Exploring the Role of the Lateral Gluteal Muscles in Running: Implications for Training

K. Aleisha Fetters, MS, CSCS
Chicago, Illinois

ABSTRACT

Gluteal-strengthening exercises are widely used for improving running performance. However, as running occurs primarily in the sagittal plane, such strength exercises have focused on the gluteus maximus and its role in producing ground reaction forces as a hip extensor. Meanwhile, strength deficits in the lateral gluteal muscles, the medius and minimus, are common among runners. This article will explore the role of the lateral gluteal muscles in running kinematics, performance, and injury, with implications for strength and conditioning professionals, sports medicine specialists, and physical therapists. Recommendations for strengthening the gluteus medius and minimus in runners will follow.

INTRODUCTION

Linking the lower extremities to the axial skeleton, the hips are integral to running mechanics. Of the more than 20 muscles that act on the ball-and-socket joint (3), the gluteals are arguably the most critical to running performance. Comprising the gluteus maximus, medius, and minimus, they form the largest muscle group of the hips. Together, they allow the femur to act in all 3 planes of motion–sagittal, frontal, and transverse–performing extension, flexion, abduction, adduction, internal rotation, and external rotation (16).

Running is primarily a sagittal plane activity, with hip extension serving as a fundamental movement pattern. Hip extension is largely responsible for creating the ground reaction forces necessary to move the body forward. As the hip extends through the late flight and early support phase, it generates forces that drive downward into the ground and act reciprocally on the body to propel the opposite leg's swing phase. Vertical forces applied to the ground are a primary determiner of running speed (10).

The gluteus maximus connects the lateral aspect of the dorsal sacral surface, posterior part of the ilium, and thoracolumbar fascia to the iliotibial tract and femur's gluteal tuberosity. Acting as the hip's primary extensor, it is the largest, most powerful, and most superficial of the 3 gluteal muscles. (22) Therefore, it is not surprising that runners and athletic professionals have long focused on strengthening the gluteus maximus as a way to improve force production, running speed, and performance. It is notable that common strength exercises for runners–such as squats, lunges, glute bridges, and deadlifts–train the hip extensors through movements that occur primarily in the sagittal plane (3).

However, despite the importance of these gluteus maximus dominant exercises in improving hip extensor strength, a focus on sagittal movements can result in detriments in the 2 lateral gluteal muscles, the medius and minimus. Weaknesses in these muscles are common, especially in runners, and have been implicated in reduced metabolic efficiency and running economy (5) as well as overuse injuries that are common in runners, including iliotibial band syndrome (6), low-back pain (4), and plantar fasciitis (21).

ANATOMY AND FUNCTION OF THE LATERAL GLUTEAL MUSCLES

Deep to the gluteus maximus (Figure 1) are the 2 lateral gluteal muscles, the gluteus medius and minimus. The larger of the 2, the gluteus medius (Figure 2) lies beneath the fascia lata. Broad and almost continuous with the iliac

Address correspondence to K. Aleisha Fetters, kafetters@gmail.com.

KEY WORDS:
running; running mechanics; gluteus medius; gluteus minimus; hip abductors; strength training

crest, it narrows to connect to the lateral aspect of the greater trochanter of the femur. Deep to the gluteus medius, the smaller gluteus minimus (Figure 3) attaches the gluteal surface of the ilium to the anterolateral aspect of the greater trochanter (3).

The 2 muscles serve as principal hip abductors, moving the femur away from the midline of the body (3). The gluteus medius is the largest hip abductor, accounting for approximately 60% of the total cross-sectional area of the hip abductor musculature. The gluteus minimus accounts for approximately 20% (19).

The gluteus minimus comprises 2 segments of fibers, anterior and posterior; the gluteus medius, 3 segments: anterior, middle, and posterior. Although all fibers contribute to abduction of the hip, each segment has its own unique functions and is able to act independently as well. From the anatomical position, the anterior fibers of the gluteus medius and minimus assist in internal rotation, and the posterior fibers produce external rotation (16). The middle segment of the gluteus medius contributes to abduction as well as internal and external rotation (24). The gluteus minimus anterior fibers also aid in internal rotation, most notably when the hip is flexed. The posterior fibers of both the gluteus medius and minimus also contribute to hip extension (16).

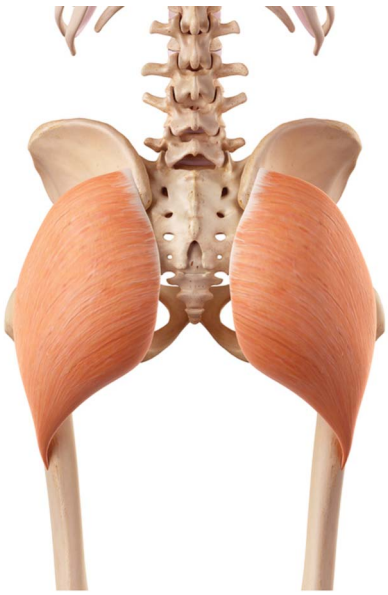

Figure 1. Gluteus maximus anatomy. The largest and most superficial of the gluteal muscles, the gluteus maximus connects multiple surfaces of the pelvis, including the surface of ilium posterior to the posterior gluteal line and posterior inferior surface of sacrum and coccyx, to the gluteal tuberosity of the femur and iliotibial band.

Figure 2. Gluteus medius anatomy. Deep to the gluteus maximus, the gluteus medius is almost continuous with the iliac crest, narrowing to connect to the lateral aspect of the greater trochanter of the femur.

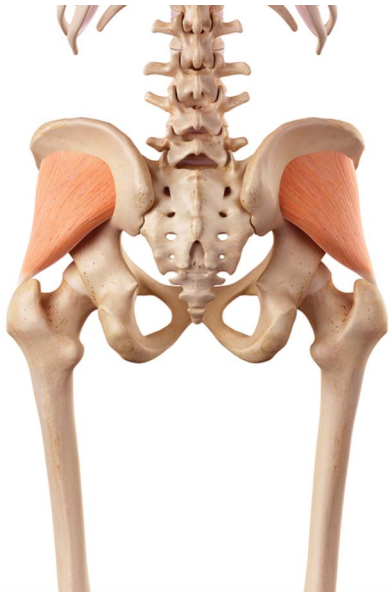

Figure 3. Gluteus minimus anatomy. Deep to the gluteus medius, gluteus minimus is the smallest of the 3 gluteal muscles, attaching the gluteal surface of the ilium to the anterolateral aspect of the greater trochanter.

CONTRIBUTIONS OF THE LATERAL GLUTEALS IN RUNNING

In running, the primary function of the lateral gluteal muscles is to stabilize the hip joint throughout the gait cycle.

Electromyography suggests that gluteus medius activity peaks in the beginning of the gait cycle; (23,25) at foot strike, the gluteus medius acts eccentrically to control hip adduction and, then, from the support phase into propulsion, concentrically to create hip abduction (2). Higher levels of gluteus medius activation have been observed with increased running speeds (23).

During the midphase and late phases of the gait cycle, the gluteus minimus assists in stabilizing the hips (9). Electromyography shows that the fibers of the posterior segment are largely recruited in the first 20% of the gait cycle and the anterior fibers later in the stance phase (24). The more posterior fibers of both the gluteus medius and gluteus minimus also contribute to hip

extension in the stance phase of running (14).

The gluteus medius and minimus produce peak forces that, in sum, are 3.5 times that of the gluteus maximus. This is likely due to the lateral gluteals' contribution to hip joint movements in all 3 planes of motion during running (14).

Weaknesses in the lateral gluteals can contribute to an increase in thigh adduction and frontal plane pelvic drop, the latter of which has been shown to result in metabolic inefficiency, and could therefore adversely affect running speed and performance (5).

INFLUENCE ON INJURY PREVENTION AND REHABILITATION

The instability created by weaknesses in the lateral gluteals has been shown to simultaneously increase the peak impact vertical ground reaction forces in running and impair the body's ability to properly absorb those forces. This can potentially increase the risk of lower extremity injury (2).

Although the role of hip abductor weaknesses in iliotibial band syndrome is currently debated (1,6), weaknesses in the gluteus medius specifically have been shown to increase knee valgus, or dynamic Q-angle. theoretically creating excess tension on the iliotibial band and increasing its risk of impingement against the femur. Dynamic Q-angle refers to the changing line of force of the quadriceps, illustrated by a line connecting the anterior superior iliac spine to the midpoint of the patella. The likelihood of impingement is greatest in the early stance phase of the gait cycle when, to absorb ground reaction forces, maximal deceleration occurs (6).

An increased dynamic Q-angle may also increase the risk of anterior cruciate ligament injury during landing (11) or cause patellofemoral tracking problems, with chronic injuries as a result (12). Electromyography shows that during gait, women with patellofemoral pain display delayed and shorter periods of gluteus medius activation compared with women without knee pain (27). A separate meta-analysis

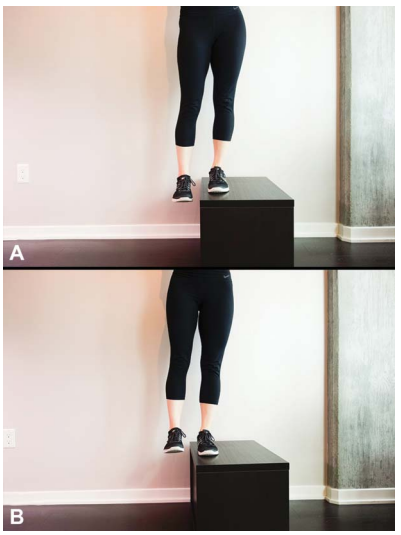

Figure 4. Hip hitch. Stand tall on the edge of a sturdy bench or step, and transfer body weight to 1 leg. Let the other leg hang off of the side of the bench, keeping both feet in line with each other. (A) From here, with the planted leg fully straight, drop the hip to lower the hanging foot a few inches toward the floor. (B) Pause, and then, raise the hip until the hanging foot is just higher than the planted one. Maintain full hip extension in the planted leg throughout. Perform all repetitions and then repeat on the opposite side.

Figure 5. Hip hitch with toe tap. (A) Stand tall with a short object (about 6–8 in) in front of feet and transfer body weight to 1 leg, raising the opposite foot up to the toes for balance. (B) From here, raise the hip of the non–weight-bearing leg, moving the foot forward and up to touch the toes to the object. Pause and then lower the hip. Maintain full hip extension in the planted leg throughout to increase gluteus medius activation. Perform all repetitions and then repeat on the opposite side.

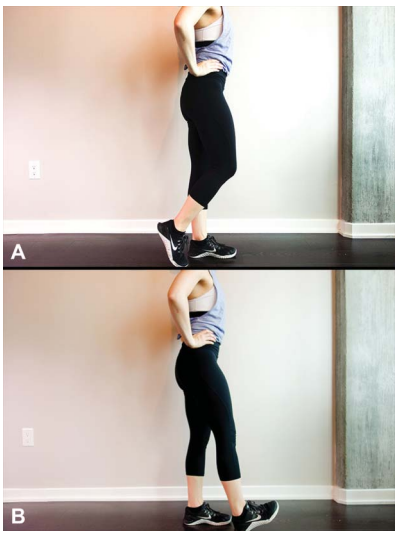

Figure 6. Hip hitch with leg swing. (A) Stand tall and transfer body weight to 1 leg. Extend the hip of the other so that the foot rests on the toe, in line with the planted foot's heel. (B) Flex the hip to move the foot forward so that the heel touches the floor, in line with the planted foot's toe. Maintain full hip extension in the planted leg throughout to increase gluteus medius activation. Perform all repetitions and then repeat on the opposite side.

showed evidence that the strengthening of the hip abductor muscles can reduce pain and improve function in patients with patellofemoral pain. However, authors note that research in highly trained athletes with patellofemoral pain is currently lacking (20).

Weaknesses in the hip abductor muscles have also been linked with increased occurrences of low-back pain (4) as well as greater trochanteric pain syndrome (8), and strengthening the hip abductors and external rotators, which would include both the gluteus medius and minimus, has been shown to be effective in helping reduce pain in plantar fasciitis (13).

STRENGTHENING THE LATERAL GLUTEALS IN RUNNERS: RECOMMENDATIONS

Given the functions of the lateral gluteal muscles and their role in running mechanics and injury risk, it is clear that exercises involving hip abduction, external rotation, and, to some degree, internal rotation can help recruit the gluteus medius and minimus to address strength deficits in those muscles.

The hip hitch (Figure 4), hip hitch with toe tap (Figure 5), and hip hitch with leg swing (Figure 6) have been shown to produce high levels of muscle activity in all sections of the gluteus medius and minimus (7). The wall press (Figure 7) has similarly been shown to elicit high levels of activation of the posterior fibers of the gluteus medius (17). This may be due to the lateral gluteals' primary role of stabilizing the planted leg in single stance.

High levels of gluteus medius activation occur in the single-leg bridge (Figure 8), clamshell (Figure 9), side plank with hip abduction (Figure 10), and side-lying hip abduction (Figure 11) (26). The side-lying hip abduction elicits high levels of activation in the posterior segment of the gluteus minimus as well (15).

However, because running is a dynamic activity involving multijoint movement, it is also important to integrate compound resistance training exercises to strengthen the lateral gluteal muscles in runners. Unilateral, closed-chain, exercises, especially, can be considered

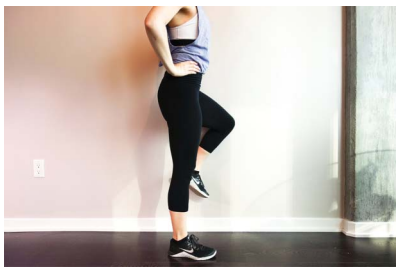

Figure 7. Wall press. Stand tall next to a wall with feet together, the nearest foot about 6 in from the wall. Flex the hip and knee of the leg closest to the wall. Externally rotate the hip—combining abduction and rotation—to press the knee and lower thigh into the wall, but not the foot and lower leg into the wall. Maintain full hip extension in the planted leg throughout to increase gluteus medius activation. Maintain a level lumbo-pelvic position (not letting the pelvis drop at all) throughout the exercise. Hold. Perform all repetitions on 1 side, then repeat on the opposite side, or perform alternating sides with each repetition.

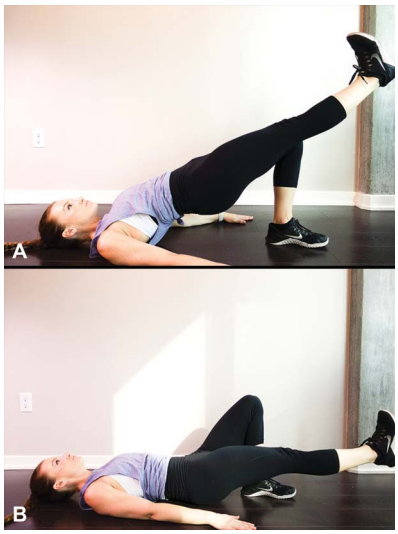

Figure 8. Single-leg bridge. (A) Lie in the supine position with the knees bent and feet flat on the floor, hip-width apart. Lift 1 foot off of the floor. It can be extended (as shown) or flexed at the hip and/or knee. (B) Push through the planted heel and engage the gluteals to fully extend the hip. (Most exercisers will feel maximal gluteal activation when the foot is placed so that the shin is perpendicular to the floor on full hip extension. However, some achieve heightened activation with a foot setup that allows the shin to form an acute or obtuse angle with the floor on full extension). Resist the tendency for the hip of the raised leg to drop. Perform all repetitions and then repeat on the opposite side.

Figure 9. Clamshell. Lie on the floor on 1 side with legs and feet stacked and knees bent to 90°. Externally rotate the top hip to raise the knee as high as possible while keeping feet stacked. The athlete must also maintain a neutral, motionless spine. The lumbosacral spine should not rotate at all and must remain stationary throughout the exercise. The range of motion attained during the exercise will also depend on the client's limb length and hip joint flexibility. Pause, and then, slowly lower the knee. A small, looped resistance band can be placed around the knees to increase resistance. Perform all repetitions and then repeat on the opposite side.

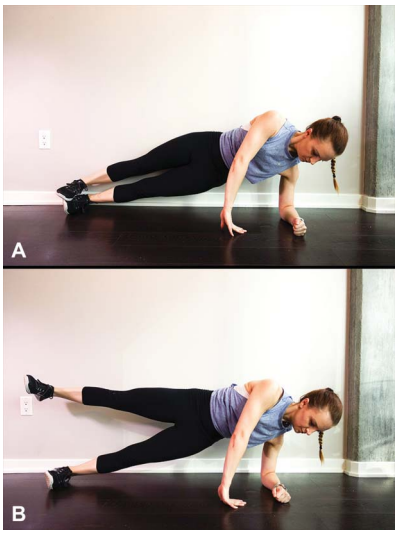

Figure 10. Side plank with hip abduction. (A) Get in a side-plank position with the bottom foot and forearm on the floor, elbow directly under the shoulder. (B) Engage the gluteals to abduct the top leg toward the ceiling. Pause, and then, slowly lower the top leg. A small, looped resistance band can be placed around the legs to increase resistance on the gluteals. To increase the demands for core stabilization, the athlete can perform the exercise with the stabilization offered by the top hand bracing against the floor. However, this could reduce the maximal force exerted by the gluteals. Perform all repetitions and then repeat on the opposite side.

Figure 11. Side-lying hip abduction. Lie on the floor on 1 side with legs and feet stacked. Engage the gluteals to abduct the top leg toward the ceiling. Pause, and then, slowly lower the top leg. A small, looped resistance band can be placed around the legs to increase resistance. Perform all repetitions and then repeat on the opposite side.

Figure 12. Lateral step-up. (A) Stand next to a sturdy bench or step, and place 1 foot firmly on top of it. Transfer body weight to that foot so that there is no weight in the trailing foot. (B) Drive through the heel of the lead foot to raise to a standing position, the trailing foot hanging behind bench in line with the lead foot. Pause, and then, slowly bend hip and knee of planted leg to the lower trailing foot toward floor without putting any weight into the foot. Perform all repetitions and then repeat on the opposite side. Bench height can be increased and external load added to increase resistance.

sports-specific to runners. These exercises functionally train the lateral gluteals to stabilize the hips, just as they are required to do during the single-leg stance phase of running. Unilateral compound exercises that have been shown to produce high levels of gluteus medius activation include the lateral step-up (Figure 12), single-leg squat (Figure 13), and skater squat (Figure 14) (26).

Single-leg squats and skater squats are both advanced movements and also place considerable load on the quadriceps. It is advised that athletes progress to these movements after becoming proficient at the bilateral squats and use a small range of motion before increasing unilateral squat depth.

In the gluteus minimus, high activity levels have been generated in the anterior segment, by the resisted hip abduction–extension, and in the posterior segment, by the single-leg bridge, side-lying hip abduction, and single-leg squat (15).

It has been advised that lateral gluteal-specific training follows a traditional resistance training model consisting of 3–5 sets of an exercise, depending on the performance level. At the beginning of a training session, more complex and heavily loaded exercises may be programmed, with less heavily loaded and bodyweight exercises following (26).

At the onset of gluteal-specific training, medius and minimus exercises should be performed according to the rate of perceived exertion with 1–2 minutes of rest between sets. The target rate of perceived exertion should be based on the athlete's current strength and injury status. Over time, heavier repetition maximum loads can be programmed with the appropriate rest intervals based on the percentage of estimated 1 repetition maximum (26).

To save training time, agonist–antagonist supersets can also be used, in which the lateral gluteals are worked and then given rest during hip flexion exercises. It is recommended to perform only 2 sets per exercise with these supersets because exercise technique can worsen as fatigue accumulates. Agonist–antagonist superset training should generally be limited to 2 sessions per week (26).

Figure 13. Single-leg squat. (A) Stand tall with feet together, transfer body weight to 1 leg and extend the opposite leg and both arms in front of the body. (B) Bend the knee and hip of the planted leg to lower body as far toward the floor as possible without losing form or the heel of the planted foot raising off of the floor. Maintain a level lumbo-pelvic position (not letting the pelvis drop at all) throughout the exercise. The athlete can be cued to "keep both hips level." Pause, then push through the heel of the planted foot to extend the hip and knee. Perform all repetitions and then repeat on the opposite side. Squat depth will depend on not only strength but also mobility as defined by joint structure. Perform sitting to a tall bench or step before progressing below parallel. Holding a weight in the outstretched hands can also serve as a counterweight.

In cases of injury or severe unilateral hip abductor strength imbalance, runners may need to avoid heavily loaded exercise in favor of protocols more geared to muscular endurance, with light sets of 15–30 reps (18). Professionals without a strong background in rehabilitation should consult with or refer to a specialized physical therapist

Figure 14. Skater squat. Stand tall with feet together, transfer body weight to 1 leg and flex hip and knee of opposite leg so it is slightly off of the floor. Flex the hip and knee of the planted leg to lower as far into a squat as possible without losing form or the heel of the planted foot raising off of the floor. The raised leg will descend behind the torso. Maintain a level lumbo-pelvic position (not letting the pelvis drop at all) throughout the exercise. Squat depth will depend on not only strength but also mobility as defined by joint structure. Perform lowering the knee of the raised leg to a BOSU or foam pad before removing the potential landing surface.

for recommendations individualized to that athlete. In cases of unilateral hip abductor strength imbalance, the weaker side should determine all programming–including training volume, load, and repetitions. The athlete should also train the weaker side before the stronger one. Unilateral exercises may be advised over bilateral ones (26).

Finally, although the lateral gluteals function to stabilize the pelvis and knee, electromyography shows that performing on an unstable surface does not result in additional gluteus medius recruitment during squatting. The use of unstable surfaces in lateral gluteal training is likely unnecessary (26).

PRACTICAL APPLICATIONS AND CONCLUSION

Deficits in lateral gluteal strength, with potential effects on both running performance and injury risk, are common among recreational and elite runners. Therefore, it is important for strength and conditioning professionals, sports medicine specialists, and physical therapists to help their athletes optimize gluteus medius and minimus strength and function. This review highlighted the roles of both muscles in running mechanics, efficiency, and overuse injuries such as IT band syndrome and low-back pain. Although more research is needed, some broad recommendations can be made from the information reviewed. Sports-specific exercises, emphasizing single-stance, hip abduction, and external rotation, should be performed, with training load and volume contingent on current strength levels and rehabilitation status.

Conflicts of Interest and Source of Funding: The author reports no conflicts of interest and no source of funding.

K. Aleisha Fetters *is a Chicago-based strength and conditioning specialist.*

REFERENCES

1. Arab AM and Nourbakhsh MR. The relationship between hip abductor muscle strength and iliotibial band tightness in individuals with low back pain. *Chiropr Osteopat* 18: 1, 2010.
2. Burnet EN and Pidcoe PE. Isometric gluteus medius muscle torque and frontal plane pelvic motion during running. *J Sports Sci Med* 8: 284–288, 2009.
3. Byrne DP, Mulhall KJ, and Baker JF. Anatomy & biomechanics of the hip. *Open Access J Sports Med* 4: 51–57, 2010.
4. Cooper NA, Scavo KM, Strickland KJ, et al. Prevalence of gluteus medius weakness in people with chronic low back pain compared to healthy controls. *Eur Spine J* 25: 1258–1265, 2016.
5. Estivalet M and Brisson P. Relationship between gluteus medius muscle activity, pelvic motion, and metabolic energy in running

(P190). In: *The Engineering of Sport* 7. Paris, France: Springer, 2009. pp. 267–271.

6. Fredericson M, Cookingham CL, Chaudhari AM, et al. Hip abductor weakness in distance runners with iliotibial band syndrome. *Clin J Sport Med* 10: 169–175, 2000.
7. Ganderton C, Pizzari T, Cook J, and Semciw A. Gluteus minimus and gluteus medius muscle activity during common rehabilitation exercises in healthy postmenopausal women. *J Orthop Sports Phys Ther* 47: 914–922, 2017.
8. Ganderton C, Pizzari T, Harle T, Cook J, and Semciw A. A comparison of gluteus medius, gluteus minimus and tensor facia latae muscle activation during gait in post-menopausal women with and without greater trochanteric pain syndrome. *J Electromyogr Kinesiol* 33: 39–47, 2017.
9. Gottschalk F, Kourosh S, and Leveau B. The functional anatomy of tensor fasciae latae and gluteus medius and minimus. *J Anat* 166: 179–189, 1989.
10. Haff GG and Triplett TN, eds. Program design and technique for speed and agility training. In: *Essentials of Strength Training and Conditioning*. Champaign, IL: Human Kinetics, 2016. pp. 527–531.
11. Hughes G and Watkins J. A risk-factor model for anterior cruciate ligament injury. *Sports Med* 36: 411–428, 2006.
12. Ireland ML, Willson JD, Ballantyne BT, and Davis IM. Hip strength in females with and without patellofemoral pain. *J Orthop Sports Phys Ther* 33: 671–676, 2003.
13. Kamonseki DH, Goncalves GA, Yi LC, and Junior IL. Effect of stretching with and without muscle strengthening exercises for the foot and hip in patients with plantar fasciitis: A randomized controlled single-blind clinical trial. *Man Ther* 23: 76–82, 2016.
14. Lenhart R, Thelen D, and Heiderscheit B. Hip muscle loads during running at various step rates. *J Orthop Sports Phys Ther* 44: 766–774, 2014.
15. Moore D, Semciw AI, McClelland J, Wajswelner H, and Pizzari T. Rehabilitation exercises for the gluteus minimus muscle segments–An electromyography study. *J Sport Rehabil* 22: 1–8, 2018.
16. Neumann DA. Kinesiology of the hip: A focus on muscular actions. *J Orthop Sports Phys Ther* 40: 82–94, 2010.
17. O'Sullivan K, Smith SM, and Sainsbury D. Electromyographic analysis of the three subdivisions of gluteus medius during weight-bearing exercises. *Sports Med Arthrosc Rehabil Ther Technol* 2: 17, 2010.
18. Presswood L, Cronin J, Keogh JW, and Whatman C. Gluteus medius: Applied anatomy, dysfunction, assessment, and progressive strengthening. *Strength Cond J* 30: 41–53, 2008.
19. Reiman MP, Bolgla LA, and Loudon JK. A literature review of studies evaluating gluteus maximus and gluteus medius activation during rehabilitation exercises. *Physiother Theor Pract* 28: 257–268, 2012.
20. Rogan S, Haehni M, Luijckx E, et al. Effects of hip abductor muscles exercises on pain and function in patients with patellofemoral pain: A systematic review and meta-analysis. *J Strength Cond Res*, 2018. [Epub ahead of print].
21. Santos BD, Corrêa LA, Teixeira Santos L, et al. Combination of hip strengthening and manipulative therapy for the treatment of plantar fasciitis: A case report. *J Chiropr Med* 15: 310–313, 2016.
22. Seidenberg PH, Bowen JD and King DJ, eds. Functional therapeutic and core strengthening. In: *The Hip and Pelvis in Sports Medicine and Primary Care*. Cham, Switzerland: Springer, 2017. p. 212.
23. Semciw A, Neate R, and Pizzari T. Running related gluteus medius function in health and injury: A systematic review with meta-analysis. *J Electromyogr Kinesiol* 30: 98–110, 2016.
24. Semciw AI, Green RA, Murley GS, and Pizzari T. Gluteus minimus: An intramuscular EMG investigation of anterior and posterior segments during gait. *Gait Posture* 39: 822–826, 2014.
25. Semciw AI, Pizzari T, Murley GS, and Green RA. Gluteus medius: An intramuscular EMG investigation of anterior, middle and posterior segments during gait. *J Electromyogr Kinesiol* 23: 858–864, 2013.
26. Stastny P, Tufano JJ, Golas A, and Petr M. Strengthening the gluteus medius using various bodyweight and resistance exercises. *Strength Cond J* 38: 91–101, 2016.
27. Willson JD, Kernozek TW, Arndt RL, Reznichek DA, and Scott Straker J. Gluteal muscle activation during running in females with and without patellofemoral pain syndrome. *Clin Biomech (Bristol, Avon)* 26: 735–740, 2011.