Multidisciplinary, biopsychosocial factors contributing to return to running and running related stress urinary incontinence in postpartum women

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ABSTRACT

Objectives To examine contributory factors behind postpartum return-to-running and return to pre-pregnancy running level, in addition to risk factors for postpartum running-related stress urinary incontinence (SUI).

Methods 881 postpartum women completed an online questionnaire. Clinically and empirically derived questions were created relating to running experiences and multidisciplinary, biopsychosocial contributory factors. Logistic regression was used to determine predictors for return-to-running, returning to pre-pregnancy level of running and running-related SUI.

Results Median time to first postpartum run was 12 weeks. Running during pregnancy (OR: 2.81 (1.90 to 4.15)), a high weekly running volume (OR: 1.79 (1.22 to 2.63)), lower fear of movement (OR: 0.53 (0.43 to 0.64)) and not suffering vaginal heaviness (OR: 0.52 (0.35–0.76)) increased the odds of return-to-running. Factors that increased the odds of returning to pre-pregnancy running level were a low weekly running volume (OR: 0.38 (0.26 to 0.56)), having more than one child (OR: 2.09 (1.43 to 3.05)), lower fear of movement (OR: 0.78 (0.65 to 0.94)), being younger (OR: 0.79 (0.65 to 0.96)) and shorter time to running after childbirth (OR: 0.74 (0.60 to 0.90)). Risk factors for running-related SUI were having returned to running (OR: 2.70 (1.51 to 4.76)) and suffering running-related SUI pre-pregnancy (OR: 4.01 (2.05 to 7.82)) and during pregnancy (OR: 4.49 (2.86 to 7.06)); having a caesarean delivery decreased the odds (OR: 0.39 (0.23 to 0.65)).

Conclusion Running during pregnancy may assist women safely return-to-running postpartum. Fear of movement, the sensation of vaginal heaviness and running-related SUI before or during pregnancy should be addressed early by healthcare providers.

INTRODUCTION

Running has several physical and mental health benefits.[1] Engagement with running by women is increasing and is a common activity in postpartum women,[2 3] given its ease of access and, minimal financial and social constraints. However, there is a high prevalence of musculoskeletal injuries associated with running[4] and the repetitive, high-impact nature of running may expose women to pelvic health issues, such as stress urinary incontinence (SUI).[5 6] Given the physical changes that occur during pregnancy and childbirth,[7–9] there is growing recognition for the need to rehabilitate postpartum women prior to returning to running, in a similar manner to rehabilitating musculoskeletal injuries.

Adopting a multidisciplinary, biopsychosocial injury rehabilitation model, by including medical, biomechanical, physiological and psychological factors, is advocated for postpartum return to high impact activities.[10 11] A recent Delphi study[12] identified potential risk factors for postpartum women returning to running, such as running too soon following childbirth, suffering from pain and having pelvic-related trauma. Pregnancy and postpartum pain in the lower back and pelvis is common and may result from altered musculoskeletal loading that manifests through changes in walking and running gait.[13 14] However, it is unknown if postpartum runners present with similar painful body areas. In addition, pelvic floor trauma and/or dysfunction may be indicated by the sensation of vaginal heaviness,[11] which could be exacerbated by returning to running. Psychologically, fear of movement has been associated with restricted postpartum physical activity and a caesarean delivery,[15 16] highlighting the importance of considering readiness to return-to-running within a biopsychosocial model of care. However, to-date, there are no empirically identified modifiable or non-modifiable multidisciplinary contributory factors for successfully returning to running postpartum or returning to pre-pregnancy running level. Such an understanding will enable clinicians to better implement targeted rehabilitation interventions and provide effective postpartum care. In addition, it will improve prenatal education and empowerment of pregnant and postpartum women.

One condition suffered by runners and postpartum women is SUI, which refers to urine leakage on exertion.[17 18] Under the broad umbrella of SUI, prevalence amongst runners varies from 19% to 40%[5 6 19] and postpartum women are at a greater risk of SUI than nulliparous women and men.[20 21] Alongside giving birth and female-sex, suggested risk factors are increasing age, having a vaginal delivery, pregnancy SUI and partaking in high impact activities.[5 17 21–24] Further, parous women are more likely to begin leaking urine during pregnancy than nulliparous women, indicating that women with multiple children may be at a greater risk of SUI postpartum.[23] It is conceivable that the physical changes during pregnancy and childbirth, coupled with returning to running too soon or with inadequate postpartum rehabilitation could increase the SUI risk, particularly during running.

Yet, risk factors for running-related SUI within the postpartum running population are unknown.

The limited attention given to the postpartum population within the field of sports medicine and science means evidence-informed return-to-running postpartum guidelines are lacking.[10 25] Therefore, the aim of this study was to examine contributory factors behind postpartum return-to-running and return to pre-pregnancy running level, in addition to risk factors of postpartum running-related SUI using a multidisciplinary, biopsychosocial approach. A secondary aim was to investigate running-related pain in terms of body area and severity.

METHODS

Participants

A total of 881 women (age 33.7±3.6 years; median number of children: 1 (range: 1–6); time since childbirth: 314±195 days) completed an online survey after providing voluntary, informed consent. Women had to be over the age of 18, within 2 years of giving birth and have run at least once a week pre-pregnancy to be eligible for the study. Women who had returned to running >52 weeks postpartum were excluded to minimise the effect of recall bias on time to first postpartum run. All data were anonymised and stored on a General Data Protection Regulation compliant, online system that only the research team had access to.

Survey

A cross-sectional online, open questionnaire was developed by pelvic health physiotherapists (EB, JP, GMD) and human movement experts (ISM, MLJ) using round-table discussions. Clinically and empirically derived questions on the experiences of postpartum runners and multidisciplinary, biopsychosocial contributory factors were created. Patients and the public were not involved in the design of this study. The questionnaire was piloted among a small group of postpartum runners to test usability, while computer and mobile phone functionality was tested within the survey software (Qualtrics; www.qualtrics.com; version June 2020) and with the pilot group. A bespoke survey website address was generated by the survey software and distributed via social media channels (Facebook, Instagram and Twitter) by coauthors (ISM, MJ, EB, JP and GMD) and was available from June 2020 until September 2020. The following topics were included: demographics, delivery mode, perineal tears, concern for the sensation of vaginal heaviness/pressure, running-levels postpartum and whether they had reached pre-pregnancy running level (online supplemental file 1). Running level was described as the volume of weekly running training. The average number of miles ran each week were reported by each participant and the median was used to split participants into low (<10 miles; 45%) and high (≥10 miles; 55%) groups. Women were asked about urine leakage pre-pregnancy, during and post-pregnancy, and during which activities leaking occurred. Only women who reported leaking urine while running were categorised as having *running-related SUI*. To assess fear of movement, an 11-item, modified Tampa Scale for Kinesiophobia was used.[26] This measure has been shown to be associated with postpartum disability levels[27] and returning to sport following a musculoskeletal injury.[28] Items were scored from 1 (strongly disagree) to 4 (strongly agree), meaning total fear of movement (sum of all items) ranged from 11 to 44. Higher scores indicate greater fear. Item 5 was adapted to suit the population of interest, with the word *childbirth* replacing *accident*. Musculoskeletal pain when running postpartum was assessed on a 0 (no pain) to 10 (severe pain) visual analogue scale for the following regions: breast, thoracic, abdominal, pelvis, lower back, coccyx and lower limb. Total pain was the sum of all pain reported for each region (maximum total pain=70). Participants were also asked whether they perceived they had changed their running gait since giving birth. No incentives were provided to participants for completing the questionnaire. Due to logical ordering required for certain items of the questionnaire, no randomisation of the item ordering occurred. Several questions referred to postpartum running or urine leakage, which were only provided to participants if they had returned to some level of postpartum running or had leaked urine, respectively. As a result of adaptive questioning the number of items and screens varied. The range for number of items was 13–20 and for screens was 6–7. It should be noted that only the questions relating to the aims of this specific study have been included. Completion of items was enforced using JavaScript and participants were able to review and change their answers as they progressed by the use of a Back button.

Data preparation and statistical analysis

Only participants who met the inclusion criteria and completed all of the study's questions were used in further analysis. Based on the number of participants who consented (n=1410) there was a completeness rate of 62.5%. Given the possibility of having more than one mother with the same IP address, duplicates were checked based on IP address and age. No duplicates were recorded in the data. Means (SD), medians (IQR) and proportions were calculated. Logistic regressions were performed using the *statsmodels* package to assess the contributory factors to three different outcome measures: return-to-running (yes, no), return to pre-pregnancy running level (yes, no) and running-related SUI (yes, no). The continuous independent variables were: age, fear of movement, total pain and time to first postpartum run. The categorical independent variables were: ran during pregnancy (yes, no), weekly running volume (high, low), delivery mode (vaginal, caesarean), parity (one child, two or more children), vaginal heaviness (yes, no), perineal tear (no, 1st degree or 2nd degree, 3rd degree) and running-related SUI for pre-pregnancy, during and post-pregnancy (yes, no). Multicollinearity was checked using a threshold of 0.45 and urine leakage pre-pregnancy, during and post-pregnancy were removed due to being related to running-related urine leakage pre-pregnancy, during and post-pregnancy, respectively. Continuous variables were mean-centred before being entered into regression models. The time between completing the survey and childbirth was reported as 'time since childbirth'. The time since childbirth ranged from 1 to 104 weeks and may be a potential confounding factor. Therefore, the effect of time since childbirth was controlled for by computing logistic regression models with and without time since childbirth and accuracy, sensitivity, specificity and the area under the receiver operator characteristic curve (AUC) recorded. The AUC was determined using the *sklearn* package. Odds ratios (OR; 95% CIs) were calculated by taking the exponent of the regression model estimates. A Mann-Whitney U test compared pain levels in those that had multiple pain sites and those who did not, in addition to those that had and had not perceived a change in gait due to the non-normality of data. Alpha level was set at ≤0.05 and all statistical analysis was undertaken using Python (Python Software Foundation).

Table 1 Means (SDs) and proportions (n) of each factor for those that had returned to postpartum running and those who had not

Factors	Returned to running (n=654)	Not returned to running (n=227)
Age	33.8 (3.6)	33.4 (3.6)
Median number of children	1	1
Time since most recent birth (days)	354 (191)	199 (159)
Fear of movement	21 (6)	26 (6)
Delivery mode		
Vaginal (unassisted and assisted)	73.7% (n=482)	82.4% (n=187)
Caesarean	26.3% (n=172)	17.6% (n=40)
Perineal tear		
No	50.9% (n=333)	44.1% (n=100)
1st or 2nd degree	41.9% (n=274)	44.1% (n=100)
3rd degree	7.2% (n=47)	11.8% (n=27)
Vaginal heaviness		
No	68.5% (n=448)	47.6% (n=108)
Yes	31.5% (n=206)	52.4% (n=119)
Running mileage		
Low	41.0% (n=268)	56.8% (n=129)
High	59.0% (n=386)	43.2% (n=98)
Postpartum running-related SUI		
No	67.3% (n=440)	81.9% (n=186)
Yes	32.7% (n=214)	18.1% (n=41)

SUI, stress urinary incontinence.

RESULTS

The majority of women (74%; n=654) had returned to running (table 1). Of those that returned, 36% (n=238) had returned to their pre-pregnancy running level (table 2) and the median time to their first postpartum run was 12 weeks (IQR: 7–20). Postpartum running-related SUI had a prevalence of 29% (table 3).

Table 2 Means (SD), medians (IQR) and proportion (n) of each factor for those that had returned to their pre-pregnancy level of running and those that had not

Factors	Returned to pre-pregnancy level (n=238)	Not returned to pre-pregnancy level (n=416)
Age	33.7 (3.7)	33.9 (3.6)
Median number of children	2 (1 - 2)	1 (1 - 2)
Median time to first postpartum run (weeks)	11.5 (6.8 - 19.3)	12.0 (8.0 - 20.0)
Time since most recent birth (days)	401 (177)	327 (193)
Fear of movement	20 (5)	22 (6)
Total pain while running	6 (6)	7 (8)
Delivery mode		
Vaginal (unassisted and assisted)	69.7% (n=166)	76.0% (n=316)
Caesarean	31.3% (n=72)	24.0% (n=100)
Perineal tear		
No	53.4% (n=127)	49.5% (n=206)
1st or 2nd degree	40.3% (n=96)	42.8% (n=178)
3rd degree	6.3% (n=15)	7.7% (n=32)
Vaginal heaviness		
No	72.7% (n=173)	66.1% (n=275)
Yes	27.3% (n=65)	33.9% (n=141)
Running mileage		
Low	53.8% (n=128)	33.7% (n=140)
High	46.2% (n=110)	66.3% (n=276)

Table 3 Means (SD) and proportion (n) of each factor for those that had running-related stress urinary incontinence (SUI) and those that had not

Factors	Running-related SUI (n=255)	No running-related SUI (n=626)
Age	33.9 (3.6)	33.6 (3.6)
Median number of children	1	1
Time since most recent birth (days)	377 (192)	289 (191)
Fear of movement	23 (7)	22 (6)
Delivery mode		
Vaginal (unassisted and assisted)	87.1% (n=222)	71.4% (n=447)
Caesarean	12.9% (n=33)	29.6% (n=179)
Perineal tear		
No	39.6% (n=101)	53.0% (n=332)
1st or 2nd degree	50.2% (n=128)	39.3% (n=246)
3rd degree	10.2% (n=26)	7.7% (n=48)
Vaginal heaviness		
No	54.9% (n=140)	66.5% (n=416)
Yes	65.1% (n=115)	33.5% (n=210)
Running mileage		
Low	42.7% (n=109)	46.0% (n=288)
High	57.3% (n=146)	54.0% (n=338)
Pre-pregnancy running-related SUI		
No	86.3% (n=220)	96.6% (n=605)
Yes	13.7% (n=35)	3.4% (n=21)
During pregnancy running-related SUI		
No	69.8% (n=178)	92.0% (n=576)
Yes	30.2% (n=77)	8.0% (n=50)

SUI, stress urinary incontinence.

Postpartum return-to-running

Running during pregnancy, a high weekly running volume and lower fear of movement increased the odds of return-to-running postpartum, while suffering vaginal heaviness reduced the odds (figure 1). Removing time since childbirth did not change these findings (online supplemental table 1). Good prediction performance was observed with time since childbirth included (accuracy: 75%; sensitivity: 89%; specificity: 36%; AUC: 0.88) and removed (accuracy: 73%; sensitivity: 87%; specificity: 33%; AUC: 0.87).

Postpartum return to pre-pregnancy running level

Factors that increased the odds of returning to the pre-pregnancy level of running were having a low weekly running volume, having more than one child, a lower fear of movement, being younger and a shorter time to first postpartum run (figure 2). Removing time since childbirth meant age was no longer significant (online supplemental table 2). The return to pre-pregnancy level of running model had poor accuracy, both with time since childbirth included (accuracy: 38%; sensitivity: 57%; specificity: 27%; AUC: 0.90) and removed (accuracy: 36%; sensitivity: 51%; specificity: 28%; AUC: 0.89).

Postpartum running-related SUI

Greater odds of experiencing running-related SUI were observed for having returned to running and suffering running-related SUI pre-pregnancy and during pregnancy (figure 3), while a caesarean

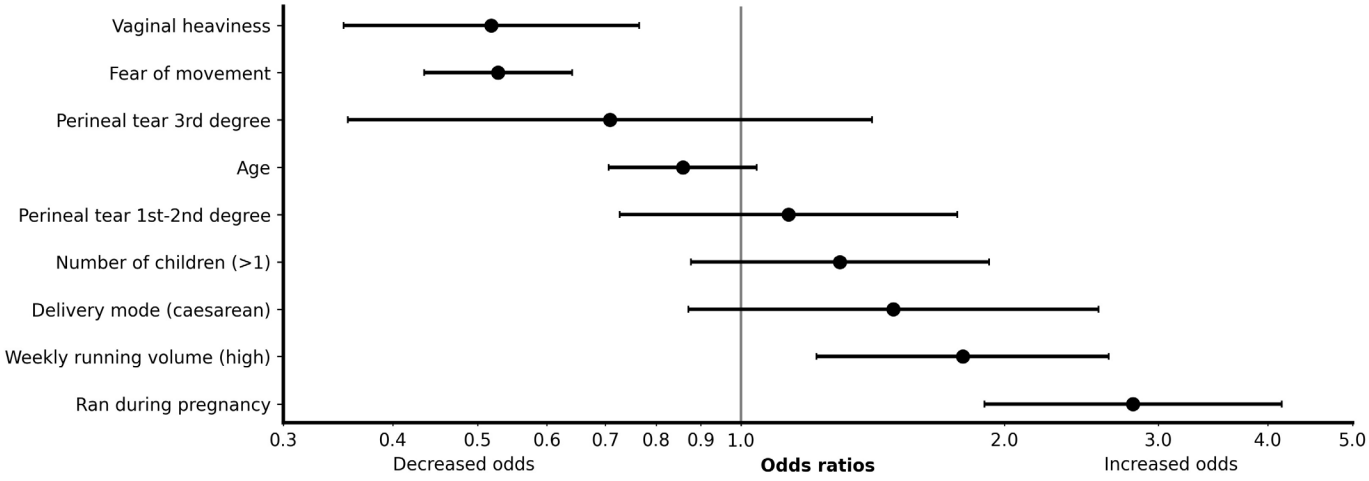

Figure 1 Odd ratios (95% CI) for return-to-running postpartum contributory factors controlling for time since childbirth. Data are presented on a log scale.

delivery decreased the odds. Removing time since childbirth did not change these findings (online supplemental table 3) The regression model had poor accuracy, but high sensitivity when time was included (accuracy: 28%; sensitivity: 71%; specificity: 11% AUC: 0.95) and removed (accuracy: 27%; sensitivity: 79%; specificity: 6%; AUC: 0.96).

Pain

Eighty-four percent of those that had returned to running had pain in at least one body area, with the median level of total pain being six (IQR: 3–11). The majority (76%, n=420) experienced pain in more than one body area, with 50% experiencing pain in three or more areas. Those that experienced pain in multiple body areas had greater pain levels than those that experienced pain in one body area (median pain: 7 (5–13) vs 2 (1–4), respectively, U=6398, p<0.001). The lower limb was the most prevalent body area (78.6%), followed by the lower back (53.3%), pelvis (52.7%), abdomen (35.7%), breasts (31.0%), thoracic (24.1%) and coccyx (20.5%). Additionally, those who reported a change in running gait had higher running-related pain than those who did not report such a change (6 (3–12) vs 4 (1–7), respectively, U=37 646, p<0.001).

DISCUSSION

This study aimed to examine factors that contribute to postpartum return-to-running, return to pre-pregnancy running level and running-related SUI using a multidisciplinary, biopsychosocial approach. A lower fear of movement increased the odds of both return-to-running and returning to pre-pregnancy running level postpartum. Running during pregnancy, a high weekly running volume and not suffering from vaginal heaviness also increased the odds of return-to-running postpartum, while a low weekly running volume, having more than one child, being younger and a shorter time to first postpartum run also increased the odds of returning to pre-pregnancy running level postpartum. Returning to running, having a vaginal delivery and suffering running-related SUI pre-pregnancy and during pregnancy increased the odds of having running-related SUI. To the authors' knowledge, this was the first study to apply a multidisciplinary, biopsychosocial approach to, and identify contributory factors for, women returning to running postpartum.

Factors contributing to postpartum return-to-running

Continuing to run during pregnancy and having a high weekly running volume pre-pregnancy increased the odds of return-to-running postpartum. These two contributory factors may be

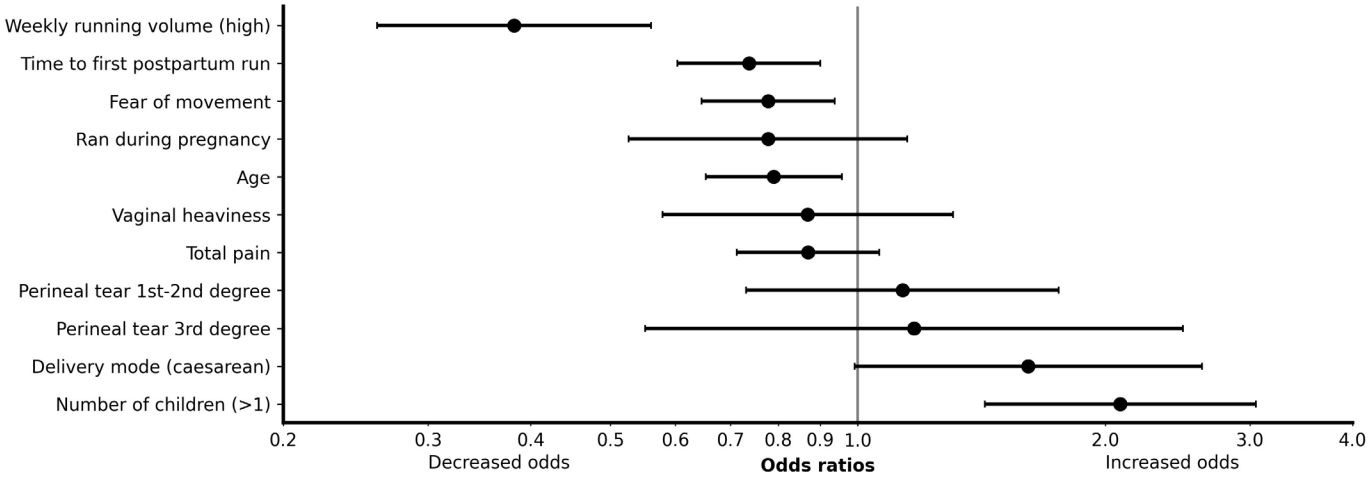

Figure 2 Odds ratios (95% CI) for return to pre-pregnancy running level contributory factors controlling for time since childbirth. Data are presented on a log scale.

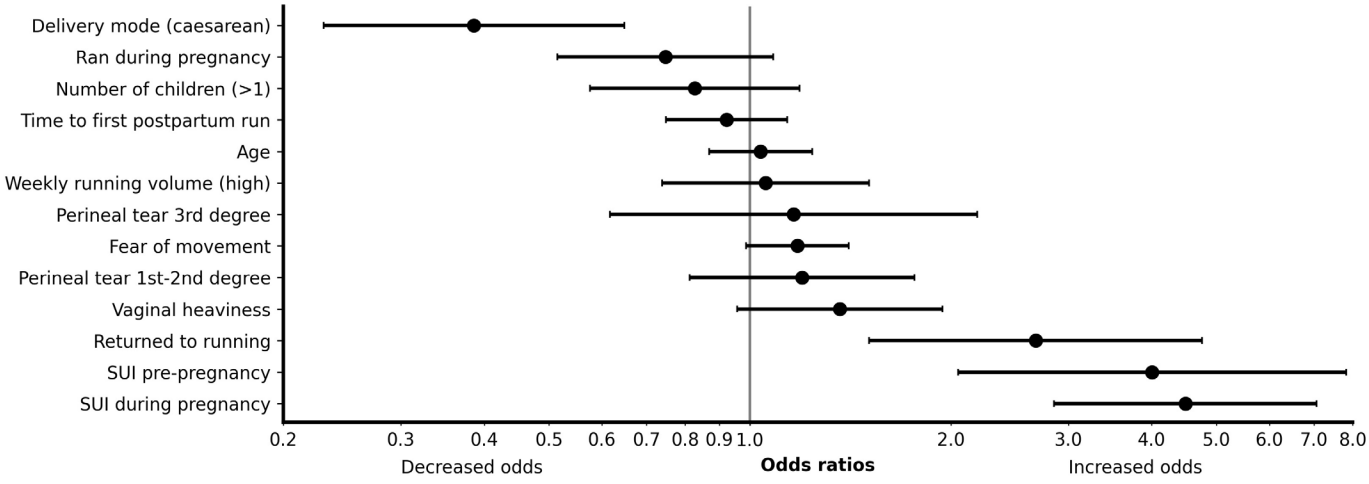

Figure 3 Odds ratios (95% CI) for risk factors for postpartum running-related stress urinary incontinence, controlling for time since childbirth. Data are presented on a log scale. SUI, running-related stress urinary incontinence.

associated, as Tenforde and colleagues[29] reported that running during pregnancy was accompanied by higher weekly running volume pre-pregnancy. Yet women are often concerned about causing harm to their baby, which can stop engagement with running.[30] However, running and/or aerobic exercise during pregnancy is not associated with an increased risk of preterm birth or reduction in gestational age at delivery.[31 32] It is therefore essential that clear messages are provided to pregnant women regarding the benefits of exercise and guidelines are updated to reflect empirical evidence.[33] While having a high weekly running volume increased the odds of postpartum return-to-running, it decreased the odds of returning to pre-pregnancy running level. This may reflect high volume runners following clinical recommendations and gradually returning to running.[2 10 11 34] Additionally, women who took longer to complete their first run following childbirth and those with only one child had lower odds of returning to pre-pregnancy running levels within 12 months. This further supports the indication that women are gradually increasing their running volume and could also suggest that prior postpartum experience is beneficial to recovery.

The sensation of vaginal heaviness, rather than known physical traumas (perineal tears) was found to decrease the odds of return-to-running postpartum. This may be a consequence of runners being unaware of whether they have suffered a perineal tear and to what degree, while vaginal heaviness is a sensation that they are able to feel. The sensation of vaginal heaviness may indicate the presence of pelvic organ prolapse (POP).[35] High-impact activities, such as running, theoretically may increase the susceptibility of POP occurrence, due to the repeated exposure to load transmitted to the pelvic floor.[24 25] Empirically, few studies have investigated high impact activities and POP, however, light-to-moderate intensity exercise has been shown to increase the severity of POP without increasing symptoms.[36] Based on our findings, the sensation of heaviness could be used as an indicator by clinicians that further examination is required as it was a barrier to returning to running postpartum.

Perineal tears not influencing returning to running may be explained by the median time to return-to-running being 12 weeks. Encouragingly, this median timeframe aligns with clinical guidelines[11] and IOC consensus recommendations[37] and differs from previous findings, showing that 49% of female runners returned within 6 weeks.[5] At 12 weeks, it is conceivable that adequate tissue healing had occurred, allowing women to successfully return-to-running even if they were unaware of any perineal tearing. Within sport, muscle tears are common and vary in severity,[38] but are rarely career-ending. Therefore, while returning to running postpartum needs to consider more than perineal tears due to the possible disruption to pelvic organs,[39] similar to sports muscle injuries, perineal tears should not be deemed a barrier to return-to-running following adequate healing time.

In support of previous findings in returning to sport post-ACL reconstruction, having a lower fear of movement increased the odds of return-to-running postpartum and returning to pre-pregnancy running level.[40] Interestingly, the fear of movement in postpartum women who had not returned to running is higher than individuals who have had ACL reconstructions,[40] but similar to those suffering chronic low back pain and osteoarthritis.[41] One explanation could be the clear pathway for, and engagement with, rehabilitation in the ACL reconstruction patients,[40] which contrasts with chronic low back pain,[41] osteoarthritis[42] and postpartum patients who were not engaged in rehabilitation. By situating pregnancy and childbirth within a fear-avoidance model, we have been able to identify a contributory factor (fear of movement) that may be a barrier to some women being able to return-to-running and pre-pregnancy running level. Additionally, total pain was not a contributory factor to returning to pre-pregnancy running level. Clinically, knowing pain levels is important for possible indications of pathology, but our findings suggest that fear of movement should also be addressed in postpartum care.

Postpartum running-related SUI risk factors

Similar to previous research, 29% of women experienced postpartum running-related SUI.[17 43] Further, those who had returned to running postpartum had greater odds of suffering running-related SUI than those who had not. Women with running-related SUI, who had not returned to running, represent those that will have attempted to run and decided against continuing. This lends support to high impact activities being a risk factor for SUI,[21 24 44] although weekly running volume did not contribute to the running-related SUI model and contradicts this. Greater understanding of high-impact exposure over a woman's lifetime, incorporating mechanical loading, is needed to discern whether accumulated exposure

to high-impact is a risk factor for SUI. However, with women still running while leaking urine, SUI was not a barrier for the majority of our cohort.

In support of past research, a history of SUI pre-pregnancy and during pregnancy, as well as a vaginal delivery, increased the odds of suffering from SUI following childbirth.[5 21–23] Similar to previous research, assisted and unassisted vaginal deliveries were included in the same group. Treating these vaginal deliveries as separate groups did not change the findings, specifically, both types of vaginal delivery increased the odds of running-related SUI compared with caesareans. This highlights that both broad SUI and movement related SUI in the postpartum population have several non-modifiable risk factors. The lack of significance for the modifiable risk factors, such as training volume, fear of movement or time to first run indicate that early prevention is warranted in nulliparous and pregnant women. Specifically, strategies such as pelvic floor muscle training are advised.[45]

Running-related pain

Eighty-four percent of women who had achieved postpartum return-to-running experienced pain, with three-quarters reporting more than one painful body area. Those that reported multiple body areas had a higher level of pain severity than those who reported one area. This constellation of pain in several body areas in the postpartum population is not unique to running, as it also presents during daily living.[46] Pelvic and lower back pain are consistently reported during pregnancy[47] and postpartum,[48] yet, the lower limb was the most prevalent pain site in our study and appears to be specific to the postpartum running population. The lower limb is commonly injured in runners[4] and may be a result of loading the body too early,[12] pregnancy-related structural changes or altered biomechanics, as those that perceived their gait had changed had higher pain in the current study. Conversely, pain may cause women to change their running gait, yet postpartum gait changes have been observed in the absence of pain.[14] While, this study cannot establish a cause-and-effect relationship between gait and pain, it may indicate that postpartum rehabilitation should consider gait retraining to alleviate lower limb pain.[49] We were unable to determine if women had attempted to return-to-running and stopped due to pain. Given the high prevalence of pain in our cohort, it is recommended that postpartum care consider exercise-related pain and advise women accordingly about exercise re-engagement. Specifically, addressing any normalisation of pain and educating women on running-related injury risk factors, such as running volume and intensity progression.[50]

Limitations and strengths

This retrospective study enabled a large cohort to be recruited, but meant pre-pregnancy SUI, during pregnancy SUI and time since first postpartum run answers may have been prone to recall bias. Predicting return-to-running postpartum had the highest accuracy and specificity, while both returning to pre-pregnancy running level and running-related SUI had lower accuracy and specificity. Further factors need to be considered for these models to improve, such as lifetime training exposure and pelvic floor assessments. While a multidisciplinary, biopsychosocial approach was used in this study, not all factors could be considered and objective, physical tests could not be conducted. Such tests are likely to play a role in a return-to-running postpartum rehabilitation pathway[10 11] and require further investigation. Fourth grade tears were not examined in this study due to the low prevalence (0.1%),[51] but may warrant attention in future research. Weekly running volume was reported pre-pregnancy and postpartum, but running intensity was not. Therefore, although runners may have returned to their pre-pregnancy weekly running volume, they may not have achieved a similar level of performance. Performance-related contributory factors should be explored in future research.

CONCLUSION

In summary, several modifiable and non-modifiable factors contributing to return-to-running postpartum were identified using a multidisciplinary, biopsychosocial approach. Having a lower fear of movement increased the odds of returning to running and returning to pre-pregnancy running levels postpartum. Running while pregnant, a high weekly running volume and not experiencing vaginal heaviness also increased the odds of returning to running, while a low weekly running volume, having more than one child, being younger and a shorter time to first postpartum run increased the odds of returning to pre-pregnancy running levels. To support women to have active postpartum lifestyles and a safe return-to-running, healthcare providers are advised to encourage continued engagement with running during pregnancy, where it is safe to do so, and to address fear of movement and the sensation of vaginal heaviness. Risk factors for running-related SUI indicate early intervention is warranted before and during pregnancy.

Key messages

What are the findings?

- On average, women returned to running at 12 weeks postpartum and 84% experienced pain in the lower limb, lower back, pelvis, abdomen, breasts, thoracic or coccyx while running.
- Running during pregnancy, lower fear of movement, high weekly running volume pre-pregnancy and no vaginal heaviness increased the odds of returning to running postpartum.
- A low weekly running volume pre-pregnancy, lower fear of movement, having more than one child, being younger and shorter time to running after childbirth increased the odds of returning to pre-pregnancy running level.
- Suffering from running-related stress urinary incontinence pre-pregnancy and during pregnancy, having returned to postpartum running and having a vaginal delivery increased the odds of suffering from running-related stress urinary incontience postpartum.

How might it impact on clinical practice in the future?

- Prenatal healthcare providers should encourage women to stay engaged in running where appropriate and address pelvic floor dysfunction.
- Assessing fear of movement and considering ways to reduce fear may help return women back to running.
- The sensation of vaginal heaviness, rather than having a perineal tear, is a barrier to return-to-running postpartum.
- Postpartum care should consider exercise-related pain and advise women accordingly about exercise re-engagement.

Correction notice This article has been corrected since it published Online First. The author affiliations have been corrected.

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REFERENCES

1 Pedisic Z, Shrestha N, Kovalchik S, *et al*. Is running associated with a lower risk of all-cause, cardiovascular and cancer mortality, and is the more the better? A systematic review and meta-analysis. *Br J Sports Med* 2020;54:898–905.
2 Mihevc Edwards K. Considerations for the postpartum runner. *Strength Conditioning Journal* 2020;42:45–52.
3 Running USA. Running USA marathon report: minor drop in U.S. marathon finishers reported in 2016. Available: https://runningusa.org/RUSA/Research/Marathon_Report/2017-Marathon-Report/RUSA/Research/Recent_Reports/Marathon_Report.aspx?hkey=19f86042-5607-459b-bcb1-7eacac5303af [Accessed 14 Apr 2020].
4 Kluitenberg B, van Middelkoop M, Diercks R, *et al*. What are the differences in injury proportions between different populations of runners? A systematic review and meta-analysis. *Sports Med* 2015;45:1143–61.
5 Blyholder L, Chumanov E, Carr K, *et al*. Exercise behaviors and health conditions of runners after childbirth. *Sports Health* 2017;9:45–51.
6 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* 2021;32:295–302.
7 Forczek W, Ivanenko Y, Salamaga M, *et al*. Pelvic movements during walking throughout gestation - the relationship between morphology and kinematic parameters. *Clin Biomech* 2020;71:146–51.
8 Peschers UM, Schaer GN, DeLancey JO, *et al*. Levator ani function before and after childbirth. *Br J Obstet Gynaecol* 1997;104:1004–8.
9 Segal NA, Boyer ER, Teran-Yengle P, *et al*. Pregnancy leads to lasting changes in foot structure. *Am J Phys Med Rehabil* 2013;92:232–40.
10 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;50:281–4.
11 Donnelly GM, Rankin A, Mills H, *et al*. Infographic. guidance for medical, health and fitness professionals to support women in returning to running postnatally. *Br J Sports Med* 2020;54:1114–5.
12 Christopher SM, Garcia AN, Snodgrass SJ, *et al*. Common musculoskeletal impairments in postpartum runners: an international Delphi study. *Arch Physiother* 2020;10:19.
13 Bagwell JJ, Reynolds N, Walaszek M, *et al*. Lower extremity kinetics and muscle activation during gait are significantly different during and after pregnancy compared to nulliparous females. *Gait Posture* 2020;81:33–40.
14 Provenzano SG, Hafer JF, Peacock J, *et al*. Restriction in pelvis and trunk motion in postpartum runners compared with Pre-pregnancy. *J Womens Health Phys Therap* 2019;43:119–26.
15 Olsson CB, Grooten WJA, Nilsson-Wikmar L, *et al*. Catastrophizing during and after pregnancy: associations with lumbopelvic pain and postpartum physical ability. *Phys Ther* 2012;92:49–57.
16 Mahmood S, Nadeem S, Maqsood U. Frequency of pain Catastrophizing and Kinesiophobia among post cesarean females with low back and pelvic pain. *Journal of the Society of Obstetrics and Gynaecologists of Pakistan* 2018;8:100–3.
17 Rodríguez-López ES, Calvo-Moreno SO, Basas-García Ángel, *et al*. Prevalence of urinary incontinence among elite athletes of both sexes. *J Sci Med Sport* 2021;24:338–44.
18 Alves JO, Luz STD, Brandão S, *et al*. Urinary incontinence in physically active young women: prevalence and related factors. *Int J Sports Med* 2017;38:937–41.
19 Capobianco G, Madonia M, Morelli S, *et al*. Management of female stress urinary incontinence: a care pathway and update. *Maturitas* 2018;109:32–8.
20 Hansen BB, Svare J, Viktrup L, *et al*. Urinary incontinence during pregnancy and 1 year after delivery in primiparous women compared with a control group of nulliparous women. *Neurourol Urodyn* 2012;31:475–80.
21 Eliasson K, Nordlander I, Larson B, *et al*. Influence of physical activity on urinary leakage in primiparous women. *Scand J Med Sci Sports* 2005;15:87–94.
22 Eftekhar T, Hajibaratali B, Ramezanzadeh F, *et al*. Postpartum evaluation of stress urinary incontinence among primiparas. *Int J Gynaecol Obstet* 2006;94:114–8.
23 Eason E, Labrecque M, Marcoux S, *et al*. Effects of carrying a pregnancy and of method of delivery on urinary incontinence: a prospective cohort study. *BMC Pregnancy Childbirth* 2004;4:4.
24 Bø K. Urinary incontinence, pelvic floor dysfunction, exercise and sport. *Sports Med* 2004;34:451–64.
25 Bø K, Nygaard IE. Is physical activity good or bad for the female pelvic floor? A narrative review. *Sports Med* 2020;50:471–84.
26 Woby SR, Roach NK, Urmston M, *et al*. Psychometric properties of the TSK-11: a shortened version of the Tampa scale for Kinesiophobia. *Pain* 2005;117:137–44.
27 Gutke A, Lundberg M, Östgaard HC, *et al*. Impact of postpartum lumbopelvic pain on disability, pain intensity, health-related quality of life, activity level, kinesiophobia, and depressive symptoms. *Eur Spine J* 2011;20:440–8.
28 Patel NK, Sabharwal S, Hadley C, *et al*. Factors affecting return to sport following hamstrings anterior cruciate ligament reconstruction in non-elite athletes. *Eur J Orthop Surg Traumatol* 2019;29:1771–9.
29 Tenforde AS, Toth KES, Langen E, *et al*. Running habits of competitive runners during pregnancy and breastfeeding. *Sports Health* 2015;7:172–6.
30 Forsyth J, Brown N, Bullingham R. Getting back on their feet: women in sport and exercise academic network virtual Conference, Sept 7–8, 2020. *Women Sport Phys Activ J* 2021.
31 Di Mascio D, Magro-Malosso ER, Saccone G, *et al*. Exercise during pregnancy in normal-weight women and risk of preterm birth: a systematic review and meta-analysis of randomized controlled trials. *Am J Obstet Gynecol* 2016;215:561–71.
32 Kuhrt K, Harmon M, Hezelgrave NL, *et al*. Is recreational running associated with earlier delivery and lower birth weight in women who continue to run during pregnancy? an international retrospective cohort study of running habits of 1293 female runners during pregnancy. *BMJ Open Sport Exerc Med* 2018;4:e000296.
33 Meah VL, Davies GA, Davenport MH. Why can't I exercise during pregnancy? Time to revisit medical 'absolute' and 'relative' contraindications: systematic review of evidence of harm and a call to action. *Br J Sports Med* 2020;54:1395–404.
34 American College of obstetricians and Gynecologists Committee opinion no. 650: physical activity and exercise during pregnancy and the postpartum period. *Obstet Gynecol* 2015;126:e135–42.
35 Swift SE, Tate SB, Nicholas J. Correlation of symptoms with degree of pelvic organ support in a general population of women: what is pelvic organ prolapse? *Am J Obstet Gynecol* 2003;189:372–7.
36 Ali-Ross NS, Smith ARB, Hosker G. The effect of physical activity on pelvic organ prolapse. *BJOG* 2009;116:824–8.
37 Bø 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 4-Recommendations for future research. *Br J Sports Med* 2017;51:1724–6.
38 Ekstrand J, Hägglund M, Waldén M. Epidemiology of muscle injuries in professional football (soccer). *Am J Sports Med* 2011;39:1226–32.
39 Bø 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. *Br J Sports Med* 2017;51:1516–25.

40 Chmielewski TL, Jones D, Day T, *et al*. The association of pain and fear of movement/reinjury with function during anterior cruciate ligament reconstruction rehabilitation. *J Orthop Sports Phys Ther* 2008;38:746–53.
41 Roelofs J, Sluiter JK, Frings-Dresen MHW, *et al*. Fear of movement and (re)injury in chronic musculoskeletal pain: Evidence for an invariant two-factor model of the Tampa Scale for Kinesiophobia across pain diagnoses and Dutch, Swedish, and Canadian samples. *Pain* 2007;131:181–90.
42 Heuts PHTG, Vlaeyen JWS, Roelofs J, *et al*. Pain-Related fear and daily functioning in patients with osteoarthritis. *Pain* 2004;110:228–35.
43 Carvalhais A, Natal Jorge R, Bø K. Performing high-level sport is strongly associated with urinary incontinence in elite athletes: a comparative study of 372 elite female athletes and 372 controls. *Br J Sports Med* 2018;52:1586–90.
44 de Mattos Lourenco TR, Matsuoka PK, Baracat EC, *et al*. Urinary incontinence in female athletes: a systematic review. *Int Urogynecol J* 2018;29:1757–63.
45 García-Sánchez E, Ávila-Gandía V, López-Román J, *et al*. What pelvic floor muscle training load is optimal in minimizing urine loss in women with stress urinary incontinence? A systematic review and meta-analysis. *Int J Environ Res Public Health* 2019;16. doi:10.3390/ijerph16224358. [Epub ahead of print: 08 11 2019].
46 Dunn G, Egger MJ, Shaw JM, *et al*. Trajectories of lower back, upper back, and pelvic girdle pain during pregnancy and early postpartum in primiparous women. *Womens Health* 2019;15:174550651984275.
47 Gjestland K, Bø K, Owe KM, *et al*. Do pregnant women follow exercise guidelines? prevalence data among 3482 women, and prediction of low-back pain, pelvic girdle pain and depression. *Br J Sports Med* 2013;47:515–20.
48 Thorell E, Kristiansson P. Pregnancy related back pain, is it related to aerobic fitness? A longitudinal cohort study. *BMC Pregnancy Childbirth* 2012;12:30.
49 Roper JL, Harding EM, Doerfler D, *et al*. The effects of gait retraining in runners with patellofemoral pain: a randomized trial. *Clinical Biomechanics* 2016;35:14–22.
50 Ramskov D, Rasmussen S, Sørensen H, *et al*. 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;48:740–8.
51 Woolner AM, Ayansina D, Black M, *et al*. The impact of third- or fourth-degree perineal tears on the second pregnancy: a cohort study of 182,445 Scottish women. *PLoS One* 2019;14:e0215180-e.