Pilates and Long Distance Running: An Examination of the correlation of weak hamstrings and core to injury.

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Abstract

Running is a wonderful cardiovascular exercise for many populations. From a biomechanical perspective, proper core strength and flexibility are essential to control proper biomechanics while running to prevent injuries. In addition, hamstring and hip muscle weakness or inflexibility can play a significant role in the development of running-related injuries such as low back pain. It is important to note that one must cross train for proper running mechanics. Pilates provides balance and stability through the core and helps create lumbo pelvic stability needed in distance running. Research has shown that good core stability along with muscle balance between the anterior and posterior sides of the body seems to be a key factor to preventing and effectively rehabilitating from overuse injuries for runners of all ages.
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Introduction

The benefits of Pilates for runners are numerous. Long distance running requires more than just strong legs and lungs to endure through the miles. A distance runner must have a strong core to complement the elements of endurance, flexibility, stability and balance. While running, a runner endures constant impact through the body. The force of each step travels up from the legs to the lower back and rib cage. The core strength acquired through Pilates not only makes those areas better able to deal with the impact, it improves body alignment and balance, helping the runner distribute the force of running throughout the body more efficiently (Runners World, 2014).

Pilates also helps runners with flexibility through proper stretching with a focus on breathing. This benefit of breath is synergistic with stretching because this stimulates the intercostals muscles that connect the ribs while warming up the core. This makes it easier to breathe smoothly using all available lung capacity.

Due to the repetitive nature of running and the demand on time to fit in the miles, many runners discover they only have time for running within their training program. Thus, they do not incorporate cross training into their training program therefore creating muscle imbalance and weakness in key areas needed for stability. This scenario creates a recipe for potential injuries to occur throughout their training. Injuries include, but are not limited to low back pain, hip pain, hamstring injuries, knee pain and/or injuries, and plantar fasciitis.

Analysis of these injuries proves that in many instances the hamstrings play a key role. Research has shown that the strength of the hamstring muscles tends to be ignored versus tightness of the muscle when examining symptoms. “Runners do a lot of quadriceps work
in particular, hoping to diminish knee problems. Many runners have quadriceps muscles that are 30 to 40 percent stronger than their hamstrings.” (Runners World, 2014). Weak hamstrings in conjunction with the gluteals affect the gait cycle and the ability to stride while running. Due to this muscular imbalance, a runner may suffer lower back pain, tightness in the hips and knee pain. Weak hamstrings can also lead to the misalignment of the pelvis, which leads to a stooped spine. According to Reform Pilates and Movement, having weak hamstrings can cause the quadriceps located on the upper thigh in front of the leg to overcompensate (2013).

Generally, tight, inflexible hamstrings get attention as a cause of lower back pain, but in many instances, weak hamstrings are causing the pain. Weaker muscles tire quickly though they may not lack strength, and tired muscles begin to contract to try to avoid further use. This relationship causes the quadriceps to activate before the hamstring recovers and lengthens. The result of this may be a pulled, strained or torn hamstring. When the hamstring cannot provide the contraction that is needed and becomes hurt or strained, other muscles will begin to compensate. Most often lower back muscles are called into action along with muscle in the hips.

Pursuing a workout regimen that includes strengthening and stretching the hamstring muscle group, balanced with strengthening and stretching the quadriceps, may prevent hamstring weakness and injury. In addition, core strengthening for stability is essential. Running technique may suffer when an individual cannot effectively stabilize the core resulting in further compensation and potential injury.
Anatomical Description and Relationship to the Biomechanics of Running

The hamstring muscle group comprises three muscles - biceps femoris, semitendonosus and semimembranosus. The hamstrings are at the back of the thigh and cross the hip and knee joints. Since the hamstrings cross two joints, they have two actions, which include knee flexion and hip extension and hyperextension. According to Amy Ridderikhoff in "Medicine and Science in Sports and Exercise," the hamstrings also have major roles in forward propulsion and transferring power between hip and knee joints (Burghelli, 2011)

Since the main actions of the hamstrings are to flex the knee and extend the hip, they are vulnerable to injury during the opposite movements. For example, during running as the leg swings forward, the hamstrings are activated and stretched. This stretching is due to both hip flexion and knee extension, both opposite actions of the hamstrings. Injuries can be avoided with proper hamstring strengthening and stretching programs.
The abdomen is the region lying between the proximal chest and the distal pelvis. Four muscles provide shape and movement to the anterior abdominal wall. The internal and external obliques, transverse abdominis, and the rectus abdominis. These muscles contribute to spine stability and also provide the following range of motion within the area: flexion, lateral flexion/side bend, and rotation. These muscles also serve to protect the abdominal organs.

Weakness in the core musculature of the body can negatively influence lower extremity biomechanics and running performance. The lumbar spine, pelvis and hip region together form the core and work together to create functional stability and mobility. When the core is functioning efficiently, advantageous length-tension relationships are maintained which allow the runner to produce strong movements in the extremities. In addition, proper core stability increases running performance, assists in maintaining the center of gravity over the base of support, controls lower extremity limb motion and help prevent running-related injuries.

![Image of abdominal muscles]

*Figure 7.1* Transversus abdominis, external oblique, internal oblique, and rectus abdominis.
Case Study

Susan is a 36-year-old female who has been running consistently since her high school years. On average she runs 3 to 4 days per week averaging 20-30 miles, and has recently taken up trail running. She competes regularly in half and full marathon races and is a top performer within her age range placing within the top 3 place positions. She has also competed in s few ultra endurance trail runs and performed exceedingly well. Beyond running Susan participates in Pilates mat class, TRX Suspension training, Piloxing and Barre classes, but on a very inconsistent basis.

Susan has been experiencing some lower back pain along with hip tightness and pain during and after her run. When taking fitness classes she notices that her hamstrings, gluteals, and abductors become increasingly sore after the workout. Upon a postural assessment, she presents with a forward head, rounded shoulders, supination of the feet, along with slight hyperlordosis of the lumbar spine, which is often associated with tight hip flexors and weak hip extensors. Her right hip has a slight hike. Her gait presents with the same findings, with an additional finding of minimal arm swing. Her running technique also presents with the same limitations. After a short assessment of manual muscles testing, it is affirmed that Susan’s hamstrings and quadriceps have a strong imbalance with the hamstring being very weak. Susan works as a high school administrative assistant sitting most of the day in front of her computer. Her core strength is poor and underactive in support and stability. This is only reinforcing her tight hip flexors, rounded shoulders, weak hamstring/gluteals, and lack of neutral spine within her posture.
Susan has some experience with Pilates in mat classes, as well as, equipment so an intermediate program would be appropriate for her. Susan has committed to an 8 week Pilates program consisting of 2 private sessions a week. She will continue her other fitness classes as her schedule permits. Her running program will be reduced to approximately 10-15 miles a week. Her goal is to take some time to strengthen her hamstrings, gluteals, and abductors and increase her flexibility in her hip flexors. In addition, she will work on maintaining neutral spine throughout her movement in and out of fitness classes and running to minimize the effects of her hyperlordotic spine. She is hoping to continue to run in ultra endurance races therefore strengthening these inhibited muscles of the core and hamstrings/abductors and gluteals and creating length in her overactive muscles of the hip flexors will be key to her success in her running, as well as, her injury prevention
BASI Conditioning Program

The following was addressed when creating a conditioning program for Susan:

- Current running mileage per week.
- Hamstrings need to be strengthened along with gluteals as they are inhibited, which has created a muscle imbalance with the quadriceps.
- Hip flexors need stretching to create length, as they are overactive and tight. This will realign hips and create stronger lumbo pelvic stability. This will also help with maintaining neutral position of the pelvis.
- Strength work through the core to help pelvic stabilization through the gait/running cycle to help reduce low back pain and hip tightness.
- Footwork on the reformer to work neutral foot to decrease supination of the foot causing tight peroneals and IT band affecting running technique and reinforcing overactive muscles and muscle imbalance.
- Strengthening of abductors and adductors, as well as, opposite gluteal strength to assist with pelvic stability to prevent hip hiking.
- Focused work on a co-contraction between abdominal and back extensors to create trunk support & stability.

Warm-Up – on mat

- Pelvic Tilt
- Pelvic Curls
- Spine Twist supine
- Chest lift
- Chest lift with rotation
- Single leg lifts/leg changes
Foot Work on Reformer – 3 Red Springs

- Heel,
- Toes
- V toes.
- Open heels
- Open toes
- Calves
- Prances

Singleg legwork 2R/1B
- Heels
- Toes

Abdominals on Reformer 1 Red/1 Blue Spring

- Hundred Prep
- Coordination

Hips on Reformer 1 Red/1 Blue Spring

- Frog
- Down Circles
- Up Circles
- Openings

Articulation on Reformer 2 Red/1 Blue Spring

- Bottom lift
- Bottom lift with Extension

Stretches on Reformer 1 Red Spring

- Kneeling lung

Full Body Integration on Reformer 1 Red Spring

- Scooter
- Elephant
- Up stretch 1

**Seated Arms on Reformer 1 Red Spring**
- Chest expansion
- Biceps
- Rhomboids
- Hug a Tree
- Salute

**Legs on Chair**
- Hamstring Curls
- Hip opener

**Legs on Mat**
- Single leg kick

**Lateral Flexion/Rotation on Combo Chair**
- Side Over

**Back Extension on Combo Chair**
- Swan Basic

**Cool Down – Roll Down**
Conclusion

After completion of the 8-week program Susan developed strength and balance during her Pilates training. She responded very well to the program in a relatively short period of time. She experienced gains in her hamstrings and core strength. She started to fire the hamstrings and glutes on cue and maintain the proper muscle contraction when needed during exercise while decreasing the use of her quadriceps. Through stretches and hip opener she feels as if her hips have greater flexibility and mobility. She continues to stretch her hip flexors on a regular basis throughout the day. Her low back pain has diminished, but we continue to work on her hip hike. She is able to control the hip while working through most exercises with the exception abduction.

Through back extension and constant awareness of neutral spine, her posture is more upright and aligned. She is able to maintain a neutral posture while running her long distances but does fatigue towards the end. Her training will need to continue as she increases her mileage, but she feels a vast improvement in overall strength and less pain during and after her runs. She has learned to activate and maintain proper muscle contraction and to not allow her compensatory muscles to overtake inhibited muscles. Susan plans to continue with her Pilates practice twice a week along with Pilates mat class and barre classes 1 to 2 times per week. She is currently training for a 50K, which takes place in the next few months.
Bibliographies


Image Credits:


Hamstrings. Retrieved from Bodybuilding24X7.com