. Runners may progress to the next phase if progression goals are met, or regress to a previous phase if symptoms are exacerbated or new symptoms arise. Continuous monitoring of symptoms is key! CV indicates cardiovascular; MSK, musculoskeletal; PSQI, Pittsburgh Sleep Quality Index; RRI, running-related injury.

(8-15) with high load.[28] As "high" load is runner-specific, we recommend a rate of perceived exertion (RPE) of 7 to 12 on the Borg Scale in phase I and 13 to 16 in phases II, III, and IV. Muscular endurance is achieved with high repetitions (15-25) of low load (RPE of 11-14).[28] During running, RPE recommendations remain constant throughout the phases.

Rest: Two to three minutes rest between sets has been recommended when strength training.[28] However, longer rest periods (≥5 minutes) may be needed after childbirth due to potentially increased fatigability.[128–130]

Exercises

Many muscles contribute to running propulsion and stability during stance. Key muscles associated with perinatal changes are included later. To limit the time to complete the home exercise program, we recommend choosing exercises that target multiple muscle groups in each phase (see Supplemental Digital Content Table D, available at: http://links.lww.com/JWHPT/A81).

Abdominal: Studies have shown that following childbirth, the anterior trunk muscles demonstrate

Table. Four-Phased Rehabilitation Framework for Initiating or Returning to Running Postchildbirth[a]

	Example Exercises			
	Hip[86]	Foot	PFM	Abs[87]
Phase I	Supine: Bilateral bridge[88,89] Side lying: Clamshell[90] Standing: Double leg body weight squat[86,88,91]	Seated[92,93]: Towel scrunches Bilateral heel raise Isolated great toe extensions Arch doming	Supine, side lying, sitting: Isolated quick flicks (1-2 s) Endurance (3-5 s)	Supine, side lying, sitting, or quadruped: ADIM with breathing Supine[94]: Knee raise to 90-90 position (Sarhmann level 1) Knee lowering from 90-90 (Sarhmann level 2) Supine[87,95–97]: Double leg bridge stable surface 10-30 s (TrA focus) Double leg bridge (stable) with end exhalation (obliques focus) Single leg raise to 45° (all abdominal focus)
	Running progression: (RPE 11) Level 1: Walk 10 min Level 2: Walk 15 min Level 3: Walk 20 min Level 4: Walk 30 min			
Phase II	Supine[88,89,98]: Bridge unilateral stable or bilateral unstable Prone: Double limb plank[89] Prone hip extension with flexed knee (90) progressing to LE straight, foot plantarflexed (triple extension)[88,99] Quadruped: Straight knee hip extension; WB or NWB[88,99] Side lying: Hip abduction neutral or with lateral rotation[88,100] Standing: Hip abduction (focus on stance leg, pelvic stability)[101] Standing single leg pelvic drops (eccentric hip abduction)[88] Single leg squat[102,103] Lunge forward[89] Step up front,[88] retro,[102] lateral[102]	Standing[92,93]: Towel scrunches Bilateral heel raise Isolated great toe extension Great toe flexion with second to fifth toe extension Medial arch doming	Supine, side lying, sitting: PFM activations simultaneous to hip and ADIM exercises Sustained contractions and quick flicks	Quadruped ADIM: Adding UE and LE movements[104] Plank on forearms and knees[87,105,106] Supine: Double leg bridge unstable surface (TrA)[97,107] Curl-up[108,109] Side lying: Side plank knees and elbow[87,106]
	Running progression: (RPE: 11-13) Level 1: 0.25 walk, 0.25 run; 0.25 walk, 0.25 run (weekly mileage: 1.5 miles) Level 2:0.25 walk, 0.28 run; 0.25 walk, 0.28 run (weekly mileage: 1.65 miles) Level 3: 0.25 walk, 0.30 run; 0.25 walk, 0.30 run (weekly mileage: 1.82 miles) Level 4: 0.25 walk, 0.33 run; 0.25 walk, 0.33 run (weekly mileage: 2.00 miles) Level 5: 0.25 walk, 0.36 run; 0.25 walk, 0.36 run (weekly mileage: 2.20 miles) Perform each level 3 times with 48 h of rest and progress if symptom-free and RPE <11			

(*continues*)

Table. Four-Phased Rehabilitation Framework for Initiating or Returning to Running Postchildbirth[a] (*Continued*)

	Example Exercises			
	Hip[86]	**Foot**	**PFM**	**Abs[87]**
Phase III	Prone: Front plank single limb NWB and WB[98] Quadruped: Bird dog[89] Side lying: Hip abduction with medial rotation[100]; or with added resistance[110] Side plank[89] Standing: Hip abduction progression[98] Single limb deadlift[98,111] Single limb deadlift with rotation (navel to wall)[112] Step-up front retro or lateral[102] Lunge lateral[111] Single leg squat: stable[98] or unstable[113] Skater squat[98] Single limb stance: NWB in circumduction[98] Monster walk[111] Plyometric: Jumping B LE: Forward/backward progressing to lateral/medial	Standing[92,93]: Single limb pelvic rotation on fixed femur stance leg (IR/ER of pelvis on femur) focus on foot posture DL heel raise with increase weight Isolated great toe extension Great toe flexion with second to fifth toe extension Movement transitions (sit to stand): Maintain arch doming Plyometrics: Jump with doming of arch	Standing: Pelvic floor muscle activations: Quick contractions for 3 sets of 10 Endurance holds in combination with hip exercises PFM activations simultaneous to other exercises[114,115] Plyometrics: Jumping with pelvic coordination (attention to landing)[116]	Supine[94]: Unilateral heel slide from 90-90 position (Sahrmann level 3) Bilateral heel slide from 90-90 position (Sahrmann level 4) Standing[117]: Back squat (RA focus) Bulgarian squat (unilateral) (EO and RA focus) Quadruped ADIM: Adding UE and LE movements with resistance/weight[118] Front plank on forearms and toes[87,105,106] Front plank with scapular adduction and posterior pelvic tilt (IO focus)[119] Forward plank with single leg hip extension (EO focus)[119] Side lying: Side plank on forearm and toes[87,106]
	Running progression: (RPE: 11-13) Level 6: 0.25 walk, 0.40 run; 0.25 walk, 0.40 run (weekly mileage: 2.40 miles) Level 7: 0.25 walk, 0.44 run; 0.25 walk, 0.44 run (weekly mileage: 2.65 miles) Level 8: 0.25 walk, 0.48 run; 0.25 walk, 0.48 run (weekly mileage: 2.90 miles) Level 9: 0.25 walk, 0.53 run; 0.25 walk, 0.53 run (weekly mileage: 3.20 miles) Level 10: 0.25 walk, 0.58 run; 0.25 walk, 0.58 run (weekly mileage: 3.50 miles) Perform each level 3 times with 48 h of rest and progress if symptom-free and RPE <11			
Phase IV	Side lying[98]: Side plank single limb Standing (add resistance/challenge surface) Step-up front or lateral[102] Hip abduction progression[98] Single limb deadlift[98,111] Single limb deadlift with rotation (navel to wall)[112] Step-up front retro or lateral Lunge lateral[98,111] Single leg squat: stable[98] or unstable[113] Skater squat[98] Plyometric: Hop forward, sideways, or transverse[98,111] Box jumps down (start up, jump down) Step hops forward and sideways	Standing[92,93,120]: Single limb heel raises (cueing for stability in the first metatarsal head and through the ankle) Rear foot elevated split squat with lead leg in slight plantar flexion. Heel hovering 2 cm off the ground Isolated great toe extension with resistance (resistance band, rubber band) Great toe flexion with second to fifth toe extension with resistance (resistance band, rubber band) Plyometric: Hops with doming	Standing: Vaginal weight in standing for proprioceptive input. Active contraction (3-5 s, 3 sets of 10)[121] Vaginal weight with endurance hold during gentle activities of daily living for no greater than 20 min/d[116,122]	Standing: Pallof press Diagonal rotations with resistance Back squat (RA focus)[117] Bulgarian squat (unilateral) (EO and RA focus)—unstable[117] Standing 1 leg press, skiing Quadruped: Plank on toes and hands (forward, side, star) Roll-out plank (RA focus)[117] Forward plank: with single leg hip extension, forearm on Swiss ball (stir the pot),[123] or suspension systems[106,124] Side lying: Side plank with leg lifts: upper body rotation, added resistance, challenge base of support

(*continues*)

Table. Four-Phased Rehabilitation Framework for Initiating or Returning to Running Postchildbirth[a] (*Continued*)

	Example Exercises			
	Hip[86]	Foot	PFM	Abs[87]
	Running progression: (RPE: 11-13) Level 11: 0.25 walk, 0.63 run; 0.25 walk, 0.63 run (weekly mileage: 3.80 miles) Level 12: 0.25 walk, 0.70 run; 0.25 walk, 0.70 run (weekly mileage: 4.20 miles) Level 13: 0.25 walk, 0.77 run; 0.25 walk, 0.77 run (weekly mileage: 4.62 miles) Level 14: 0.25 walk, 0.83 run; 0.25 walk, 0.83 run (weekly mileage: 5.00 miles) Level 15: 0.25 walk, 0.92 run; 0.25 walk, 0.92 run (weekly mileage: 5.50 miles) Level 16: 0.25 walk, 1.02 run; 0.25 walk, 1.02 run (weekly mileage: 6.10 miles) Level 17: 0.25 walk, 1.12 run; 0.25 walk, 1.12 run (weekly mileage: 6.70 miles) Level 18: 0.25 walk, 1.50 run; 0.25 walk, 0.75 run (weekly mileage: 6.75 miles) Level 19: 0.25 walk, 1.75 run; 0.25 walk, 0.50 run (weekly mileage: 6.75 miles) Level 20: 0.25 walk, 2.0 run; 0.25 walk, 0.25 run (weekly mileage: 6.75 miles) Level 21: 0.25 walk, 2.25 run; 0.25 walk (weekly mileage: 6.75 miles) Level 22: 0.25 walk, 2.48 run; 0.25 walk (weekly mileage: 7.43 miles) Perform each level 3 times with 48 h of rest and progress if symptom-free and RPE <11			

Abbreviations: ADIM, abdominal draw-in maneuver; B, bilateral; DL, double leg; EO, external oblique; ER, external rotation; IO, internal oblique; IR, internal rotation; LE, lower extremity; NWB, non–weight bearing; PFM, pelvic floor muscles; RA, rectus abdominis; RPE, rate of perceived exertion (Borg); TrA, transverse abdominis; UE, upper extremity; WB, weight bearing.
[a]Example exercises for each muscle group and detailed progression of running through the 4 phases. Note that a runner may be in different phases for each component of the framework, and it is acceptable to progress or regress only 1 component, if necessary.

decreased strength and steadiness of contraction and increased fatigability.[128,129] More severe impairments in muscular function are associated with wider interrecti distance or diastasis recti abdominus.[128–130] Rehabilitation of all muscles of the abdominal wall is essential, as trunk flexion and rotation and lumbopelvic stabilization have been shown to be impaired following childbirth.[128–130] Conflicting evidence exists on which exercises are best to reduce interrecti distance in the long term[131–134]; however, ultrasonographic studies suggest that performing an abdominal draw-in maneuver prior to an abdominal curl-up reduces linea alba distortion.[135,136] Therefore, abdominal draw-in maneuver exercises start in phase I of the framework, and curl-up exercises (only in the absence of abdominal doming) are added in phase II. Phases III and IV focus on higher-level exercises that require significant activity of all abdominal muscles.

Pelvic floor: The exercises starting in phase I of the framework are quick contractions held for 1 to 2 seconds and performed repeatedly with proper rest, and endurance contractions held for 3 to 5 seconds for 8 to 12 repetitions, increasing hold time to 10 seconds in later phases.

Hip: The key muscle targeted in this section is the gluteus medius, as it stabilizes the pelvis in single limb stance.[137] Specifically, it prevents hip adduction, a risk factor for RRI.[138,139] Gluteus medius weakness has also been associated with low back pain in pregnancy, due to a Trendelenburg gait or a strain in the muscle itself.[140] In females with stress urinary incontinence, strengthening the hip abductors along with the PFMs resulted in less daily urine loss.[141] Exercises in phase I (low EMG activity) are bilateral leg bridge, squat, and prone bent knee hip extension. Phases II and III (moderate to high EMG)[125] include quadruped straight leg hip extension and single limb stance exercises. Phase IV includes single limb side plank and hops.

Foot: The foot has important roles in running including impact absorption at contact and propulsion.[142] Feet experience changes during pregnancy leading to altered biomechanics and pressure patterns.[143] Excessive pronation has been linked with RRI.[144] Pronation is present in runners during pregnancy and is not observed to return to baseline at 6 weeks postpartum.[143] Foot strengthening exercises were included in this framework as they have been observed to improve foot muscle volume and propulsive forces in healthy runners.[93] The exercises in phase I begin in sitting and include foot intrinsic isometric holds to improve neuromuscular coordination, strength, and stability. Phases II to IV include progressively more challenging exercises for arch doming and foot intrinsic strength.[92,93]

Running progression: The runner must be able to walk for 30 minutes without symptom exacerbation and pass the run readiness screen before starting the running progression component of this framework; as such, the runner may progress through the phases for muscular endurance and running progression asynchronously (eg, phase 3 for strengthening exercises but phase I for running). The runner should first be evaluated for shoe fit as foot dimensions may increase and dynamic arch stability may decrease after childbirth.[143,145,146] Running should begin on a flat surface, every other day to ensure recovery between sessions. The runner should monitor symptoms such as pain, incontinence, swelling, prolapse symptoms, or muscle stiffness during and after running. We recommend slow progression, through the levels 0 to 22 suggested (Table), to ensure appropriate adaptation to impact loads. If symptoms arise or worsen, running should stop and a running gait evaluation by a physical therapist should be sought. Elite athletes or runners who ran throughout pregnancy and desire a quicker progression may do so under supervision; however, it is recommended that only 1 variable (velocity, distance, frequency) is increased weekly and running distance increases by no more than 10% weekly.[147] Runners with a step rate below 170 steps per minute should be encouraged to increase step rate by approximately 10% to decrease ground reaction forces.[42,148,149] As research highlights workload optimization, it is also important to monitor recovery, fatigue,[150] sleep,[151] pain,[2] and heart rate.[152]

The running progression is based on mileage, not time, as increased mileage has been associated with RRI, and this is a more conservative approach.[147,153] We recommend a speed that feels comfortable to the runner, as changing speeds has been associated with increased loading rate.[154] To control for intensity, we recommend using an RPE of 11 to 13 throughout the plan. Before initiating each run, a dynamic warm-up should be performed. A walk-run progression is used, beginning with a total of 0.5 miles (2 bouts of 0.25 miles) of running interspersed with walking. The framework progresses running mileage up to 2.48 miles per run (weekly mileage of 7.43 miles) by level 22. Each workout should be performed 3 times a week for at least 1 week, and symptoms should be stable or improving to advance to the next level.[147,153]

Phases of Progression

Detailed information regarding exercise prescription and recommendations for each phase is provided (Table). Runner report of ease of exercise performance, and meeting the objective criteria described later, indicates readiness for progression.

Phase I: The aim of this phase is to establish neuromuscular coordination, strength, endurance (muscular and cardiovascular), and control of the hip, trunk, pelvic floor, and lower extremity muscles. This phase may be prolonged for runners who experienced bed rest or complicated pregnancies, deliveries, or postpartum recoveries.[9,155]

- Intensity and type: Exercises with low to moderate EMG activity (0%-40% maximal voluntary isometric contraction (MVIC)[125]; primarily isometric, open chain isotonic, and bilateral closed chain).
- Cardio/general fitness: Low-impact aerobic exercises including walking, cycling, elliptical, and swimming are ideal. It is recommended to progress by increasing time before intensity.[28]

Goals and progression to the next phase: The runner should demonstrate good lumbopelvic control, proper breathing, and adequate abdominal engagement during all exercises. Monitor for Trendelenburg sign in single-limb stance (see Supplemental Digital Content Table C, available at: http://links.lww.com/JWHPT/A80). Pelvic floor muscle strength should be adequate to avoid leakage during exercise. For the foot, the runner should demonstrate smooth quality of movement with no compensations (eg, medial or lateral deviations or rotations at the ankle). Running may be initiated in the next phase (phase II) if the runner can walk symptom-free for 30 minutes and pass the running readiness screen (see Supplemental Digital Content Appendix A, available at: http://links.lww.com/JWHPT/A76). As runners may compensate with other muscles while performing an exercise, it is important to query them on where they feel the exercise to ensure correct exercise performance.

Phase II: The aim of this phase is to continue to improve strength, coordination, and endurance of the muscles pertinent to running, as well as continue to progress cardiovascular endurance. Phase II introduces positional and stability changes to further challenge neuromuscular control.

- Intensity and type: The goal is moderate-high EMG (20%-60% MVIC),[125] primarily achieved through isometric and isotonic exercises progressing from bilateral closed chain or unilateral open chain to unilateral closed chain. Challenging positions such as a narrow base of support or against gravity are utilized.
- Cardio/general fitness: If the running readiness screen is passed, and the runner can walk 30 minutes without symptom exacerbation, running is introduced via a walk-run program starting with level 1 (weekly mileage up to 1.5 miles) progressing to level 5 (weekly mileage up to 2.2 miles). Running should be performed only 2 to 3 days per week with 48 hours of rest to monitor symptoms. Each running level should be performed 3 times for a minimum of 1 week. Cross-training may be progressed to increase cardiovascular endurance, with a goal of 30 minutes of aerobic exercise per day.

Goals and progression to the next phase: The runner should demonstrate good motor control and biomechanics with all exercises. No exacerbation of symptoms with running/aerobic exercise or strength exercises, abdominal wall doming, or musculoskeletal compensations should be noted.

Phase III: The aim of this phase is to build on muscular endurance, power, dynamic stability, and load management. Phase III progresses exercises in the standing position, bringing added challenge to the muscles against gravity, and includes low-level plyometrics. If a runner has not yet passed the impact screen, plyometric training will be especially important to facilitate improved load tolerance to eventually pass the impact screen and initiate the running progression portion of the framework.

- Intensity and type: The goal is high to very high EMG (>60% MVIC),[125] primarily achieved through resistance training and unstable surface variations (foam surface, ball, roller, disk, etc)
- Cardio/general fitness: If earlier running phases have been performed with no exacerbation of symptoms, running is progressed to level 6 (weekly mileage up to 2.4 miles) through level 10 (weekly mileage up to 3.5 miles). If the running workout takes less than 45 minutes total and the runner is eager to exercise longer, walking or a low-impact exercise choice can be added to reach a total of 45 minutes.

Goals and progression to the next phase: The runner should demonstrate good motor control and biomechanics with all exercises. No exacerbation of symptoms with running or strength exercises, abdominal wall doming, or musculoskeletal compensations should be noted.

Phase IV: The aim of this phase is to return to full participation in running. Exercises challenging muscular endurance and power are progressed by adding increased resistance and changing surface stability. Strength exercises and plyometrics are progressed to single leg to increase load tolerance and strength in running-specific positions. Compound movements with higher resistance are also recommended. It is imperative to use weights for resistance as running forces can be up to 5 times a runner's body weight.[156]

- Intensity and type: The goal continues to be high to very high EMG (>60% MVIC),[125] primarily achieved through resistance training and unstable surface variations (foam surface, ball, roller, disk, etc).
- Cardio/general fitness: If the earlier levels of running have been performed successfully, the goal of this phase is to increase cardiovascular endurance to match the runner's running goals. The running progression begins at level 11 and continues until desired goals are reached. At level 18, the amount of walking decreases, while the amount of running increases. In levels 18 to 21, length of running interval increases but total mileage is held constant. Some runners may end at level 20 with goals of running 2 miles; for others, the progression may continue after level 22. We recommend the runner conservatively increase weekly mileage (only 10% per week).[147] If the runner wishes to add speed work or tempo runs after level 22, running mileage should be held constant as other variables are manipulated. Each level should be performed without exacerbation of symptoms and at least 3 times before progressing.

Goals and progression: At the end of this phase, the runner has been symptom-free (or mild symptoms have remained stable) and running up to 2.48 miles per run. If musculoskeletal or pelvic symptoms appear or reoccur, the runner is advised to return to an earlier phase of the running progression framework or scale back within the current phase (eg, level 22 to level 20) (Figure 2). If symptom-free, it is recommended that the runner continues to engage in strength and plyometric training while advancing or maintaining total weekly running mileage.

CONCLUSION

Research-based rehabilitation guidelines regarding running after childbirth are limited. Therefore, this clinical commentary proposes a comprehensive 4-phase progression, guided by evidence, for clinicians to assist runners after childbirth. Clinicians should ensure that a runner is medically cleared, able to walk 30 minutes without symptom exacerbation, has had a thorough musculoskeletal examination, and passes a running readiness screen before beginning running in this framework. This framework is not exhaustive; however, it provides evidence and expert opinions on how to progressively rehabilitate a runner through a comprehensive continuum of care after childbirth. Clinical judgment should be exercised with each runner, and modification of the framework based on runner-specific examination findings is essential. Future research is necessary to validate this framework in people returning to running after childbirth.

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