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Is Hip Abduction Strength Asymmetry Present in Female Runners in the Early Stages of Patellofemoral Pain Syndrome?

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Investigation performed at the Rehabilitation Institute of Chicago, Chicago, Illinois, USA

Background: The current literature indicates that hip abduction weakness in female patients is associated with ipsilateral patellofemoral pain syndrome (PFPS) as part of the weaker hip abductor complex. Thus, it has been suggested that clinicians should consider screening female athletes for hip strength asymmetry to identify those at risk of developing PFPS to prevent the condition. However, no study to date has demonstrated that hip strength asymmetry exists in the early stages of PFPS.

Purpose: To determine whether hip abduction strength asymmetry exists in female runners with early unilateral PFPS, defined as symptoms of PFPS not significant enough to cause patients to seek medical attention or prevent them from running at least 10 miles per week.

Study Design: Controlled laboratory study.

Methods: This study consisted of 21 female runners (mean age, 30.5 years; range, 18-45 years) with early unilateral PFPS, who had not yet sought medical care and who were able to run at least 10 miles per week, and 36 healthy controls comparably balanced for age, height, weight, and weekly running mileage (mean, 18.5 mi/wk). Study volunteers were recruited using flyers and from various local running events in the metropolitan area. Bilateral hip abduction strength in both a neutral and extended hip position was measured using a handheld dynamometer in each participant by an examiner blinded to group assignment.

Results: Patients with early unilateral PFPS demonstrated no significant side-to-side difference in hip abduction strength, according to the Hip Strength Asymmetry Index, in both a neutral (mean, 83.5 ± 10.2; P = .2272) and extended hip position (mean, 96.3 ± 21.9; P = .6671) compared with controls (mean, 87.0 ± 8.3 [P = .2272] and 96.6 ± 16.2 [P = .6671], respectively). Hip abduction strength of the affected limb in patients with early unilateral PFPS (mean, 9.9 ± 2.2; P = .0305) was significantly stronger than that of the weaker limb of control participants (mean, 8.9 ± 1.4; P = .0305) when testing strength in a neutral hip position; however, no significant difference was found when testing the hip in an extended position (mean, 7.0 ± 1.4 [P = .1406] and 6.6 ± 1.5 [P =.1406], respectively).

Conclusion: The study data show that early stages of unilateral PFPS in female runners is not associated with hip abduction strength asymmetry and that hip abduction strength tested in neutral is significantly greater in the affected limb in the early stages of PFPS compared with the unaffected limb. However, when tested in extension, no difference exists. Further studies investigating the early stages of PFPS are warranted.

Clinical Relevance: Unlike patients with PFPS seeking medical care, early PFPS does not appear to be significantly associated with hip abduction strength asymmetry.

Keywords: patellofemoral syndrome; dynamometer; muscle strength; sports injury

Patellofemoral pain syndrome (PFPS) is one of the most common orthopaedic injuries, with a reported incidence of 8.5% to 15%,[1,3,5,6] accounting for approximately 25% of all knee injuries.[8] PFPS is particularly common in women, with a female:male ratio of 2:1 to 3:1,[2,4] and it is characterized by altered patellar tracking that leads to increased forces within the patellofemoral joint during flexion. Vastus medialis weakness; decreased gastrocnemius, soleus, hamstring, quadriceps, or iliotibial band flexibility; patella alta; femoral anteversion; excessive femoral internal rotation; a shallow femoral trochlear groove; excessive subtalar joint pronation; and leg-length discrepancy have all been proposed to contribute to PFPS.[††]

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[††]References 7, 10, 12, 16, 22, 23, 25-29, 31, 33, 35, 37.

Gluteal weakness has been implicated in other knee pain syndromes such as iliotibial band syndrome.[14] Recently, hip abduction weakness has been implicated in PFPS. Hip abduction weakness causes excessive internal rotation of the leg,[37] which predisposes the patella to track more laterally in the patellofemoral groove, potentially leading to PFPS. Dierks et al[9] and Ireland et al[17] found that female patients with PFPS had, respectively, 12% and 26% less hip abduction strength in the affected side compared with the hip strength of asymptomatic controls. Building on this evidence, Baldon Rde et al[2] found a 28% reduction in eccentric hip abduction strength in female patients with PFPS compared with healthy controls, and Souza and Powers[32] found a 22% decrease in hip abduction strength during running in similar groups. Training of hip abductor muscles in the early phases of the rehabilitation of PFPS has been shown to decrease symptoms more quickly than does quadriceps training.[11]

More relevant to clinicians, as the standard physical examination compares side-to-side differences to determine muscular strength, Magalhaes et al,[21] Robinson and Nee,[30] and Cichanowski et al[5] investigated hip abduction strength asymmetry in female patients and reported 12% to 22% reduction in hip strength of the leg with PFPS compared with the unaffected side. The only study to date that demonstrated no asymmetry in hip abduction strength in patients with PFPS compared with healthy controls was reported by Piva et al,[25] but this study was unblinded and included a coeducational population with bilateral symptoms. Thus, the current body of literature indicates that in female patients, unilateral patellofemoral pain is associated with hip abduction weakness on the same side.

The authors of this body of literature concluded that clinicians should consider screening female athletes for hip strength weakness or asymmetry as a means of preventing PFPS. However, to the best of our knowledge, no study to date has demonstrated that hip strength asymmetry exists in the early stages of PFPS before the utilization of health care. Our study investigated athletes before symptoms became significant enough to require medical attention.

We investigated hip abduction strength asymmetry in a population of female athletes with patellofemoral pain who had not yet sought medical care and who were functionally active (running at least 10 mi/wk). Studying this population with early symptoms allowed us to determine whether hip strength asymmetry exists before developing more significant PFPS symptoms that require the utilization of health care. Therefore, we posed the following question: Is there a role for screening female athletes for hip strength asymmetry to identify those in the early stages of PFPS? We hypothesized that female patients with early PFPS would demonstrate hip abduction strength asymmetry, which would support the consensus recommendation for clinicians to consider hip strength asymmetry as a means of identifying those in the early stages of PFPS before they require health care.

METHODS

Participants

Approval was obtained from the University of Pennsylvania Institutional Review Board (IRB) and the Northwestern University IRB for the described study protocol, and approval was obtained from the University of Pennsylvania IRB for subsequent statistical analysis. This was a single, blinded case-control study including 21 female runners with early unilateral PFPS and 36 healthy female runners who served as controls.

A power analysis was performed that estimated that 5 patients and 5 controls would provide 80% power to detect a clinically significant difference of 18% in side-to-side hip asymmetry in patients with PFPS compared with controls, estimated as the mean difference for the combined participants reported in the reviewed literature.[6,30,34] Our enrolled sample of 21 patients with early unilateral PFPS and 36 controls could detect a difference in hip abduction strength asymmetry of 8% with the targeted 80% power, which is a difference less than that of the smallest difference reported in the literature at 12%.[6,30,34]

Procedures

Study volunteers were recruited using IRB-approved recruitment flyers as well as recruitment in the vendor section at various local road races, half marathons, triathlons, and running club meetings in the metropolitan area, and each was provided US$30 reimbursement for participating. The text on the recruitment flyer read, “Are you an avid female runner between 18-45? Do you suffer from pain in the front knee while running? The purpose of the study is to examine the relationship between hip strength and PFPS. PFPS is pain in the front of the knee or behind the kneecap that occurs with running, prolonged sitting, or when climbing

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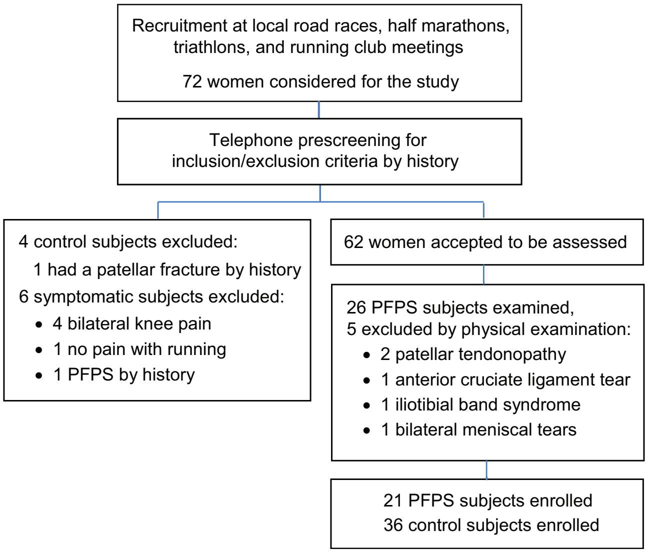

Figure 1. Flowchart for enrollment of study participants. PFPS, patellofemoral pain syndrome.

stairs. Whether you have knee pain or not, you may qualify for participation in this research study." An IRB-approved consent form was reviewed with potential participants orally, and written consent was obtained from the participant if she enrolled. The consent introduction read, "You are asked to take part in a research study. The purpose of the study is to determine the relationship between hip strength and patellofemoral syndrome. You are asked to take part in this study because we want to know more about the relationship between hip strength and patellofemoral syndrome."

Prescreening for inclusion and exclusion criteria (see below) was performed over the telephone before study volunteers were later tested at the Rehabilitation Institute of Chicago. After telephone prescreening, an assessment of study volunteers was performed at the Rehabilitation Institute of Chicago using 4 stations to gather further necessary data to either include or exclude volunteers from analysis according to the inclusion and exclusion criteria (Figure 1).

At the first station, participants filled out a biographical questionnaire, which included their age, their ball-kicking leg preference to determine leg dominance, and the Anterior Knee Pain Questionnaire (AKPQ),[20] which is reliable and sensitive to clinical change for PFPS.[18,36]

At the second station, participants underwent hip strength testing by a single trained examiner blinded to groups (symptomatic or control). Hip strength in neutral and extended hip positions was tested. Hip abduction in extension is considered to preferentially recruit the gluteus medius, while hip abduction in neutral recruits the tensor fasciae latae more.[14] The preliminary pilot studies of one of the authors (J.M.) suggested that there might be a difference between the 2 positions in the female population; thus, this study examined female athletes only using these 2 hip positions. In a side-lying position, each participant's hip abduction strength was tested in a neutral and

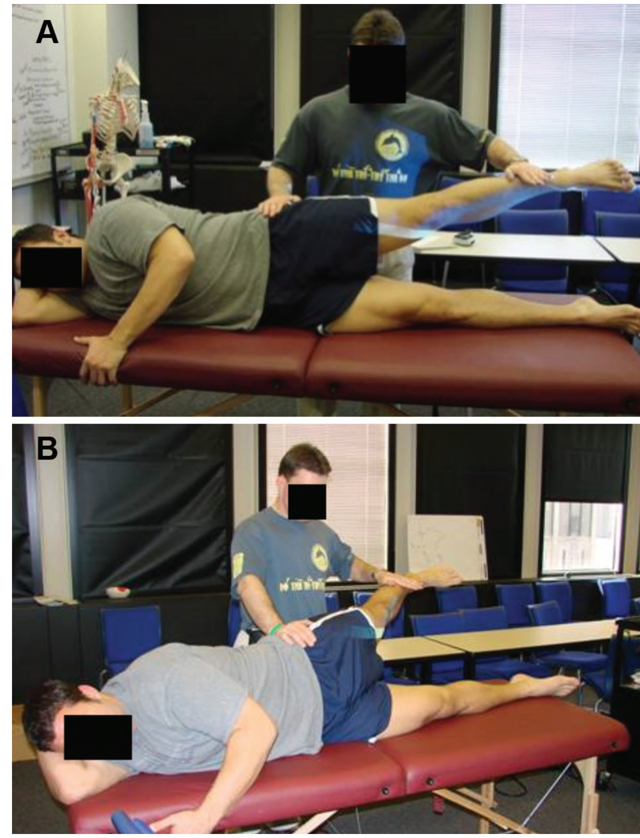

Figure 2. Hip abduction strength testing in (A) neutral hip position and (B) extended hip position.

extended hip position, with a handheld dynamometer (manual muscle testing system No. 01163; Layfayette Instruments). The trunk, hips, and legs were in neutral alignment and parallel to the long axis of the table with the left and right anterior superior iliac spine aligned vertically. The participant's downward-facing arm was placed underneath her head, and the participant's upward-facing arm grasped the table (Figure 2). Three measurements were taken on each side with the hip in approximately 30° of abduction, with 5 seconds of rest between each measurement. The examiner stabilized the hip and placed the dynamometer 5 cm proximal to the lateral malleolus while the participant abducted the hip with maximal effort for 3 seconds. In the neutral position, the legs remained vertically aligned during testing, while in the extended position, the top leg was placed in 15° of extension before testing hip abduction strength. The order of testing and the first side tested were both randomized by Maple software (Cybernet Systems Co Ltd).

At the third station, an examiner blinded to the group designation measured the height, weight, and leg-length discrepancy of the participants. Leg-length discrepancy was measured with the participant in a neutral side-lying position. The distance from the anterior superior iliac spine to the medial malleolus was measured with a tape measure.

At the fourth station, participants underwent a focused physical examination of the knee by a different blinded examiner. The examiner performed a physical examination of the knee, which included an inspection, Lachman test, anterior drawer test, varus and valgus stress test, medial and lateral joint line palpation, McMurray test, and palpation of the patellar borders. Once these data were collected, participants were grouped as those with PFPS or controls for analysis, or they were excluded from analysis based on the criteria described in the following section.

Study Inclusion and Exclusion Criteria

Participants were grouped into the early unilateral PFPS group if they met all of the following criteria: (1) female sex; (2) 18 to 45 years of age; (3) running at least 10 miles per week; (4) reporting unilateral anterior knee pain associated with running at a frequency of least once per week that had occurred for at least 6 weeks; and (5) exhibiting pain with compression of the patella into the femoral condyles, pain with palpation of the anterior surface of the patella, or pain with a single-leg squat (Table 1). Alternatively, participants were grouped into the control group if they met only the first 3 above inclusion criteria.

Participants were excluded from the early unilateral PFPS group if they met any of the following criteria: (1) pain syndrome in the knee or lower extremity other than PFPS; (2) bilateral knee pain; (3) history of patellar dislocations; (4) ligamentous or meniscal injuries in the knee; (5) history of surgery or trauma in either the knee or lower extremity; (6) physical examination results consistent with bilateral PFPS; (7) ligamentous injuries as evidenced by a positive Lachman test finding, anterior drawer, posterior drawer, varus instability, or valgus instability; or (8) physical examination results consistent with meniscal injuries as evidenced by medial or lateral joint line tenderness or a positive McMurray test finding (Table 1). Participants were excluded from the control group if they (1) reported unilateral anterior knee pain associated with running at a frequency of at least once per week that had occurred for at least 6 weeks, (2) exhibited a physical examination finding consistent with PFPS or any other chronic overuse injury, (3) reported a history of PFPS in the past 6 months, or (4) met any of the exclusion criteria applied to the early unilateral PFPS group listed in the first half of this paragraph.

Statistical Analysis

Patients with early unilateral PFPS and controls were comparably balanced with respect to variables believed to be potential confounders, including age, height, weight, miles run per week, and leg-length discrepancy. A Student *t* test of independent variables was applied to confirm that an unacceptable balance was not observed between the 2 cohorts with respect to the aforementioned potential confounders. A *P* value <.05 was considered to be statistically significant.

TABLE 1
Physical Examination Findings Used in Inclusion and Exclusion Criteria[a]

Physical Examination Findings
Findings consistent with PFPS
Tenderness of the medial or lateral patellar facets
Pain with compression of the patella into the femoral condyles
Anterior knee pain with single-leg squat
Findings consistent with a knee injury other than PFPS
Positive Lachman test result
Positive posterior drawer test result
Positive McMurray test result
Medial joint line tenderness
Lateral joint line tenderness
Valgus or varus instability

[a]PFPS, patellofemoral pain syndrome.

To look for demographic differences between the early unilateral PFPS and control groups, we applied the Student *t* test for independent groups to continuous variables and the Pearson χ^2 test or Fisher exact test for discrete variables. Differences in hip abduction strength asymmetry in the early unilateral PFPS group versus control group were assessed using the Hip Strength Asymmetry Index (HSAI). The HSAI is equal to (*weaker hip strength*/*stronger hip*) × 100, with strength being determined by the maximum force measured by a dynamometer during 3 trials of isometric contraction. Differences in the mean absolute hip abduction strength of the affected limb in the PFPS group versus the mean absolute hip abduction strength of the weaker limb in the control group were also calculated. We compared the 2 groups with the Student *t* test or Wilcoxon rank-sum test. We report descriptive statistics and 95% CIs where appropriate.

RESULTS

Analysis of baseline characteristics of the early unilateral PFPS and control groups failed to achieve statistically significant differences between the 2 groups with respect to age, height, weight, leg-length discrepancy, or weekly running mileage (Table 2). As expected, the early unilateral PFPS group scored significantly lower on the AKPQ (mean, 85.7 ± 10.1; $P < .0001$) compared with the control group (mean, 97.6 ± 5.7; $P < .0001$), which indicated a greater degree of anterior knee pain.

Analysis of hip abduction strength asymmetry according to the HSAI failed to achieve a significant difference in hip abduction asymmetry between the early unilateral PFPS and control groups when tested in both a neutral and extended hip position (P = .2272 and .6671, respectively) (Table 3 and Figure 3). Because our study sample size was large enough to find a difference as small as 8% at a power of 80%, this finding of no significant difference between groups indicates that if a difference exists, it is less than 8%. Scatter charts of the data demonstrate the presence of outliers or any unusual data distribution (see

TABLE 2
Demographics of the PFPS and Control Cohorts[a]

Characteristic	PFPS (n = 21)	Control (n = 36)	*P* Value
Age, y	30.5 ± 6.1	30.4 ± 15.2	.512
Height, cm	164.6 ± 5.8	166.4 ± 6.6	.154
Weight, kg	62.1 ± 9.9	62.6 ± 8.0	.421
Weekly running mileage, mi/wk	18.6 ± 6.8	18.5 ± 6.9	.505
Leg-length discrepancy, cm	0.57 ± 0.08	0.65 ± 0.11	.277
AKPQ	85.7 ± 10.1	97.6 ± 5.7	<.0001[b]

[a]Results are reported as mean ± SD. AKPQ, Anterior Knee Pain Questionnaire; PFPS, patellofemoral pain syndrome.
[b]Statistically significant difference between groups ($P < .05$).

TABLE 3
Hip Strength Asymmetry Index of the PFPS and Control Cohorts[a]

Position	PFPS (n = 21)	Control (n = 36)	*P* Value
Neutral	83.5 ± 10.2 (78.9-88.2)	87.0 ± 8.3 (84.2-89.8)	.2272
Extension	96.3 ± 21.9 (86.3-106.3)	96.6 ± 16.2 (91.1-102.1)	.6671

[a]Results are reported as mean ± SD (95% CI). PFPS, patellofemoral pain syndrome.

the Appendix, available in the online version of this article at http://ajsm.sagepub.com/supplemental).

Analysis demonstrated that hip abduction strength of the affected limb in patients with early unilateral PFPS was significantly stronger than that of the weaker limb of controls when testing strength in a neutral hip position; however, no significant difference was found when testing the hip in an extended position (P = .0305 and .1406, respectively) (Tables 4 and 5).

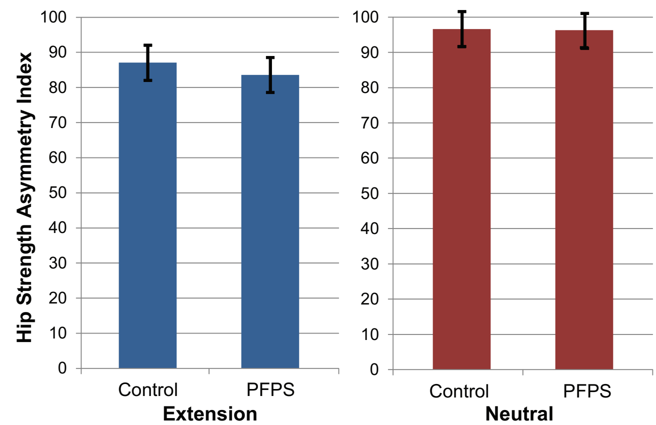

Figure 3. Mean Hip Strength Asymmetry Index of the hip abductors for the patellofemoral pain syndrome (PFPS) and control groups, measured with the hip in neutral and in extension. PFPS versus control: P = .2272 (neutral) and P = .6671 (extension). Error bars indicate 95% CI.

DISCUSSION

The results of our study demonstrated that female runners with early symptoms of PFPS do not appear to have clinically significant hip abduction strength asymmetry with respect to the HSAI when compared with healthy controls. This finding indicates that screening for hip abduction strength asymmetry may not be a useful method for identifying those at risk for developing PFPS that might require a health care provider visit, as had been postulated in previous literature.

Our finding of a lack of asymmetry in hip abduction strength between patients with early PFPS and healthy controls was unexpected. This result did not support our original hypothesis that hip strength asymmetry exists before the development of clinically significant PFPS and

TABLE 4
Hip Abduction Strength of the PFPS (Affected/Unaffected Limbs) and Control (Weaker/Stronger Limbs) Cohorts[a]

	PFPS (n = 21)			Control (n = 36)		
Position	Affected Limb	Unaffected Limb	*P* Value	Weaker Limb	Stronger Limb	*P* Value
Neutral	9.9 ± 2.2	10.0 ± 1.7	.8071	8.9 ± 1.4	10.3 ± 1.7	<.0001[b]
Extension	7.0 ± 1.4	7.4 ± 1.5	.7682	6.6 ± 1.5	8.1 ± 1.6	<.0001[b]

[a]Results are reported as mean ± SD. PFPS, patellofemoral pain syndrome.
[b]Statistically significant difference between weaker and stronger limbs ($P < .05$).

TABLE 5
Hip Abduction Strength of the PFPS (Affected Limb) and Control (Weaker Limb) Cohorts[a]

Position	PFPS, Affected Limb (n = 21)	Control, Weaker Limb (n = 36)	*P* Value
Neutral	9.9 ± 2.2 (8.9-11.0)	8.9 ± 1.4 (8.4-9.4)	.0305[b]
Extension	7.0 ± 1.4 (6.4-7.7)	6.6 ± 1.5 (6.1-7.1)	.1406

[a]Results are reported as mean ± SD (95% CI). PFPS, patellofemoral pain syndrome.
[b]Statistically significant difference between affected and weaker limbs ($P < .05$).

TABLE 6
Hip Abduction Strength of Dominant Leg Compared With Hip Abduction Strength of Both Legs in Controls

Neutral				Extension			
	Hip Abduction Strength, kg				Hip Abduction Strength, kg		
Dominant Leg	Left Hip	Right Hip	Hip Stronger on Dominant Side?	Dominant Leg	Left Hip	Right Hip	Hip Stronger on Dominant Side?
Right	10.4	10.8	Yes	Right	9.1	9.2	Yes
Right	8.5	8.5	Equal	Right	7.6	6.3	No
Right	10.2	10.6	Yes	Right	9.5	6.9	No
Right	7.7	9.9	Yes	Right	6.4	5.7	No
Right	10.2	12.0	Yes	Right	8.9	9.5	Yes
Right	7.4	10.4	Yes	Right	6.1	10.1	Yes
Right	8.3	9.3	Yes	Right	6.0	6.4	Yes
Right	10.4	9.5	No	Right	7.5	6.1	No
Right	7.6	7.7	Yes	Right	4.6	4.6	Equal
Left	8.2	9.8	Yes	Left	6.8	7.4	Yes
Right	9.8	11.0	Yes	Right	8.9	8.2	No
Right	8.5	9.2	Yes	Right	8.0	4.4	No
Right	8.6	9.9	Yes	Right	6.1	4.9	No
Right	9.2	9.6	Yes	Right	8.1	7.1	No
Right	6.0	7.3	Yes	Right	4.1	5.8	Yes
Right	8.0	10.1	Yes	Right	5.3	5.9	Yes
Right	10.5	14.2	Yes	Right	8.3	11.4	Yes
Right	11.3	10.7	No	Right	7.7	5.5	No
Right	7.7	9.2	Yes	Right	6.7	4.9	No
Right	9.2	9.2	Equal	Right	7.0	5.4	No
Right	9.6	13.3	Yes	Right	7.3	9.3	Yes
Right	7.9	8.9	Yes	Right	6.6	6.7	Yes
Right	6.0	6.6	Yes	Right	6.4	4.9	No
Right	10.0	10.7	Yes	Right	8.8	6.4	No
Right	8.6	9.2	Yes	Right	9.3	6.4	No
Right	11.3	9.9	No	Right	9.9	6.8	No
Right	8.9	10.2	Yes	Right	7.0	6.0	No
Right	8.0	10.4	Yes	Right	8.6	7.1	No
Right	10.9	11.4	Yes	Right	10.7	8.9	No
Right	12.1	10.1	No	Right	8.1	4.7	No
Right	8.8	10.5	Yes	Right	7.4	5.7	No
Right	8.1	9.4	Yes	Right	8.1	8.3	Yes
Right	10.1	13.6	Yes	Right	7.9	8.6	Yes
Right	7.9	10.4	Yes	Right	7.4	8.2	Yes
Right	12.4	12.7	Yes	Right	11.2	10.8	No
Right	8.6	7.0	No	Right	7.9	7.7	No

likely contributes to the progression of PFPS. An explanation of this finding is left to conjecture and thus needs further study to understand the mechanisms and pathophysiology that are associated with the early evolution of patellofemoral pain. Perhaps the absence of asymmetry could be explained by the time that it takes to clinically detect strength differences due to chronic overcompensation by the opposite hip. Runners with PFPS may favor their unaffected side to unload force on the painful knee, thus leading to increased strength in the favored side and decreased strength in the affected side. This measurable strength imbalance would likely take time to develop and therefore may not be measurable until later stages of PFPS. This theory is supported by the current body of literature that demonstrates hip strength asymmetry at clinically significant stages of PFPS[19,24] in conjunction with our finding of a lack of hip strength asymmetry relative to healthy controls at early stages of the condition. Another postulated mechanism is that gluteal weakness may develop later in the course of PFPS because of pain- or effusion-induced inhibition of nerve firing. The weakness of hip external rotators (gluteus maximus and the 6 deep lateral rotators) may also contribute as a risk factor of PFPS, but our study did not investigate these other muscles specifically. Knee joint effusion has been described to cause quadriceps weakness secondary to neural inhibition.[13,15] Potentially, a similar neural inhibitory mechanism of the hip musculature could be activated by knee pain or effusion in PFPS; this connection remains to be explored.

The results of our study also demonstrated no significant difference in hip abduction strength of the hip on the same side as the knee affected by PFPS in women with early PFPS compared with hip abduction strength of the weaker hip of controls when tested in an extended position. However, hip abduction strength of the hip on the same side as the knee affected by PFPS in women with early PFPS was significantly stronger than the weaker hip of controls when tested in a neutral position. Because testing hip abduction strength in a neutral position engages the tensor fasciae latae in addition to the gluteus medius compared with testing in an extended position, it may be the case that in early stages of PFPS, the tensor fasciae latae on the affected side is initially strengthened. It is possible that in the early stages of PFPS, the tensor fasciae latae on the affected side is engaged more significantly to unload stress on the knee affected by PFPS, thus leading to initial strengthening of this muscle.

With regard to our study methods, we elected not to use the Limb Symmetry Index (LSI) in our analysis, as done by other authors. In our opinion, the LSI is a less precise method for reporting hip strength asymmetry when compared with the HSAI because of 2 incorrect assumptions intrinsic to the LSI formula. First, the LSI for patients with knee pain is calculated based on the assumption that the hip on the same side as the painful knee is weaker. However, this is not always the case, as demonstrated by our data (Table 6). This assumption could bias the LSI to show less strength asymmetry than truly exists in a study population, once averaged. Consider 2 patients with a right leg that is truly 10% stronger than the left leg: one with knee pain on the right and the other with knee pain on the left. The average LSI for this group is 100%, so the mean LSI demonstrates no side-to-side hip strength asymmetry when there is truly a mean asymmetry of 10%. The second questionable assumption inherent to the LSI formula is that the stronger leg in the control group is the dominant kicking leg; however, it is not always the case that the dominant leg is stronger than the opposite limb.[14,16,31]

To create a more precise measure of hip strength asymmetry than the LSI, we have introduced the HSAI, which ensures that the stronger leg is correctly determined and placed in the denominator of the equation; thus, the HSAI provides the same measure of asymmetry (truly weaker/stronger side) in PFPS and control cohorts rather than assuming that the dominant kicking leg is also the stronger leg. This consistency allows for more precise comparison between the patient and control groups; therefore, we propose that the HSAI should be used by investigators when reporting side-to-side strength asymmetry assessed with a dynamometer.

We acknowledge that this study is limited by its specific study population and the lack of a true gold standard measure to objectively and clinically measure hip strength. Our data set demonstrates a lack of association between early PFPS and hip abduction strength asymmetry. However, a large prospective trial would be required to further define the point during the spectrum of the disease at which hip abduction strength asymmetry does in fact develop. This would help answer the “chicken or the egg” question: Does hip abduction strength asymmetry develop because of PFPS, or does it cause progression of PFPS symptoms? Moreover, we studied only female runners aged 18 to 45 years, which limits the generalizability of our results beyond female runners in this age range.

CONCLUSION

Our results indicate that, unlike patients with PFPS seeking medical care, early PFPS does not appear to be significantly associated with hip abduction strength asymmetry.

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