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Clinical and Exercise Professional Opinion on Designing a Postpartum Return-to-Running Training Program: An International Delphi Study and Consensus Statement

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Abstract

Objective: Returning to running postpartum presents challenges such as musculoskeletal pain and pelvic floor dysfunction for some females, but there is little guidance on developing and progressing postpartum training programs. This study aims to establish expert consensus recommendations on designing and modifying a postpartum return-to-running training program, highlight costs and access to qualified professionals as potential barriers, and discuss clinical, research, and sport policy implications.

Methods: A three-round Delphi survey of clinical and exercise professionals working with postpartum runners was conducted. Round 1 consisted of open-ended questions related to designing the training plan, modifications based on biopsychosocial factors, key muscle groups to train, and referral and payment sources. Rounds 2 & 3 involved Likert-scale voting to identify consensus (≥75% agreement).

Results: 118 participants completed Round I, 107 completed Round II (response rate 90.6%), and 95 completed Round III (response rate 80.5%). Consensus was reached in 42/47 (89%) statements, including recommendations for a period of relative-rest, gradual increases in duration and intensity, starting with a walk-run protocol, and incorporating strength training. Training should be modified based on musculoskeletal or pelvic symptoms, sleep, mental health, lactation, or energy availability concerns. Cost and access to experienced postpartum running professionals were identified as potential barriers for runners to receive care.

Conclusion: Consensus recommendations for a postpartum return-to-running program include an individualized exercise prescription, gradual increases in physical activity, walk-run protocols

and targeted muscle strengthening. Further research and improved access to clinical and exercise professionals is needed to inform and facilitate best practices.

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Introduction

The last century has seen a change in our view of what athletic females can or should do. In 1926, Violet Piercy was the first female in modern times to run in a marathon recognized by the International Association of Athletics Federations. It would be decades before female runners would become commonplace, and 2018 was the first year that females made up more than half of all runners.[1] In the last decade, Allyson Felix, the most decorated athlete in World Athletics history, smashed societal norms by returning to elite sport as one of the top runners in the world after experiencing an emergency, pre-term Caesarean delivery due to pre-eclampsia.[2,3] While she has served as a role model for future mother-athletes, some runners—whether elite or recreational—report facing several barriers to returning to running after childbirth.[4-6] Felix, along with other professional runners like Alysia Montano and Kara Goucher, have also reported facing significant pay cuts from sponsors while navigating pregnancy and the recovery from childbirth, which puts undue pressure on athletes to rapidly return to pre-pregnancy performance.[7]

At the elite level, up to 50% of postpartum runners report injuries that delayed training/running or competition[8], while 33-84% of recreational postpartum runners report running-related pain.[9,10] While running related injuries (RRIs) and pain are common in the general running population[11], the prevalence of pain/injury in postpartum runners may be due to lack of evidence informed guidance provided by healthcare, clinical, fitness, and rehabilitation professionals on how to return to running safely.[4-6] Some athletes report anxiety regarding injury susceptibility after childbirth, which can also act as a barrier to returning-to-sport and athletic performance.[4,5] Given the high rates of pain and injury among postpartum runners, along with

the increased risk of pelvic health symptoms (e.g., incontinence and pelvic organ prolapse [POP]), guidance on how to return to running after childbirth is essential.[8-10,12,13]

It is increasingly recognized that rehabilitation following pregnancy and childbirth is needed to optimize return to running.[14-18] Following major injuries or surgeries, post-operative protocols or rehabilitation guidelines provide individuals with phase-specific exercises.[19,20] These guidelines are based on tissue healing, the individual's symptoms, psychological readiness, and clearly defined goals that indicate an individual's ability to safely progress to the next stage, eventually culminating in full return to the desired level of exercise/sport participation.[19,20] Pregnancy and childbirth can result in several biopsychosocial changes (e.g., incontinence, depression, muscular weakness, lack of social support, etc.) that may influence physical activity (PA) and/or exercise participation and performance.[21-25] Consequently, some postpartum females may benefit from directed, evidence-informed guidance on how to start and progress PA/exercise, as well as access to health and fitness professionals who can identify specific areas of impairment and tailor a return-to-exercise program. In the last five years, postpartum return-to-running guidelines and frameworks have been suggested to support safe return to running.[14-18,26] However, it is unclear what specific parameters are used by exercise and clinical professionals for progression of PA/exercise to running postpartum, how those parameters align with best practice, or what barriers postpartum runners face when trying to access this expertise. As consensus and expert opinion recommendations on how to determine postpartum run-readiness have been described elsewhere[27], this study sought to establish an international consensus on key topics related to designing a postpartum training plan to facilitate return to running (i.e., training plan design and key muscle groups to strengthen) by surveying experienced clinical and exercise professionals in postpartum running. Study participants were

also asked to identify current practice factors that may act as barriers to postpartum females accessing professional return-to-running guidance (i.e., referral sources and payment sources), and to identify where they obtain information that guides their professional practice.

Methods

A three round Delphi survey design was utilized.[28-32] The study was approved by the Elon University Institutional review board. Methods are outlined in detail in a previous manuscript.[27] In summary, the authors (all of whom are research and/or clinical experts in perinatal health) developed an initial survey of open-ended questions regarding return to running after childbirth. This initial survey was piloted by experts in the field who are no longer working with postpartum runners. The survey was edited based on feedback from the pilot participants and used for Round I.

Subjects (Respondent Group)

Inclusion criteria are described in a previous manuscript.[27] Briefly, all participants had to be health, exercise or fitness professionals who worked with postpartum runners. A minimum of five years' professional experience with postpartum runners was used as the threshold to be considered "experienced clinical and exercise professionals" unless their caseload was reported to be ≥50% postpartum runners, in which case the 5-year minimum was waived. Recruitment was conducted through a purposeful snowball sampling method. All possible participants completed a recruitment survey which was used to determine if the inclusion criteria were met.

Procedure

Figure 1 provides an overview of the study procedure. Participants received an email through Qualtrics (Seattle, WA USA) with a personalized link to each Round of the survey which

prevented each participant from completing the survey more than once while also allowing respondents to complete the survey in multiple attempts. Respondents were not notified of who else was participating in the study, thus responses were anonymous. Written informed consent was obtained on the first page of each survey Round. Consensus was defined *a priori* as 75% agreement.[33] Round I was distributed to all interested participants who met inclusion criteria, while Rounds II and III were only distributed to those participants who completed the Round I survey.

Round I Survey

The first Round consisted of demographic questions, referral patterns and how clinical and exercise professionals are compensated for the services they provide to postpartum runners, and four open-ended questions about return-to-running program development (exercises, running progression, amount of mileage initially, and milestones for advancement). Participants were also asked about sources of information that inform their clinical decision making.

Round II Survey

Four authors (SMC, RED, SD and MHD) with experience in consensus statements and/or mixed methods research coded the responses from Round I to identify common themes. These themes were used to develop the Round II survey, which consisted of statements and a four-point Likert-scale for respondents to indicate their level of agreement/disagreement with each statement. Some gaps in knowledge were also identified during Round I coding, and additional free-text questions were developed and included in Round II to obtain additional information, such as specific starting points for a mileage- or time-based run training plan.

Round III Survey

For Round III, the Likert-scale questions from Round II were presented again with graphs indicating participant responses (percentages of respondents who strongly agreed, agreed, disagreed, strongly disagreed) from Round II, and respondents were again asked to rate their level of agreement using a Likert-scale. The free-text questions from Round II were thematically coded, and themes were presented as statements with the Likert-scale to indicate level of agreement when there were any gaps in the knowledge. As these items provided specific parameters used by the respondents for previously established themes (time-based vs mileage-based progression), these items only went through one round of voting.

Author Recommendations

The authors discussed the Delphi data and current evidence, leading to development of recommendations for each section. A survey consisting of the recommendation created from group discussion and free-text options to indicate dissenting opinions was then sent to all authors. A second survey with all author-suggested recommendations for each section was then sent out. Unanimous agreement was obtained after two rounds on all recommendations except one, which had one dissenting opinion.

Evidence Review

All authors participated in the review of evidence, searching for articles related to exercise, rehabilitation, running, and/or sport in the postpartum period/after childbirth/after pregnancy. Evidence review was utilized to inform the creation of Round I survey questions, and to determine if the results of the clinical and exercise professional consensus was in line with current research evidence, thus allowing the authors to make final recommendations on each

topic. The level of evidence is provided for the literature summary after each consensus section.[34]

Equity, Diversity, and Inclusion Statement

The author group consists of 12 women, primarily white and a woman of color, from five different countries.. Clinical and exercise professionals (Respondent group) were included based on number of years working with postpartum runners and thus junior, mid-career and senior level practitioners from a variety of professional backgrounds were included. Only two men participated in the Delphi survey as respondents. In discussing generalizability of our results and limitations in our findings we recognize that these results may exclude professionals of a low socioeconomic status, where advanced education is unavailable, or from marginalized communities as perinatal care is not part of basic training in many professions.

Results

Respondent Group

Two-hundred-twenty-two participants met inclusion criteria and were sent a link for Round I. 118 participants completed Round I, 107 completed Round II (response rate 90.6%), and 95 completed Round III (response rate 80.5%). Demographics for the respondents are presented in Table 1.

Referral sources and payment

Referral sources and method of payment are presented in Tables 2 and 3. The top three sources referring postpartum runners to clinical and exercise professionals were: (1) self-referral, (2) primary care providers and (3) birth providers. In Round I, 42% of respondents indicated that they exclusively work with self-pay postpartum running clients (i.e., care is not covered by

insurance or a universal health care system) and 78% reported at least part of their caseload was self-pay.

Sources of Information for Clinical Decision Making

In Round I, participants were asked to identify specific sources used to inform their clinical decision making while designing postpartum return-to-running training programs. Five themes were identified (Table 4), with non-peer reviewed expert opinion being the most common source.

Consensus on Designing a Postpartum Return-to-Running Training Program

Training Plan Design:

Consensus. Consensus was reached (92.9%) that *how* the return-to-running plan is implemented (i.e., dosing of exercise) is more important than *when* a runner returns to running after childbirth (i.e., weeks postpartum). Respondents also agreed (97.7%) that it is better to be conservative than to progress too fast too soon. Consensus was reached that the run-training program should incorporate progression of walk-run intervals (98.8%), cross-training (95.3%), strength training (100%), and a rest day between runs (75.3%). Consensus was also reached (98.8%) that the amount of running prescribed in the initial stages of run training is dependent upon the runner's past running history, including time since their last run and how far they were running at that time. Additionally, consensus was reached regarding the optimal starting point for a return-to-running program from a time perspective, but not from a minimum distance perspective (Table 5).

Current evidence. All runners will experience some deconditioning during recovery following birth and will require reconditioning prior to resuming running.[15,16,35] The degree of deconditioning

will influence the duration of the rehabilitation phase.[15,16,35] A gradual return to baseline (pre-pregnancy) fitness is encouraged[35] and experienced clinical and exercise professional consensus recommends that an individual first be able to walk 30 minutes without pelvic health or other musculoskeletal symptoms before being assessed for run-readiness.[27] While some postpartum females can resume symptom-free physical activities/exercise prior to six weeks postpartum[36,37], others may be more susceptible to injury.[8,24] Although the underlying mechanisms are unclear, recent literature has reported bone stress injuries (BSIs) in lactating elite athletes (~3% of elite athletes; 43% of BSIs were sacral stress fractures), some of which have occurred during non-impact exercise, such as cross-country skiing.[8,24] In addition, several case studies have reported sacral stress fractures in sedentary postpartum females with and without normal bone mineral density (BMD).[38,39] Although BSIs after childbirth are relatively rare, the elevated risk of sacral stress fractures compared to nulligravid females highlights the importance of gradual progression of low-impact aerobic activities to ensure an appropriate progression of load and to monitor for signs/symptoms of BSI before initiating high impact activities. Regarding rest between run days, no literature exists in the postpartum population. In the general running population, two expert opinion papers have suggested one day of rest between run days for the first two weeks of a run-training progression following return to running after a stress fracture[40,41], and one study on elite endurance athletes showed that less than two rest days per week during training was associated with a 5.2 fold increased risk of overuse injury.[42] (Overall level III evidence with minimal level I evidence)

To our knowledge, there is no evidence to support a mileage- vs. time-based approach when designing a run training program in the general population. A recent expert opinion suggested a mileage-based approach for postpartum return to running in an effort to control total

load accumulation and load tolerance[14], as rapid mileage progression (>30%) has been shown to cause an increase in injury risk.[43,44] This expert opinion also recommended that running speed be held constant while mileage is progressed, and suggested the use of RPE to avoid drastic increases in intensity while using a mileage-based approach.[14] (Overall level V evidence)

Recommendations (12/12 authors assent): The length of the recovery period after childbirth is person-specific and should be based on the individual's symptom and risk-factor profiles (e.g., physiological recovery, tissue healing, training history, psychosocial factors, etc.). Once readiness-to-run has been established, initiation of run training should begin slowly with a walk-run protocol to assess symptom provocation. Cross-training can be used to optimize cardiorespiratory and muscular fitness prior to and after initiating running. Although BSI is a relatively rare occurrence, particularly in non-elite athletes, runners (and the professionals working with them) should be vigilant for signs and symptoms of BSI. Due to lack of evidence, no recommendation can be made regarding the amount of rest/recovery between runs (i.e., spacing of run days). No recommendation can be made at this time regarding the use of a mileage-based or time-based run training plan.

<u>Progressions/Regressions based on Biopsychosocial factors</u>

Consensus: There was unanimous agreement that biopsychosocial factors (e.g., sleep, fatigue, pain, social support, infant needs, energy availability, lactation, etc.) should be considered when adapting training (progression vs. regression), and that progression of the run training program should be specific to each runner's goals. There was no agreement on *how* run training programs should progress (e.g., distance vs. time), but agreement was reached (89%) for educating runners

on the need to cease run portions of walk-run programs if pelvic health symptoms arise (Table 6).

Current evidence: When considering biopsychosocial factors, sleep has been identified as an important predictor of athletic performance and injury.[45] Sleep is often disrupted while caring for an infant[46], with poor sleep and fatigue having been identified as barriers to exercise participation in postpartum females.[6,47] Sleeping less than 6.8 hours/night and a Postnatal Accumulated Fatigue Scale (a validated questionnaire that assesses physical, emotional and cognitive fatigue, with a maximum score of 39 indicating severe fatigue in all three subsections)[48] score ≥19, were identified as risk factors for postpartum running-related pain[9], which is experienced by 33-84% of postpartum runners.[9,10] However, engaging in regular PA is associated with improved sleep quality and duration, as well as tiredness and daytime function during the perinatal period.[49-51] Thus, encouraging some level of PA postpartum may have a beneficial impact on sleep, but sleep deprivation may also prevent participation in impact exercise like running and/or increase the risk of running-related pain in postpartum runners. (Overall level II evidence)

Lack of physical and emotional support from family or healthcare professionals is consistently cited as a key barrier to exercise in the general postpartum population.[23,47,52] Elite athletes (including, but not limited to, runners) have also expressed a lack of social support—including childcare and sport organizations and policy makers—as well as negative public opinion as challenges to returning to training after childbirth.[5,53] (Overall level I evidence, some level II evidence)

Lack of social support and increased stress are two of many established factors that contribute to depression and anxiety postpartum.[54] One in seven postpartum females world-wide

224 are affected by depression or anxiety, with even greater prevalence (~33%) in low- and middle-
225 income countries.[22,55] Maternal depression and anxiety can negatively impact mother-child
226 bonding and child development.[56] PA can be beneficial for preventing and ameliorating
227 postpartum depression and depressive symptoms.[57] The use of validated measures to screen for
228 postnatal depression and well-being issues when returning to activity has been recommended to
229 allow for targeted appropriate support.[16] (Level I to Level V evidence)

230 Consensus from the Delphi respondents also identified two important biological factors
231 to consider when adapting the postpartum training plan: (1) lactation and (2) the risk of relative
232 energy deficiency in sport (REDs). Energy requirements increase after childbirth for lactating
233 females and vary based on the timeframe postpartum.[58] A multi-center study of lactating females
234 found that overall energy intake and intake of several key vitamins and minerals was below
235 recommended amounts.[59] Problematic low energy availability (LEA) and REDs in female
236 athletes is associated with a number of detrimental conditions, such as urinary incontinence,[60,61]
237 BSI, cardiovascular dysfunction, and endocrine dysfunction, all of which effect exercise
238 participation and performance.[62-64] Energy balance is a difficult construct to assess in the
239 lactating athlete[65] as many lactating females experience a prolonged absence of the menstrual
240 cycle,[66] a commonly used marker of energy status in non-lactating athletes.[63-65,67-69] In healthy
241 lactating females (i.e., in the absence of chronic LEA), there is sufficient evidence to show that
242 PA and exercise are compatible with breastfeeding. Low- to moderate-intensity aerobic activities
243 do not alter levels of cortisol or lactic acid in breastmilk and will not impair volume of
244 breastmilk as long as hydration and nutrition intake is adequate.[70,71] Maximal or very high
245 intensity activities have been shown to influence breastmilk composition[72], but further high-
246 quality research is needed in this area. (Overall level II evidence)

There is no evidence to date that has assessed an ideal magnitude of change in running volume in postpartum runners when progressing run training. In the general running population, sudden increases in mileage or intensity have been hypothesized as risk factors for RRIs: in novice runners, a running mileage progression of ≥30% compared to ≤10% in a span of two weeks was associated with 59% greater volume of injury.[43,44] In healthy runners training for a half-marathon, progression of running distance by < 20% per week was associated with a 22.6% decreased risk of developing a RRI.[73] Recent changes in velocity, distance and/or running frequency have also been shown to increase risk of RRI.[74] In addition, the runner's training history may also influence RRI risk: novice postpartum runners have increased odds of developing running-related pain.[9] In the general population of novice runners, use of structured run progressions (such as "Couch to 5K") have been associated with decreased injury risk compared to self-progressing.[75] When considering what component of the training plan to progress first, general exercise physiology evidence recommends increasing the duration of exercise prior to increasing intensity for safe progression of cardiorespiratory fitness and decreased risk of injury[76], which is also supported by a narrative evidence review on postpartum females engaging in elite sport and physically demanding jobs.[77] Injury risk associated with increasing running volume has been shown to be similar to increasing running intensity, but in recreational runners with a degree of conditioning already present.[43] (Overall level II evidence)

There is minimal long-term evidence on pelvic floor symptoms in postpartum runners[21], and no studies have been done to compare long-term pelvic floor function in runners who *stopped* the run-portion of a run-walk protocol due to presence or exacerbation of symptoms to those who *completed* the run-portion of a run-walk protocol despite the presence or exacerbation of symptoms. That is, there is no evidence to say that terminating running due to pelvic health

symptoms is protective to PFM function or that continuing to run despite symptoms is detrimental to PFM function. It is known, however, that pelvic health issues are common in nulligravid female athletes (including, but not limited to, runners) and in the general postpartum population.[13,21,35,61,78-90] Two of the three primary reasons that postpartum females report not returning-to-running are incontinence and pelvic organ prolapse symptoms.[6] Returning to running was also associated with increased odds of urinary incontinence compared to females who ran prior to or during pregnancy but did not return to running after childbirth.[10] (Overall level II evidence)

To our knowledge, no evidence exists on muscle flexibility and functional mobility in postpartum runners. There is very low quality (and often conflicting) evidence addressing the influence of muscle flexibility and range of motion on RRI in the general running population, with no clear associations identified regarding RRI and lower extremity range of motion or alignment.[91] A recent Delphi study reported that clinicians working with postpartum runners identified impaired flexibility in the hip flexors, limited lumbar extension, "dynamic knee valgus, increased lumbar lordosis, overpronation, and thoracic kyphosis" in postpartum runners with running-related pain.[13] However, literature review did not support the Delphi consensus in that study.[13] (Level I and Level V evidence)

Recommendations (12/12 authors assent): When determining whether to progress or regress training, several biopsychosocial factors (including sleep, mental health, lactation, energy availability, pelvic health and musculoskeletal symptoms, etc.) should be monitored and training should be adjusted accordingly (i.e., decrease running volume if symptoms arise or baseline symptoms are exacerbated; running volume can be progressed if symptoms are not present or existing symptoms do not worsen). When progressing run-training, only one variable should be

changed at a time, and overall running volume should be progressed gradually, avoiding drastic increases in volume, to minimize injury risk. General principles of exercise prescription recommend that the duration (mileage or time) of exercise be progressed before intensity (speed).

Key Muscle Groups to Target With Exercise Before and During Run-Training.

Consensus. Several trunk (e.g., pelvic floor muscles, abdominal muscles) and lower extremity (e.g., hip abductors, hamstrings) muscle groups reached consensus as key for exercise training while preparing for return to running and throughout run training (Table 7). Consensus was reached in both rounds that all postpartum runners should have a full musculoskeletal assessment and areas of impairment should be targeted with exercise (95.3%) and that specific muscle groups are less important than overall movement patterns (87.1%).

Current evidence. Very little evidence exists comparing postpartum pelvic floor outcomes in active/athletic females and sedentary females. In the general postpartum population, there is evidence that several metrics of pelvic floor muscle (PFM) function—such as ability to volitionally contract the PFMs, vaginal resting pressure (VRP), maximal PFM strength, PFM endurance, measurements of levator hiatus, etc.—are commonly impaired, particularly following vaginal or instrumented vaginal birth.[79,85,86] In addition, continent females have stronger and less fatigable PFMs than incontinent females.[79] Up to 61% of females experience an episiotomy and up to 57% sustain perineal tearing during vaginal birth.[92] Although all degrees of perineal trauma increase the risk for pelvic floor dysfunction (PFD), females who sustain third- or fourth-degree obstetric anal sphincter injuries (OASIS) during childbirth are at a higher risk of experiencing

315 symptoms such as incontinence, pelvic pain, sexual dysfunction, or prolapse.[93] Only 30% of
316 primiparous females with OASIS and 40% of primiparous females with no, or first-degree,
317 perineal tears returned to normal urinary and colorectal function by 6-months postpartum.[93]
318 Forceps-assisted vaginal delivery increases the odds of PFD at 5-10 years after first delivery.[92]
319 Females with PFM defects (such as avulsion) have been shown to have 47% lower strength and
320 endurance, with no difference in VRP, compared to postpartum females without PFM defects.[80]
321 Most females with major defects can contract the PFM correctly, which implies that pelvic floor
322 muscle training (PFMT) might be a worthwhile intervention in this population.[80] Again, it is
323 important to note that the majority of studies in this area have not been conducted in female
324 athletes, and research on these topics in athletic females is necessary to determine if female
325 athletes present similarly. A systematic review and meta-analysis of elite athletes showed no
326 association between athlete status before/during pregnancy with self-reported incidence of
327 urinary and fecal incontinence after childbirth.[24] (Overall level II evidence, with some level I)

328 It is important to note that postpartum PFD may be prevented by PFMT during
329 pregnancy. A Cochrane review by Woodley et al (2020)[94] found that there was a 22% reduced
330 risk of UI in late pregnancy and the "mid-postnatal period" in those who did PFMT during
331 pregnancy. In RCTs of pregnant continent females (primary prevention) who exercise, those
332 training the PFM were 62% less likely to experience UI in late pregnancy and had 29% less risk
333 of UI at 3-6 months postpartum.[94] There was insufficient evidence for effect >12 months
334 postpartum.[94] As many females (45%) do not contract their PFMs correctly (i.e., demonstrate
335 compensatory muscle contractions, such as the gluteal muscles or abdominal muscles, instead of
336 contracting the PFMs), when possible, professional assessment of PFM function and guidance of

PFMT is ideal.[86] Further studies are needed to assess the effect of PFMT on fecal incontinence and POP in the peripartum period. (Level I Evidence)

Impairments in abdominal muscle function have also been reported in postpartum females. Strength and fatigability of the trunk flexor muscles, as well as fatigability of the lumbopelvic stabilizing muscles, has been shown to be impaired in a mixed-sample of postpartum females (i.e., runners and non-runners) up to six months after childbirth compared to nulligravid females.[25,95] Females with diastasis recti abdominis (DRA) demonstrate impaired trunk rotation strength compared to females without DRA at one year postpartum.[96] A systematic review also highlighted a negative impact of DRA on physical functioning.[97] Additionally, some females deliver via Cesarean section, which warrants appropriate consideration of tissue healing and functional recovery.[98] However, to date there are no validated tools for determining such recovery.[98] (Level I to II evidence)

While general muscle strength has not been identified as a risk factor for RRI in the general population[91,99], it has been hypothesized that pregnancy may affect biomechanics.[100] In initial small sample investigations, postpartum runners have weaker hip muscles than nulliparous controls.[101] A Delphi study that investigated impairments in postpartum runners with running-related pain indicated that abdominal, hip, and pelvic floor weakness were all impairments contributing to pain in postpartum runners.[13] (Level II to III evidence)

Recommendation (11/12 authors assent). A return-to-running program should include strengthening exercises in conjunction with a return-to-running plan. Postpartum runners with pelvic health symptoms should receive specific PFMT. From a prevention standpoint, it is ideal to begin PFMT during pregnancy, further emphasizing the need for a multi-disciplinary perinatal care model. Considering the current evidence regarding PFM function in the general postpartum

population, as well as the lack of evidence regarding PFM tissue healing in multiparous females and in athletic females, it is recommended that pelvic health symptoms be monitored throughout training and not just in the initial return-to-running phase. There is also sufficient rationale to support evaluation and strengthening (when necessary) of abdominal muscles after pregnancy and childbirth. As research in postpartum running cohorts is limited but has identified hip weakness in postpartum runners, it is also suggested to evaluate the postpartum runner for weakness in the lower extremity muscles, particularly hip muscles.

Dissenting opinion (1/12 authors): One author disagreed with the recommendation of evaluating for weakness of the lower extremity muscles due to lack of evidence.

[Figure 2]

Discussion

The results of an international Delphi consensus survey of experienced clinical and exercise professionals on the development of a return-to-running exercise plan after childbirth have been contextualized by current scientific literature and refined by an International Panel of researchers and clinical experts in perinatal exercise and rehabilitation. The recommendations provide an initial framework for clinical and exercise professionals to facilitate a postpartum-specific return-to-running plan.

Limitations

Limitations of this study include the relative lack of research evidence in postpartum runners, resulting in the need to extrapolate findings from the general running population and the general postpartum population. In addition, a narrative evidence review was performed instead of a systematic review as our goal was to see what is currently being done in the field, which would

make an *a priori* systematic review impossible. Because we took our search terms/topics for the subsequent comparison with current literature from the Delphi responses, we chose to do a narrative evidence review that would allow us to thoroughly search all of the topics indicated by the Delphi respondents. Respondents were also predominantly white, female physiotherapists, which may bias the consensus survey results. However, this sample does include a broader multi-disciplinary voice than previous expert opinion on this topic. In addition, the author group, which came to consensus on the recommendations, is also composed of individuals from various areas of expertise. Finally, as these recommendations have not been tested in postpartum runners, future research validating this approach is warranted.

Clinical Implications

While some runners are able to return to running after childbirth without major issues, the lack of evidence on postpartum running presents a barrier to both symptomatic and at-risk postpartum females who wish to run, and to healthcare providers who are guiding them. Several expert opinion frameworks on return to running have been proposed by small author groups.[14-18,26,102] However, this consensus statement provides recommendations on the development of a postpartum training program informed by a large, multi-disciplinary, international group of experienced professionals and current research evidence. Widespread distribution of such recommendations may help to minimize barriers to return to running postpartum and provide health and exercise professionals with more detailed, evidence-informed recommendations to apply to runners in their care.

As previously mentioned, many postpartum runners experience pain and/or pelvic health symptoms that may require further evaluation and treatment to facilitate continued engagement

in physical activity and exercise.[6,9,10,12,13] This Delphi survey identified that most clinical and exercise professionals working with postpartum runners primarily see self-paying clients who are self-referred, which highlights two key barriers to postpartum exercise: cost and access. These barriers are not novel findings—a recent systematic review identified financial concerns and healthcare provider knowledge gaps as barriers to postpartum females pursuing a healthy lifestyle (encompassing both nutrition and physical activity/exercise).[23] Health care providers have also acknowledged that financial issues (primarily insurance coverage) and lack of health care access are barriers to postpartum females receiving appropriate postpartum care (not specific to exercise), particularly in regard to low-income postpartum females.[103]

Education needs to be provided to perinatal females regarding resources available on physical activity and exercise engagement. Pelvic floor education is especially needed, as ~26% of postpartum females have no knowledge of the pelvic floor.[86] An international survey of postpartum runners indicated that 62% of runners prefer to receive return-to-running education via websites and physiotherapists; only 41% preferred to receive return-to-running information from their general practitioner.[104] As such, it is also necessary to educate birth providers and primary care practitioners on the importance of referring perinatal runners to rehabilitation and fitness professionals with expertise in perinatal exercise, running, and pelvic health. There is also a need to increase overall accessibility of perinatal rehabilitation/ fitness services, both by increasing the number of educated professionals in these fields and by decreasing financial barriers to obtaining these services. Access to these professionals is especially crucial for elite athletes, and sport policy organizations should be educated on the importance of incorporating a multi-disciplinary team in postpartum training in order to promote gender equity in sport. The need for a multi-disciplinary team is further supported by the importance of monitoring

427 biopsychosocial factors in perinatal care, and by literature regarding management of female
428 athletes.[14-18,105,106] Barriers to physical activity and exercise can negatively impact both maternal
429 and child wellbeing,[56] thus it is crucial to keep the runner running if this is their preferred
430 exercise.

431 Research Implications

432 The postpartum period is notoriously understudied. The dearth of knowledge regarding general
433 postpartum exercise and physical activity, and return to running specifically, leaves both patient
434 and professional with little to no evidence-informed guidance. There is a significant need to
435 establish return-to-run protocols in postpartum runners of all experience levels via high-quality
436 research studies to determine incidence of injury. This consensus statement provides
437 recommendations for program design that should be tested for efficacy. There is also a need for
438 research examining whether inclusion of rehabilitation and fitness professionals throughout the
439 continuum of perinatal care influences postpartum return-to-running timelines, incidence of
440 injury/pelvic health symptoms, and the percentage of runners that can continue running during
441 pregnancy and return after childbirth. In addition, research is needed regarding clinical
442 assessments for postpartum females, including screening tools for REDs for lactating
443 amenorrheic females.[65]

444 Unfortunately, clinical and exercise professionals in this study indicated that most of their
445 clinical decision making on postpartum running is based on non-peer reviewed opinion, with
446 research being listed as the fourth of five sources of information. In addition, health professionals
447 consistently report that they are not trained or up-to-date with best practice recommendations to
448 guide perinatal physical activity.[23,107,108] This highlights not only the critical need for further

high-quality research in postpartum exercise/running, but also the need to make research more accessible to the professionals in the field and the need for clinical leaders in the field to be up-to-date with best practice recommendations. Increasing open access to research may be the key to improved dissemination among professionals and the general public. For example, the first return-to-run postpartum guidance by Goom and colleagues[26]—which was released on the author's website and promoted on social media—led to subsequent research[6,10,104] and their associated British Journal of Sports Medicine blog[109], which has over 69,000 views, highlighting the impact open access dissemination has had in this field. However, costs for publishing research findings in open access formats are often burdensome for researchers, especially in a field where research funding can be difficult to obtain.[15]

Sport Policy Implications

The need for policy and contract protections for pregnant and postpartum athletes has received significant attention in recent years.[4,5,53] While there is evidence to support that return to physical activity and exercise can safely happen early in the postpartum period for some females[36,37,110], there is also evidence of injury risk and pelvic health symptoms in athletes following childbirth.[9,10,21,24,35] As such, the highly individualized nature of pregnancy, childbirth and postpartum recovery provide strong rationale for supporting protected recovery time for postpartum female athletes. Evidence on pelvic health symptoms, running-related pain, running-related injuries, and bone stress injuries in postpartum athletic females suggests rate of training progression may be more closely associated with injury risk than when physical activity/exercise is first initiated in the postpartum period.[8-10,24] This further supports the need for protected leave to allow gradual return-to-exercise and gradual progression of exercise to minimize injury risk. Furthermore, elite athletes have reported that a more generous time frame for return-to-sport

would have lessened the challenges they faced when attempting to return to competition.[5] Elite athletes have also admitted to a more accelerated progression of exercise due to pressure from sponsoring agencies and/or coaches of returning to top performance within such a short period of time.[5] In addition to physical recovery, there are many other reasons to support protected maternity leave policies not only for athletes, but for all postpartum females. These include, but are not limited to, promoting parent-child bonding, lactation struggles, mental health concerns, sleep quality issues associated with the postpartum period, and time constraints for seeking out professional care for perinatal issues. Sport policy makers and agencies that sponsor elite athletes have an obligation to promote the health and well-being of postpartum athletes by acknowledging appropriate timelines for initiation and safe progression of exercise in the context of postpartum recovery and providing funding and access to a multidisciplinary health care team.

Conclusion

Research and consensus from clinical and exercise professionals support the recommendation that physical activity and exercise should be initiated at a low level (i.e., low-impact, low-moderate intensity) after childbirth and gradually progressed, while consistently monitoring for the following: (1) pelvic health symptoms; (2) musculoskeletal pain; (3) sleep; (4) mental health concerns (including, but not limited to, anxiety, depression, and maternal-infant bonding); and (5) energy availability. There is a need for evidence informed return-to-run guidance to be freely and easily accessible to the public so that postpartum females can be informed and empowered to carry out a basic self-screen if necessary due to lack of available and affordable local healthcare providers. Furthermore, there is an urgent need to improve interest in and accessibility of evidence-based courses and/or literature to ensure that clinicians and fitness professionals are up-to-date with current best practices. There is also critical need to support protected parental leave

to allow for recovery and safe, gradual progression of PA and exercise, as well as improved social support of postpartum females. Further research is needed in all aspects of postpartum exercise, with a concurrent need to increase the available research funding for investigation of postpartum exercise to allow for creation of evidence-based guidelines.

Key Points:

What is already known on this topic: • Running is associated with high rates of pain and injury both in the general population and following childbirth. • High quality evidence on designing a return-to-running training programme is limited
What this study adds: • Some period of recovery (i.e., relative rest) is recommended after childbirth; the length of the recovery period will be specific to each individual's pregnancy, birth and postpartum experience. • A gradual exercise progression is recommended to facilitate cardiorespiratory and muscular reconditioning prior to initiating running. • Progression or regression of exercise training should be determined by a number of biopsychosocial factors, including sleep quality/quantity, mental health status, lactation status, social support, socioeconomic status, and musculoskeletal dysfunction (including pain and pelvic health symptoms). • Strengthening exercises for trunk and lower extremity muscles are important prior to and after returning to running. • The majority of experienced professionals in postpartum running treat clients who self-pay for services, highlighting cost as a potential barrier for some postpartum runners to seek professional guidance.
How this study might affect research, practice, or policy: • A high incidence of injury and/or pain in postpartum runners (elite and recreational) highlights the need for a gradual progression of training. • Due to limited evidence and athlete calls for improved guidance on postpartum training, further research is needed in postpartum runners to determine best practice for designing and progressing a training program. • Maternity leave protections are necessary to allow sufficient time to implement a gradual progression of exercise and training.

REFERENCES

1. Andersen JJ. The State of Running 2019. International Association of Athletics Federations. RunRepeat.com Web site. https://runrepeat.com/state-of-running?fbclid=IwAR3x_Z4MeyKxCaLBwOTBL8uSqcAnz64s5H_Lh8aGHbsm72GxRz_G4Su1zcU. Published 2021. Accessed May 2, 2023.
2. Allyson Felix. International Olympic Committee. https://olympics.com/en/athletes/allyson-felix. Published 2023. Accessed 27 June, 2023.
3. Unexpected Pregnancy Complications: Allyson Felix's Story. Centers for Disease Control and Prevention. HEAR HER Campaign Web site. https://www.cdc.gov/hearher/allysonfelix/index.html#:~:text=Yet%20with%20two%20months%20to,the%20neonatal%20intensive%20care%20unit. Published 2022. Updated November 21, 2022. Accessed October 2, 2023.
4. Davenport MH, Nesdoly A, Ray L, Thornton JS, Khurana R, McHugh TF. Pushing for change: a qualitative study of the experiences of elite athletes during pregnancy. *Br J Sports Med.* 2022.
5. Davenport MH, Ray L, Nesdoly A, Thornton J, Khurana R, McHugh TF. We're not Superhuman, We're Human: A Qualitative Description of Elite Athletes' Experiences of Return to Sport After Childbirth. *Sports Med.* 2023;53(1):269-279.
6. James ML, Moore IS, Donnelly GM, Brockwell E, Perkins J, Coltman CE. Running During Pregnancy and Postpartum, Part A: Why Do Women Stop Running During Pregnancy and Not Return to Running in the Postpartum Period? *Journal of Women's Health Physical Therapy.* 2022;46(3):111-123.
7. Felix A. Allyson Felix: My Own Nike Pregnancy Story. *The New York Times.* May 22, 2019, 2019.
8. Darroch F, Schneeberg A, Brodie R, et al. Effect of Pregnancy in 42 Elite to World-Class Runners on Training and Performance Outcomes. *Med Sci Sports Exerc.* 2023;55(1):93-100.
9. Christopher SM, Cook CE, Snodgrass SJ. What are the biopsychosocial risk factors associated with pain in postpartum runners? Development of a clinical decision tool. *PLoS One.* 2021;16(8):e0255383.
10. Moore IS, James ML, Brockwell E, Perkins J, Jones AL, Donnelly GM. Multidisciplinary, biopsychosocial factors contributing to return to running and running related stress urinary incontinence in postpartum women. *Br J Sports Med.* 2021.
11. van Gent RN, Siem D, van Middelkoop M, van Os AG, Bierma-Zeinstra SM, Koes BW. Incidence and determinants of lower extremity running injuries in long distance runners: a systematic review. *Br J Sports Med.* 2007;41(8):469-480; discussion 480.
12. Christopher S, McCullough J, Snodgrass S, Cook C. Predictive Risk Factors for First-Onset Lumbopelvic Pain in Postpartum Women: A Systematic Review. *Journal of Women's Health Physical Therapy.* 2019;43(3):127-135.
13. Christopher SM, Garcia AN, Snodgrass SJ, Cook C. Common musculoskeletal impairments in postpartum runners: an international Delphi study. *Arch Physiother.* 2020;10:19.
14. Christopher SM, Gallagher S, Olson A, Cichowski S, Deering RE. Rehabilitation of the Postpartum Runner: A 4-Phase Approach. *Journal of Women's Health Physical Therapy.* 2022.
15. Deering RE, Christopher SM, Heiderscheit BC. From Childbirth to the Starting Blocks: Are We Providing the Best Care to Our Postpartum Athletes? *J Orthop Sports Phys Ther.* 2020;50(6):281-284.
16. Donnelly G, Brockwell E, Rankin A, Moore I. Beyond the Musculoskeletal System: Considering Whole-Systems Readiness for Running Postpartum *Journal of Women's Health Physical Therapy.* 2022;46(1):48-56.

17. Donnelly GM, Moore IS, Brockwell E, Rankin A, Cooke R. Reframing return-to-sport postpartum: the 6 Rs framework. *Br J Sports Med.* 2022;56(5):244-245.
18. Donnelly GM, Rankin A, Mills H, DE Vivo M, Goom TS, Brockwell E. Infographic. Guidance for medical, health and fitness professionals to support women in returning to running postnatally. *Br J Sports Med.* 2020;54(18):1114-1115.
19. Ardern CL, Glasgow P, Schneiders A, et al. 2016 Consensus statement on return to sport from the First World Congress in Sports Physical Therapy, Bern. *Br J Sports Med.* 2016;50(14):853-864.
20. Brinlee AW, Dickenson SB, Hunter-Giordano A, Snyder-Mackler L. ACL Reconstruction Rehabilitation: Clinical Data, Biologic Healing, and Criterion-Based Milestones to Inform a Return-to-Sport Guideline. *Sports Health.* 2022;14(5):770-779.
21. Blyholder L, Chumanov E, Carr K, Heiderscheit B. Exercise Behaviors and Health Conditions of Runners After Childbirth. *Sports Health.* 2017;9(1):45-51.
22. Gavin NI, Gaynes BN, Lohr KN, Meltzer-Brody S, Gartlehner G, Swinson T. Perinatal depression: a systematic review of prevalence and incidence. *Obstet Gynecol.* 2005;106(5 Pt 1):1071-1083.
23. Makama M, Awoke MA, Skouteris H, Moran LJ, Lim S. Barriers and facilitators to a healthy lifestyle in postpartum women: A systematic review of qualitative and quantitative studies in postpartum women and healthcare providers. *Obes Rev.* 2021;22(4):e13167.
24. Kimber ML, Meyer S, McHugh TL, et al. Health Outcomes following Pregnancy in Elite Athletes: A Systematic Review and Meta-analysis. *Med Sci Sports Exerc.* 2021.
25. Deering RE, Cruz M, Senefeld JW, Pashibin T, Eickmeyer S, Hunter SK. Impaired Trunk Flexor Strength, Fatigability, and Steadiness in Postpartum Women. *Med Sci Sports Exerc.* 2018;50(8):1558-1569.
26. Goom T, Donnelly G, Brockwell E. Return to running postnatal--guidelines for medical, health and fitness professionals managing this population. In. *The Running Physio*2019.
27. Christopher S, Donnelly GM, Brockwell E, et al. Expert Opinion on Determing Return-to-Running Readiness After Childbirth: An International Delphi Consensus Statement. *Br J Sports Med.* 2023;*in review*.
28. Rowe G, Wright G. The Delphi technique as a forecasting tool: issues and analysis. *International Journal of Forecasting.* 1999;15(4):353-375.
29. Jünger S, Payne SA, Brine J, Radbruch L, Brearley SG. Guidance on Conducting and REporting DElphi Studies (CREDES) in palliative care: Recommendations based on a methodological systematic review. *Palliat Med.* 2017;31(8):684-706.
30. Niederberger M, Spranger J. Delphi Technique in Health Sciences: A Map. *Front Public Health.* 2020;8:457.
31. Hasson F, Keeney S, McKenna H. Research guidelines for the Delphi survey technique. *J Adv Nurs.* 2000;32(4):1008-1015.
32. McMillan SS, King M, Tully MP. How to use the nominal group and Delphi techniques. *Int J Clin Pharm.* 2016;38(3):655-662.
33. Diamond IR, Grant RC, Feldman BM, et al. Defining consensus: a systematic review recommends methodologic criteria for reporting of Delphi studies. *J Clin Epidemiol.* 2014;67(4):401-409.
34. Sackett DL. Rules of evidence and clinical recommendations on the use of antithrombotic agents. *Chest.* 1989;95(2 Suppl):2S-4S.
35. Bo K, Artal R, Barakat R, et al. Exercise and pregnancy in recreational and elite athletes: 2016/17 evidence summary from the IOC Expert Group Meeting, Lausanne. Part 3--exercise in the postpartum period. *British Journal of Sports Medicine.* 2017;51:1516-1525.
36. Tennfjord MK, Engh ME, Bø K. The Influence of Early Exercise Postpartum on Pelvic Floor Muscle Function and Prevalence of Pelvic Floor Dysfunction 12 Months Postpartum. *Phys Ther.* 2020;100(9):1681-1689.

37. Nygaard IE, Wolpern A, Bardsley T, Egger MJ, Shaw JM. Early postpartum physical activity and pelvic floor support and symptoms 1 year postpartum. *Am J Obstet Gynecol.* 2021;224(2):193.e191-193.e119.
38. Hilal N, Nassar AH. Postpartum sacral stress fracture: a case report. *BMC Pregnancy Childbirth.* 2016;16:96.
39. Speziali A, Tei MM, Placella G, Chillemi M, Cerulli G. Postpartum Sacral Stress Fracture: An Atypical Case Report. *Case Rep Orthop.* 2015;2015:704393.
40. Harrast MA, Colonno D. Stress fractures in runners. *Clin Sports Med.* 2010;29(3):399-416.
41. Liem BC, Truswell HJ, Harrast MA. Rehabilitation and return to running after lower limb stress fractures. *Curr Sports Med Rep.* 2013;12(3):200-207.
42. Ristolainen L, Kettunen JA, Waller B, Heinonen A, Kujala UM. Training-related risk factors in the etiology of overuse injuries in endurance sports. *J Sports Med Phys Fitness.* 2014;54(1):78-87.
43. Ramskov D, Rasmussen S, Sørensen H, Parner ET, Lind M, Nielsen R. Progression in Running Intensity or Running Volume and the Development of Specific Injuries in Recreational Runners: Run Clever, a Randomized Trial Using Competing Risks. *J Orthop Sports Phys Ther.* 2018;48(10):740-748.
44. Nielsen R, Parner ET, Nohr EA, Sørensen H, Lind M, Rasmussen S. Excessive progression in weekly running distance and risk of running-related injuries: an association which varies according to type of injury. *J Orthop Sports Phys Ther.* 2014;44(10):739-747.
45. Watson AM. Sleep and Athletic Performance. *Curr Sports Med Rep.* 2017;16(6):413-418.
46. McGuire E. Maternal and infant sleep postpartum. *Breastfeed Rev.* 2013;21(2):38-41.
47. Edie R, Lacewell A, Streisel C, et al. Barriers to Exercise in Postpartum Women: A Mixed-Methods Systematic Review. *The Journal of Women's Health Physical Therapy.* 2021;45(2):83-92.
48. Tsuchiya M, Mori E, Sakajo A, Iwata H, Maehara K, Tamakoshi K. Cross-sectional and longitudinal validation of a 13-item fatigue scale among Japanese postpartum mothers. *Int J Nurs Pract.* 2016;22 Suppl 1:5-13.
49. Kredlow MA, Capozzoli MC, Hearon BA, Calkins AW, Otto MW. The effects of physical activity on sleep: a meta-analytic review. *J Behav Med.* 2015;38(3):427-449.
50. Wang F, Boros S. The effect of physical activity on sleep quality: a systematic review. *European Journal of Physiotherapy.* 2021;23(1):11-18.
51. Choong SYX, Tan XYJ, Cheng LJ, Lau Y. Effectiveness of Exercise in Improving Sleep Outcomes among Perinatal Women: A Systematic Review and Meta-analysis of randomised Controlled Trials. *Behav Sleep Med.* 2022;20(4):410-428.
52. Ryan RA, Lappen H, Bihuniak JD. Barriers and Facilitators to Healthy Eating and Physical Activity Postpartum: A Qualitative Systematic Review. *J Acad Nutr Diet.* 2022;122(3):602-613.e602.
53. Darroch FE, Giles AR, Hillsburg H, McGettigan-Dumas R. Running from responsibility: athletic governing bodies, corporate sponsors, and the failure to support pregnant and postpartum elite female distance runners. *Sport in Society.* 2019;22(12):2141-2160.
54. Biaggi A, Conroy S, Pawlby S, Pariante CM. Identifying the women at risk of antenatal anxiety and depression: A systematic review. *J Affect Disord.* 2016;191:62-77.
55. Coast E, Leone T, Hirose A, Jones E. Poverty and postnatal depression: a systematic mapping of the evidence from low and lower middle income countries. *Health Place.* 2012;18(5):1188-1197.
56. Glover V. Prenatal stress and its effects on the fetus and the child: possible underlying biological mechanisms. *Adv Neurobiol.* 2015;10:269-283.
57. McCurdy AP, Boulé NG, Sivak A, Davenport MH. Effects of Exercise on Mild-to-Moderate Depressive Symptoms in the Postpartum Period: A Meta-analysis. *Obstet Gynecol.* 2017;129(6):1087-1097.

58. Dietary Energy. In: NHMRC, ed. *Nutrient Reference Values for Australia and New Zealand Including Recommended Dietary Intakes.* Commonwealth of Australia2006.
59. Wang D, Thielecke F, Fleith M, et al. Analysis of dietary patterns and nutritional adequacy in lactating women: a multicentre European cohort (ATLAS study). *J Nutr Sci.* 2021;10:e17.
60. Whitney KE, Holtzman B, Cook D, et al. Low energy availability and impact sport participation as risk factors for urinary incontinence in female athletes. *J Pediatr Urol.* 2021;17(3):290.e291-290.e297.
61. Carvalhais A, Araújo J, Natal Jorge R, Bø K. Urinary incontinence and disordered eating in female elite athletes. *J Sci Med Sport.* 2019;22(2):140-144.
62. Holtzman B, Ackerman KE. Recommendations and Nutritional Considerations for Female Athletes: Health and Performance. *Sports Med.* 2021;51(Suppl 1):43-57.
63. Mountjoy M, Sundgot-Borgen JK, Burke LM, et al. IOC consensus statement on relative energy deficiency in sport (RED-S): 2018 update. *Br J Sports Med.* 2018;52(11):687-697.
64. Mountjoy M, Ackerman K, Bailey D, et al. The 2023 International Olympic Committee's (IOC) consensus statement on Relative Energy Deficiency in Sports (REDs). *British Journal of Sports Medicine.* 2023;[in review].
65. Deering RE, Mountjoy M. REDs and the Lactating Athlete: An Evidence Gap. *British Journal of Sports Medicine.* 2023;in press.
66. Lawrence RM, Lawrence RA. The Breast and the Physiology of Lactation. In: Lockwood CJ, Copel JA, Dugoff L, et al., eds. *Creasy and Resnik's Maternal-Fetal Medicine: Principles and Practice.* Ninth ed.: Elsevier; 2019.
67. Mountjoy M, Sundgot-Borgen J, Burke L, et al. The IOC consensus statement: beyond the Female Athlete Triad--Relative Energy Deficiency in Sport (RED-S). *Br J Sports Med.* 2014;48(7):491-497.
68. Mountjoy M, Sundgot-Borgen J, Burke L, et al. The IOC relative energy deficiency in sport clinical assessment tool (RED-S CAT). *Br J Sports Med.* 2015;49(21):1354.
69. Mountjoy M, Sundgot-Borgen J, Burke L, et al. RED-S CAT. Relative Energy Deficiency in Sport (RED-S) Clinical Assessment Tool (CAT). *Br J Sports Med.* 2015;49(7):421-423.
70. Be'er M, Mandel D, Yelak A, Gal DL, Mangel L, Lubetzky R. The Effect of Physical Activity on Human Milk Macronutrient Content and Its Volume. *Breastfeed Med.* 2020;15(6):357-361.
71. Osman DA, Yousef AM, El-Badry S, El-Taweel AA, Hamada HA, Hasanin ME. Impact of moderate exercise on breast milk cortisol in healthy lactating women: A randomized controlled trial. *EurAsian Journal of BioSciences.* 2020;14:1113-1117.
72. Carey GB, Quinn TJ, Goodwin SE. Breast milk composition after exercise of different intensities. *J Hum Lact.* 1997;13(2):115-120.
73. Damsted C, Parner ET, Sørensen H, Malisoux L, Hulme A, Nielsen R. The Association Between Changes in Weekly Running Distance and Running-Related Injury: Preparing for a Half Marathon. *J Orthop Sports Phys Ther.* 2019;49(4):230-238.
74. Damsted C, Glad S, Nielsen RO, Sørensen H, Malisoux L. IS THERE EVIDENCE FOR AN ASSOCIATION BETWEEN CHANGES IN TRAINING LOAD AND RUNNING-RELATED INJURIES? A SYSTEMATIC REVIEW. *Int J Sports Phys Ther.* 2018;13(6):931-942.
75. Linton L, Valentin S. Running with injury: A study of UK novice and recreational runners and factors associated with running related injury. *J Sci Med Sport.* 2018;21(12):1221-1225.
76. American College of Sports Medicine, Liguori G, Feito Y, Fountaine C, Roy B. ACSM's guidelines for exercise testing and prescription. In: Eleventh edition. ed. Philadelphia: Wolters Kluwer,; 2021.
77. Jackson T, Bostock EL, Hassan A, Greeves JP, Sale C, Elliott-Sale KJ. The Legacy of Pregnancy: Elite Athletes and Women in Arduous Occupations. *Exerc Sport Sci Rev.* 2022;50(1):14-24.

78. Guzmán Rojas R, Wong V, Shek KL, Dietz HP. Impact of levator trauma on pelvic floor muscle function. *Int Urogynecol J.* 2014;25(3):375-380.
79. Hilde G, Stær-Jensen J, Siafarikas F, Engh ME, Brækken IH, Bø K. Impact of childbirth and mode of delivery on vaginal resting pressure and on pelvic floor muscle strength and endurance. *Am J Obstet Gynecol.* 2013;208(1):50.e51-57.
80. Hilde G, Staer-Jensen J, Siafarikas F, Gjestland K, Ellström Engh M, Bø K. How well can pelvic floor muscles with major defects contract? A cross-sectional comparative study 6 weeks after delivery using transperineal 3D/4D ultrasound and manometer. *BJOG.* 2013;120(11):1423-1429.
81. Martin-Martin S, Pascual-Fernandez A, Alvarez-Colomo C, Calvo-Gonzalez R, Muñoz-Moreno M, Cortiñas-Gonzalez JR. Urinary incontinence during pregnancy and postpartum. Associated risk factors and influence of pelvic floor exercises. *Arch Esp Urol.* 2014;67(4):323-330.
82. Nygaard IE, Shaw JM. Physical activity and the pelvic floor. *Am J Obstet Gynecol.* 2016;214(2):164-171.
83. Reimers C, Siafarikas F, Stær-Jensen J, Småstuen MC, Bø K, Ellström Engh M. Risk factors for anatomic pelvic organ prolapse at 6 weeks postpartum: a prospective observational study. *Int Urogynecol J.* 2019;30(3):477-482.
84. Shin GH, Toto EL, Schey R. Pregnancy and postpartum bowel changes: constipation and fecal incontinence. *Am J Gastroenterol.* 2015;110(4):521-529; quiz 530.
85. Stær-Jensen J, Siafarikas F, Hilde G, Benth J, Bø K, Engh ME. Postpartum recovery of levator hiatus and bladder neck mobility in relation to pregnancy. *Obstet Gynecol.* 2015;125(3):531-539.
86. Vermandel A, De Wachter S, Beyltjens T, D'Hondt D, Jacquemyn Y, Wyndaele JJ. Pelvic floor awareness and the positive effect of verbal instructions in 958 women early postdelivery. *Int Urogynecol J.* 2015;26(2):223-228.
87. Wallace SL, Miller LD, Mishra K. Pelvic floor physical therapy in the treatment of pelvic floor dysfunction in women. *Curr Opin Obstet Gynecol.* 2019;31(6):485-493.
88. Hadizadeh-Talasaz Z, Sadeghi R, Khadivzadeh T. Effect of pelvic floor muscle training on postpartum sexual function and quality of life: A systematic review and meta-analysis of clinical trials. *Taiwan J Obstet Gynecol.* 2019;58(6):737-747.
89. de Mattos Lourenco TR, Matsuoka PK, Baracat EC, Haddad JM. Urinary incontinence in female athletes: a systematic review. *Int Urogynecol J.* 2018;29(12):1757-1763.
90. Forner LB, Beckman EM, Smith MD. Do women runners report more pelvic floor symptoms than women in CrossFit®? A cross-sectional survey. *Int Urogynecol J.* 2020.
91. Christopher SM, McCullough J, Snodgrass SJ, Cook C. Do alterations in muscle strength, flexibility, range of motion, and alignment predict lower extremity injury in runners: a systematic review. *Arch Physiother.* 2019;9:2.
92. Handa VL, Blomquist JL, McDermott KC, Friedman S, Muñoz A. Pelvic floor disorders after vaginal birth: effect of episiotomy, perineal laceration, and operative birth. *Obstet Gynecol.* 2012;119(2 Pt 1):233-239.
93. Tilak M, Mann GK, Gong M, Koenig NA, Lee T, Geoffrion R. Pelvic floor healing milestones after obstetric anal sphincter injury: a prospective case control feasibility study. *Int Urogynecol J.* 2023;34(2):553-561.
94. Woodley SJ, Lawrenson P, Boyle R, et al. Pelvic floor muscle training for preventing and treating urinary and faecal incontinence in antenatal and postnatal women. *Cochrane Database Syst Rev.* 2020;5(5):CD007471.
95. Deering RE, Senefeld J, Pashibin T, Neumann DA, Cruz M, Hunter SK. Fatigability of the Lumbopelvic Stabilizing Muscles in Women 8 and 26 Weeks Postpartum. *J Womens Health Phys Therap.* 2018;42(3):128-138.

96. Hills NF, Graham RB, McLean L. Comparison of Trunk Muscle Function Between Women With and Without Diastasis Recti Abdominis at 1 Year Postpartum. *Phys Ther.* 2018;98(10):891-901.
97. Fuentes Aparicio L, Rejano-Campo M, Donnelly GM, Vicente-Campos V. Self-reported symptoms in women with diastasis rectus abdominis: A systematic review. *J Gynecol Obstet Hum Reprod.* 2021;50(7):101995.
98. Sharawi N, Klima L, Shah R, Blake L, Carvalho B, Sultan P. Evaluation of patient-reported outcome measures of functional recovery following caesarean section: a systematic review using the consensus-based standards for the selection of health measurement instruments (COSMIN) checklist. *Anaesthesia.* 2019;74(11):1439-1455.
99. Peterson B, Hawke F, Spink M, et al. Biomechanical and Musculoskeletal Measurements as Risk Factors for Running-Related Injury in Non-elite Runners: A Systematic Review and Meta-analysis of Prospective Studies. *Sports Med Open.* 2022;8(1):38.
100. Conder R, Zamani R, Akrami M. The Biomechanics of Pregnancy: A Systematic Review. *J Funct Morphol Kinesiol.* 2019;4(4).
101. Christopher SM, Bauer L, Maylone R, et al. Biomechanical and Musculoskeletal Differences Between Postpartum Runners and Nulliparous Controls. *Journal of Women's Health Physical Therapy.* 2022;46(1):11-17.
102. Selman R, Early K, Battles B, Seidenburg M, Wendel E, Westerlund S. Maximizing Recovery in the Postpartum Period: A Timeline for Rehabilitation from Pregnancy through Return to Sport. *Int J Sports Phys Ther.* 2022;17(6):1170-1183.
103. Ruderman RS, Dahl EC, Williams BR, et al. Provider Perspectives on Barriers and Facilitators to Postpartum Care for Low-Income Individuals. *Womens Health Rep (New Rochelle).* 2021;2(1):254-262.
104. Donnelly G, James M, Coltman C, Brockwell E, Perkins J, Moore I. Running During Pregnancy and Postpartum, Part B: How Does Running-Related Advice and Guidance Received During Pregnancy and Postpartum Affect Women's Running Habits? *Journal of Women's Health Physical Therapy.* 2022;46(3):124-131.
105. Tanaka MJ, Szymanski LM, Dale JL, Dixit S, Jones LC. Team Approach: Treatment of Injuries in the Female Athlete: Multidisciplinary Considerations for Women's Sports Medicine Programs. *JBJS Rev.* 2019;7(1):e7.
106. Chalmers B, Mangiaterra V, Porter R. WHO principles of perinatal care: the essential antenatal, perinatal, and postpartum care course. *Birth.* 2001;28(3):202-207.
107. Hayman M, Reaburn P, Alley S, Cannon S, Short C. What exercise advice are women receiving from their healthcare practitioners during pregnancy? *Women Birth.* 2020;33(4):e357-e362.
108. Whitaker KM, Wilcox S, Liu J, Blair SN, Pate RR. Provider Advice and Women's Intentions to Meet Weight Gain, Physical Activity, and Nutrition Guidelines During Pregnancy. *Matern Child Health J.* 2016;20(11):2309-2317.
109. Donnelly GM, Brockwell E, Goom T. Ready, steady…GO! Ensuring postnatal women are run-ready! In. *British Journal of Sports Medicine Blog.* Vol 20232019.
110. Physical Activity and Exercise During Pregnancy and the Postpartum Period: ACOG Committee Opinion, Number 804. *Obstet Gynecol.* 2020;135(4):e178-e188.

782 TABLE 1. Respondent Group Demographics

	Round 1	Round 2	Round 3
Total number of surveys started (n)	**144**	**108**	**96**
Total number of surveys completed (n)	**118**	**107**	**95**
Physical Therapist/Physiotherapist	96	88	80
Occupational Therapist	1	1	1
Personal Trainer	8	7	6
Chiropractor	1	1	0
Exercise Physiologist	5	4	4
Physician	5	4	3
Run Coach	1	2	1
Completion Rate (%)	**82**	**99**	**99**
Years in current profession (n)			
0-4 years	10	10	8
5-9 years	27	24	22
10-14 years	36	31	28
15-19 years	20	18	15
20+ years	25	24	22
Years working with postpartum runners (years)			
Mean	8.85	8.99	8.93
Range	1-30	1-30	1-30
Percentage of caseload consisting of postpartum runners (n)			
0-24%	65	57	52
25-49%	37	35	31
50-74%	15	14	11
75-100%	1	1	1
Gender identity of respondents (n)			
Woman	116	105	93
Man	2	2	2
Age (years)			
Mean	38.9	39.0	39.2
Range	23-63	23-63	23-63
Race/ethnicity of respondents (n)			
White	114	103	92
Black/African American	2	2	1
Asian	3	3	3
Other	1	1	1
Respondents who identify as a runner (n)			
Yes	86	79	70
No	32	28	25
Have the respondents themselves given birth? (n)			

Yes	65	60	51
No	21	19	19
Preferred not to answer	32	28	25
Trained in internal pelvic floor muscle assessment? (n)			
Yes		72	75
No, refers to pelvic floor trained provider		20	20
No, relies on symptom reports from patient		6	0
No Response		9	0

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TABLE 2. Respondent Group Reported Sources of Referral of Postpartum Runners

	Round 1 (n)	**Round 2 (n)**	**Round 3 (n)**
Primary Care Provider	77	68	62
Birth provider (OB/GYN, midwife)	69	62	54
Urogynecologist	5	5	5
Self-referral by client	108	98	89
Running club	2	2	2
Chiropractor	5	5	5
Word of mouth (social media, mother's groups, other clients, family/friends, etc.)	9	8	9
Fitness professionals (personal trainers, pilates instructors, yoga instructors, etc.)	19	16	14
Perinatal Exercise Classes	1	1	0
Coaches (running coaches, triathlon coaches, etc.)	7	6	6
Health Visitor	14	14	11
Allied health professionals (massage therapists, acupuncturists, naturopathic providers, etc.)	6	5	5
Physical Therapist/Physiotherapist	17	16	15

788 TABLE 3. Experienced Professional Report Payment Sources

Payment Source(s)	Round 1 (n)	Round 2 (n)	Round 3 (n)
Insurance only	22	19	19
Private pay only	50	45	41
National Health Service (NHS) only	4	4	2
Military	2	2	2
NHS + insurance + private pay	7	7	6
Insurance + private pay	35	32	27

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TABLE 4. Experienced Professional Reported Sources of Information to Inform Clinical Decision Making When Working with Postpartum Runners

INFORMATION SOURCE	%
Expert opinion	68.6
Personal Experience	55.9
Organization sponsored continuing education	48.3
Research literature	41.5
Social media	6.8

795 TABLE 5. Experienced Profession Consensus on Mileage vs. Time Considerations for

796 Postpartum Run-Training

Theme for run training	Agree/ Strongly Agree (%)	Disagree/ Strongly Disagree (%)	Agree/ Strongly Agree (%)	Disagree/ Strongly Disagree (%)
Time-based progression (e.g., run for 1 minute, walk for 2 minutes) is better than distance-based progression (e.g., run 0.25 miles, walk 0.5 miles)	66	34	73.8	26.2
An ideal starting point for a time-based running progression is a walk-run interval with 30 second intervals of running to start, with 1-2 minutes of walking between each interval.			**81**	19
Distance-based progression (e.g., run 0.25 miles, walk 0.5 miles) is better than time-based progression (e.g., run for 1 minute, walk for 2 minutes)	4	**96**	1.2	**98.8**
An ideal starting point for a mileage-based running progression is 0.25 miles			64.7	35.3
An ideal starting point for a mileage-based running progression is 0.5 miles			44.1	55.6
An ideal starting point for a mileage-based running progression is 1 mile			25	**75**

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TABLE 6. Experienced Professional Consensus on Progression of the Postpartum Run-Training Program.

Theme for run training	Round II		Round III	
	Agree/ Strongly Agree (%)	**Disagree/ Strongly Disagree (%)**	**Agree/ Strongly Agree (%)**	**Disagree/ Strongly Disagree (%)**
It is important to only change one parameter at a time (e.g., distance, speed, incline, etc.)	**93**	7	**98.8**	1.2
It is important not to progress running volume by more than 10% per week in most cases.	**80**	20	**87.1**	12.9
It is important to progress distance first, then progress intensity	62	38	62.4	37.7
It is important to achieve mileage goals first, then add speed and tempo work	50	50	37.7	62.4
It is important to train overall functional mobility (e.g. thoracic rotation, hip range of motion, etc.) and flexibilty (e.g., hamstring length, hip flexor length, etc.) while progressing running volume	**95**	5	**97.7**	2.4
It is important to use a pre-packaged, set program (such as a "couch to 5K" program) to dictate run progression parameters	14	**86**	3.6	**96.4**
Runners should be educated to stop running and return to walking if pelvic health symptoms (e.g., incontinence, vaginal heaviness, vaginal pressure, etc.) arise during the run portion of a walk-run interval training session	**82**	18	**86.9**	13.1
Runners should be educated that they can complete the full run portions of a walk-run interval training session if pelvic health symptoms (e.g., incontinence, vaginal heaviness, vaginal pressure, etc.) arise during the running portion	18	**82**	10.7	**89.3**

804 TABLE 7. Experienced Professional Consensus On Muscle Groups To Target With Exercise
805 Before and During Run Training

	Prior to Initiating Running		**Throughout Run Training**	
Muscle Group	**Agree/Strongly Agree in Round II (%)**	**Agree/Strongly Agree in Round III (%)**	**Agree/Strongly Agree in Round II (%)**	**Agree/Strongly Agree in Round III (%)**
Pelvic Floor Muscles	**98.4**	**100**	**87.2**	**94.1**
Abdominal Muscles (deep and superficial)	**98.9**	**98.8**	**91.5**	**96.5**
Hamstrings	**92.6**	**95.3**	**90.4**	**96.5**
Quads	**93.6**	**98.8**	**86.2**	**98.8**
Gastroc/soleus	**94.7**	**98.8**	**89.4**	**98.8**
Instrinsic foot muscles	**86.2**	**90.6**	**80.9**	**89.4**
Back extensors	**77.7**	**80**	74.5	**76.5**
Hip extensors	**98.9**	**98.8**	**96.8**	**98.8**
Hip abductors	**98.9**	**97.7**	**97.9**	**98.8**
Hip rotators	**95.7**	**96.5**	**93.6**	**98.8**
Diaphragm	**88.3**	**92.9**	**81.9**	**90.6**

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FIGURE 1. CREDES flowchart of study development, piloting, recruitment, and survey distribution.

FIGURE 2. Infographic summarizing the recommendations for designing a postpartum return-to-running training plan.