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Getting Back To Exercise Without Pain: The Knee

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Abstract: Most people today live a sedentary lifestyle, lack of movement results in the body becoming less equipped to take part in sporting activities. When the body is expected to perform, a weak musculoskeletal foundation can lead to postural deviations, muscular imbalances and unaligned joints. The risk of musculoskeletal disorders (MSDs)(7,11,17,19,20,21,27) increased which are presenting considerable challenges for personal trainers and sports coaches. One approach to counter ailments is the NASM Corrective Exercise Continuum (CEx) – that promotes the activation and deactivation of muscles, fascia and the nervous system(5).

One common issue of the modern body is repetitive excessive knee valgus (knee collapse). Lack of control from the hips, particularly from the gluteus medius can result in excessive adduction and internal rotation of the femur (8,23) which will affect joints above and below the knee (11,30). Structures such as the Anterior Crucial Ligament (ACL), the patella (11,16,19,20) and the Ilio-Tibial Band (ITB)(12) can become overstressed.
The NASM screening process helps identify potential musculoskeletal problems by drawing attention to the signs of movement and range of motion (ROM) dysfunctions. My aim is to discuss how improved muscle strength and flexibility around the hips can help prevent or help improve musculoskeletal disorders linked to the knee. In line with the CEx system, I have suggested some easy to implement techniques and exercises.
Keywords: knee valgus, gluteus medius, hip strength, ankle dorsiflexion, the NASM Corrective Exercise Continuum

Introduction

In the nine years that I have been helping people in their training, from those new to the gym to accomplished athletes, many have come to me suffering with an injury. They mistakenly come to the conclusion that their problems are a sign that they should give up their preferred exercise routines.

However, if they were to incorporate a number of preventative steps into their warm up, in most cases, they would keep injury-free and could be practicing their chosen sport for longer. This approach is called the CEx system, it has enabled my clients to eliminate minor MSDs such as anterior and lateral knee pain, IT Band Syndrome, also called runner's knee, shin splints and keep major MSDs under control such as Chondromallacia Patellea, chronic ankle instability and past ACL injuries (11,12,16,19).

Knee injuries are particularly common with both regular gym users and those who reserve their exercise to the weekend. Surprisingly, the problem rarely originates from the knee. The issue is more likely to stem from weak hip muscles, and a lack of mobility at the ankle (25).
Typically, it is the bottom muscles that are most affected by sitting long hours, specifically, the gluteus maximus and the medius muscle (29). Literature is still divided on their role in knee valgus, but it commonly seems that the gluteus medius is weak or underactive when excessive knee valgus is present (8,11,29). It is a common occurrence in the weight room and in sports that the knee caves in upon landing, or in squatting in flexion of the hips and knees (3,8,10) (Figure 2). In excessive knee valgus the knee becomes more heavily impacted with high repetitive movement, such as running, pain syndromes can then develop, including the extremely common IT Band Syndrome (12,26).
It might be an equally important factor that weak buttocks are usually coupled with the presence of a stiff ankle and lack of dorsiflexion, where the foot's upward movement to the shin in weight-bearing exercises is limited (30). This subsequently forces the foot to pronate in order to gain range while in the squatting position (2,3). These impacting factors will be revisited in my next article of the series about the ankle complex.

Figure 2. Knee valgus while squatting, landing and running. Source: Bret Contreras

The suggested hip exercises in this article will help improve mobility, flexibility, strength and dynamic stability of the hips by activating the bottom, and improving range of movement at the front of the hips (12).

The importance of the bottom muscles

The bottom muscles comprise the glutes, of which there are three: the gluteus maximus (GM1), gluteus medius (GM2) and gluteus minimus (GM3) – of which the former two are possibly the more important in gait movement(11) (Figure 3).

The GM2 muscle originates at the top of the ilium (hip bone of the pelvis) and runs downwards in a fan shape to the top outer side of the thighbone. It is the major abductor of the thigh, lifting it away from the body to the side. The fibers at the front and middle rotate the hip internally and the rear fibers rotate it externally(14)

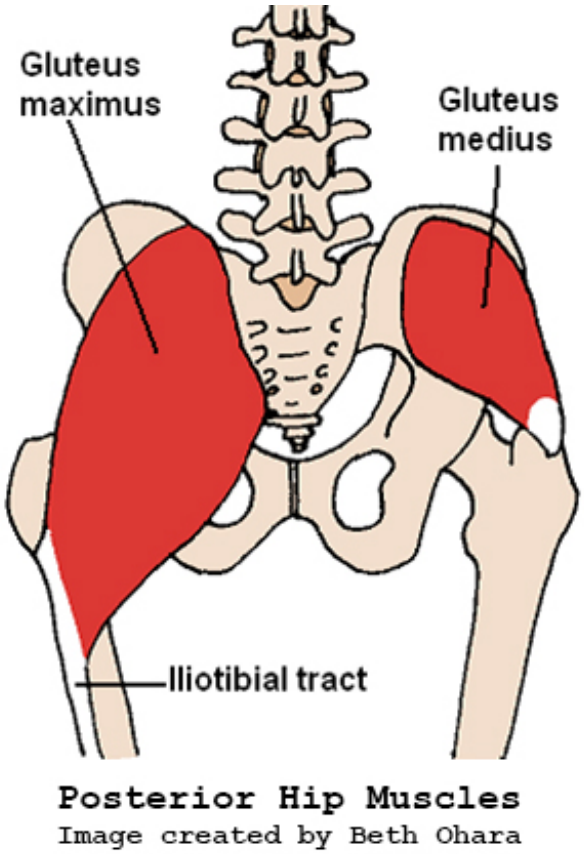

Figure 3. Visual representation of the Gluteus Maximus, Gluteus Medius muscles and the Ilio-tibial Band. Source: Wikipedia Commons

In addition, the glutes are also the stabilizers of the trunk and the hips over a planted leg in the frontal, sagittal and transverse planes(25). They therefore have a massive role in stabilizing the running gait(11). The GM1 also provides power for forward leg movements and works to its greatest capacity in the last portion of hip extension. These key stabilizers of the hip have the tendency to weaken due to lengthening of the muscles while they are inactive, such as when the body is seated. A lengthened GM1 and GM2 reduce pelvic stability and power development in bilateral and unilateral movements(22). GM2 weakness is becoming evident when standing on one leg and a hip drop occurs on the opposite side, this is otherwise known as a positive Trendelenburg sign(11,28) (Figure 4). The function and the signs of weakness of the GM1 will be further discussed in a future article about the hips.

In response other muscles will compensate for what can be termed as a 'lazy bottom'. Majority of hip stabilization then has to take place via the tensor fascia latae (TFL) muscle and fascia lata (FL) fibrous sheet (11,12). These structures are synergists to the GM1 and GM2 and connected to the IT band which runs down the outer side of the thigh, attaching to the lateral portion of tibia. Overactivity and tightness of these structures would cause the tightening of the ITB. The TFL not only assist GM1 in hip extension but works in synergy, in joint effort, with GM2 to abduct and medially rotate the femur. This means that in case of weaknesses in the glutes, the TFL, as a cheating muscle, will take over in tasks that require the leg to move away from the center of the body and/or rotate outward(18).

When the TFL is overactive and the ITB is tensed after repetitive motions, pain is felt at the side of the knee as the ITB band rubs against the knee causing irritation and inflammation around the lateral part of the knee, commonly termed IT Band Syndrome. Research shows that strengthening the hips, glutes might be able to prevent this occurring(10,11,15, 26, 29). In our practice we see over and over again, that a physiotherapist and the client themselves can massage and stretch the ITB all day, but the problem will always return as long as the hip muscles function incorrectly and remain the source of the problem.

Figure 4: The GM2 is highlighted as the dark area on the right hip. The difference is that in image (A) the GM2 dynamically stabilizing image (B) shows a weaker GM2 not fulfilling its role and allowing a marked drop (more than 5 degrees) of the left hip (Positive Trendelenburg). The photo to the right of the drawings shows this same scenario for a real life runner.

Another common problem is that the gluteus maximus can become inhibited by the tight, overactive hip flexors at the front of the pelvis due to adaptation to sitting or prolonged hip flexed positions. This results that the GM1 does not contract upon foot contact, placing strain on the hamstrings or the sacroiliac joint. With thousands of footstep striking the ground one after another during a run or walk, this delay in timing is significant, causing further, accumulative injuries of the joint below and above the hips(11).

NASM Single-Leg Squat Movement Screening and ROMs
When the observed client performs a hurdle step and in the right weight-bearing side the GM2 not functioning sufficiently well, the client will show a positive 'Trendelenburg Gait' as shown in Figure 4. Often, you will see the same weakness in walking, producing a waddling motion, the dysfunction will be more marked in running.
Clients can be encouraged to perform a single-leg squat (SLS) so the trainer can evaluate the dynamic quality of single-leg support and control at the foot, ankle, knee and pelvis(5, 6, 9) (Figure 5).

Figure 5. NASM single-leg squat deviations; photo 1 is an excessive valgus knee movement, photo 3 demonstrates a hip drop on the opposing side(5).

It is very likely that with weak glutes in the SLS test the knee/s will collapse in and the foot/feet turn out, which latter also collapsing into excessive pronation. If a client performs a poor single-leg squat, as this movement shows, it is important to test the GMs for strength with manual muscle testing(22) (Figure 6a,b). When proven weak the trainer should implement strengthening exercises and then re-test their strength after activation of these muscles. If the test cannot be improved because of a genuine weakness or limitation, the trainer should revise the strengthening program and try a further re-test at a later date to measure the effectiveness of the intervention.

Figure 6: a) Gluteus Medius and b) Gluteus Maximus strength tests(22)

Good and Bad Posture
When performing any activity, the aim is to achieve musculoskeletal balance. This protects the body's supporting structures against injury or progressive deformity. Adopting a good posture should be effortless, non-fatiguing and, above all, painless – even when remaining in the position for a prolonged period(4) On the contrary, bad posture increases stress and strain on joints and connective tissues and does not provide good shock absorption nor promotes the required transfer of force through the tissues in movement (Figure 7).

The focus is the pelvis – the direction and degree of pelvic tilt being the key determinants of our posture. Its misalignment can cause pathologies and associated pain below and above it. Therefore for an optimal posture an appropriate muscle balance in strength and length needed around the hips.

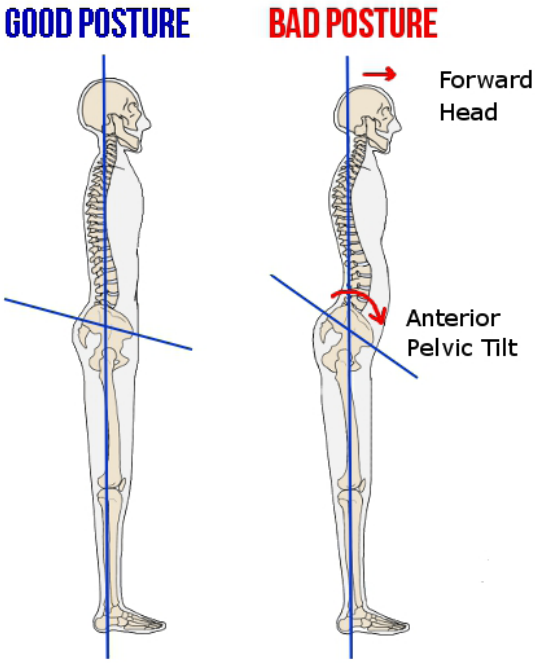

Figure 7: Natural hip position where hips are at level, weight is evenly distributed, feet facing and there is a slight bent at the knees; forward tilt of 7-10 degrees for women and 4-7degrees for man is normal.

Clients need guidance as to how to stay balanced and centered while performing exercises, as well as being efficient while sitting or standing. The trainer therefore needs to teach his or her client about the anterior and posterior tilt

of the pelvis, as well as the bracing of the core in keeping a neutral spine and achieving core stability.
A simple reminder for clients is to set themselves up for an exercise as follows: while standing, keep the pelvis in neutral (i.e. level), equally distribute weight through both buttocks, keep the knees slightly bent and face the feet forward. Shoulders should be back and down, ribcage down and chin tucked in. However, as we hardly ever stand still, the right dynamic posture is ever so relevant to clients while moving.

The Anterior Pelvic Tilt
An anterior tilt occurs when the pelvis rotates forward, placing the front of the pelvis well below the level of the back. This tilted position can be related to tight hip flexor muscles that will pull the pelvis forward. One of the main contributing factors to this tightness is prolonged sitting which, over time, shortens the hip flexor muscles. When a person with tight hip flexors stands up, the shortened muscles will pull the front of the pelvis downward resulting in an exaggerated curvature of the lower lumbar spine which will make the pelvis instable(31) (Figure 7,8).

To determine whether there is an excessive anterior pelvic tilt, the client stands with the heels, bottom and the back flat against the wall and the trainer measures the space between the lower back and the wall. With normal curvature, only the back of the hand can slide through the space. If the wrist can fit through, then it's likely that a large anterior tilt exists.

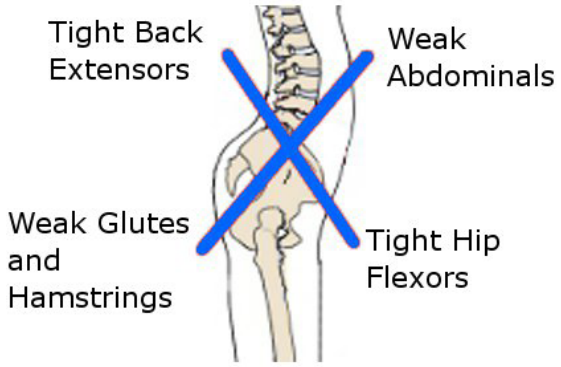

Figure 8: tight hip-flexors pulling the pelvis into excessive anterior tilt which in turn can cause the abdominals and the gluteus to lengthen and weaken permanently this also termed Lower Crossed Syndrome (21)

Warm up with the Corrective Exercise Continuum

As I discussed in my previous article some muscles tend to get tight or overactive while others have the tendency to become weak or underactive(21,22,27). To prevent or address these muscle imbalances, the CEx-NASM is used and a sequence will be demonstrated in four steps. In step one, a releasing technique, Self-Myofascial Release (SMR) is utilized to inhibit the overactive muscle and fascia. In step two, stretching is introduced for the overactive muscles. In step three and four, the tested weak or underactive muscles will be activated first in isolation before being integrated into a complex, dynamic movement(5).

Figure 9. The Corrective Exercise Continuum

Self-Myofascial Release and Stretching

SMR can help to deal with painful points in the muscles called trigger points (TrPs). A muscle with one or more TrPs will lose its strength until the trigger point is treated(1,13). A typical example would be the trigger points of the gluteus medius or the TFL, which are, for the most part, only painful when palpated or rolled on (Figure 10,11).
If a joint is not being sufficiently protected from excessive shear forces by a muscle that has become weak or underactive, the joint will function out of normal ranges and send pain messages to the brain without our recognition that something was wrong. Later it becomes inflamed and begins to degenerative. In this scenario, it is not enough to work ‚through the pain' or just stretch (Figure 12). Often the pain will get worse unless the trigger point is being treated at the same time that joint stability and muscle activation exercises are prescribed. Please refer to the previous article to more details on TrPs and descriptions of stretching practices.

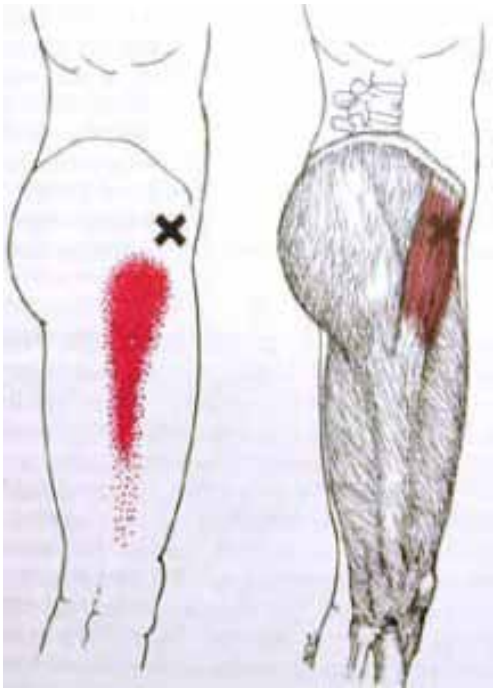

Figure 10: Trigger point in the TFL muscle marked with a cross and the referred pain in red further away from the TrP itself.

Activation explained

Once the release and lengthening of the muscles has been achieved at the front and lateral portion of the hips, activation can now take place at the back of the pelvis by employing isolation exercises such as the bridge. These are exercises that mainly involve only one joint and a limited number of muscles. More attention can therefore be paid to the muscle(s) contraction – and to avoid using the overactive, 'cheating' muscle(23)(Figure 13).
Activation should be a slow, controlled motion until it becomes second nature to keep the knees out of valgus, the feet out of pronation and the bottom engaged. Once the brain-muscle relationship is established integrating the muscle/s into a complex movement is the task. The purpose of these complex exercises is to build hip abduction/lateral rotation strength throughout the hip flexion-extension range of motion (Figure 14).

CEx for injury prevention at the knee
Step 1: SMR

Look for tender knots using a foam roller or ball and roll over the muscle. Hold as close to the tension area as possible for 30 to 45 seconds or if the pain is too intense hold for 90 seconds with lower intensity. Repeat for increased effectiveness.
If an area really hurts, transfer more body weight to your arms as you support yourself on them. More bodyweight can be moved to the area as the muscle begins to relax.

Figure 11: TFL Inhibition.
The TFL is a small muscle at the very top of the thigh. It runs into the ITB. Placing weight on the forearm, movement should be slight as you move up and down along the roller; the body can also rotate slightly downwards. If the client is a runner or a cyclist, even a person that sits a lot, this will be painful. Head should be aligned with the rest of the spine for stability the core should be braced.

Step 2: Static and Dynamic Stretches
I advise clients to do static stretches usually after their workouts. However, if a particular muscle is tight – particularly the hip flexors, they should stretch out these before their main workout so to enable greater ranges of movement.

While stretching, the client should breathe deeply and hold each stretch for 15-30 seconds, repeating if possible and only to the edge of discomfort – on a scale of 1-10, aiming for 7-8.

Figure 12: Hip Flexor stretch
From a kneeling position, plant the right foot on the ground in front, so the leg is bent at 90 degrees, the knee and ankle aligned. The back should be straight, shoulders back and chin tucked in. Press the pelvis forward, so that the left hip is stretched, and leaning over the body from the left so to stretch the TFL. To increase the intensity of the stretch, the bottom muscles of the left hip should also be squeezed(24)

Step 3: Isolation Exercises
2-3 sets of 12-15 repetitions with a 2-second hold

Figure 13: The Glute Bridge
Starting on the back, with the heels on the ground and legs at about 90 degrees. As the glutes are squeezed, the hips lift up to a straight line from the knees to shoulders. To minimize the hamstring activation and isolate gluteus maximus, imagine yourself lifting from the heels. With the exercise band added, the gluteus medius can be activated at the same time.

Step 3: Integration
I incorporate exercises designed to promote hip stability into routine exercises such as squatting. I place an exercise band a little higher than the knee for squats, wall squats, and leg press to additional gluteal activation. The client

should be pushing into the band while doing the exercises. This type of exercise requires the hips to stabilize against the hip adduction/internal rotation forces.
2-3 sets of 10-15 repetitions.

Figure 14: The squats
While squatting, the knees should be kept out and in line with the second and third toes. The chest should be kept high, shoulders back and down. Gaze straight ahead with the feet straight or turned out few degrees. Inhale on the way down and exhale on the way up.

Conclusion

Once excessive knee valgus sets in, it can sometimes take hundreds of repetitions to restore function and take even longer to change bad postural habits. Trainers and clients should therefore persist with the four-step sequence of the CEx, performing it at least three times a week(23) until movement quality is restored. However, the best practice would be to use a hip-conditioning program regardless of the circumstances for maintenance purposes.
The five primary benefits of gluteal strengthening and hip muscle balance are postural improvements, injury and pain prevention, increased athleticism, strength and power improvements and the improvements in physic.

Isolated and complex hip exercises should be incorporate in every training routine, including the bridge and the squat exercises – individuals advised watching themselves in the mirror for form and postural alignments. If necessary initially they should invest in a well-informed personal trainer, who can immediately identify and correct against faulty sitting, standing, squatting, landing and running postures.

Footnote

Please consult with a doctor or physician if you have any unusual symptoms doing any of these exercises. Foam rolling should be avoided if you have unhealed wounds, bone fractures, skin cancer, osteoporosis, high blood pressure or any others strains or sprains. It is not advised to roll on an area that is affected by varicose veins and broken capillaries. While performing these exercises, please be aware of good body positioning and control of movement.

1. Alvarez D.J. & Rockwell P.G. (2002): Trigger Points: Diagnosis and Management. Am Fam Physician. 65(4):653-661.
2. Bell D.R., Padua D.A., & Clark M.A. (2008): Muscle strength and flexibility characteristics of people displaying excessive medial knee displacement. Arch Phys Med Rehabil. 89(7):1323–1328.
3. Bell D.R., Oates D.C., Clark M.A., Padua D.A. (2013): Two- and 3-dimensional knee valgus are reduced after an exercise intervention in young adults with demonstrable valgus during squatting. J Athl Train. 48(4):442-9.
4. Cailliet R. (1981): Low Back Syndrome. Davis, Philadelphia, PA (1981). P33.
5. Clark M.A. & Lucett S.C. (2011): NASM Essentials of Corrective Exercise Training. Lippincott Williams & Wilkins, United States. P108-139.
6. Crossley K.M., Zhang W.J., Schache A.G., Bryant A., and Cowan S.M. (2011): Performance on the single-leg squat task indicates hip abductor muscle function. Am J Sports Med. 39(4):866–873.
7. Davies, S.C., McBride, M., Keel, A., Hussey R. (2014): Musculoskeletal health: Public Health Approach. www.arthritisresearchuk.org/~/media/Files/…/public-health-guide.ashx
8. Dierks T.A., Manal K.T., Hamill J., & Davis I.S. (2008): Proximal and distal influences on hip and knee kinematics in runners with patellofemoral pain during a prolonged run. J Orthop Sports Phys Ther. 38(8):448-56.
9. Dimattia M.A., Livengood A.L., Uhl T.L., Mattacola C.G., Malone T.R. (2005): What are the validity of the single-leg squat test and its relationship to hip abduction strength. J Sport Rehabil. 14:2; 108–123.
10. Distefano L.J., Blackburn J.T., Marshall S.W. & Padua D.A. (2009): Gluteal muscle activation during common therapeutic exercises. J Orthop Sports Phys Ther. 39(7):532-40.
11. Earl J., Hertel J., & Denegar C. (2005): Patterns of dynamic malalignment, muscle activation, joint motion and patellofemoral pain syndrome. J Sport Rehabil. 14:215–233.
12. Fredericson M., Cookingham C.L., Chaudhari A.M., Dowdell B.C., Oestreicher N., & Sahrmann S.A. (2000): Hip abductor weakness in distance runners with iliotibial band syndrome. Clin J Sport Med. 10(3):169-75.
13. Gerwin R. (1993): The management Myofascial Pain Syndromes. J Muskuloskeletal Pain. 1(3-4).
14. Gottschalk F., Kourosh S., & Leveau B. (1989): The functional anatomy of tensor fasciae latae and gluteus medius and minimus. J Anat. 166:179-189.
15. Heiderscheit B. (2010): Lower extremity injuries: is it just about the hip strength? J Orthop Sports Phys Ther. 40(2): 39-41.
16. Hewett T., Meyer G., Ford K., Heidt R., Colosimo A., Mclean S., Van Den Bogert A., Paterno M. & Succop P. (2005): The Effect of Biomechanical Measures of Neuromuscular Control and Valgus Loading of the Knee Predict Anterior Cruciate Ligament Injury Risk in Female Athletes A Prospective Study. Am J Sports Med. 27, 699-706.

17. Holth H.S., Werpen H.K.B., Zwart J.A., Hagen K. (2008): Physical inactivity is associated with chronic musculoskeletal complaints 11 years later: Results from the Nord-Trondelag Health Study. BMC Musculoskel Disord. 9:159.
18.http://en.wikipedia.org/wiki/Tensor_fasciae_latae_muscle
19. Ireland M. L. (1999): Anterior Cruciate Ligament Injury in Female Athletes: Epidemiology. J Athl Training. 34, 150–154.
20. Ireland M. L., Wilson J. D., Ballantyne B. T. & Davis I. M. (2003): Hip strength in females with and without patellofemoral pain. J Orthop & Sports Phys Therap, 33, 671-676.
21. Janda, V. (1987): Muscles and motor control in low back pain: Assessment and management. In Physical Therapy of the low back, ed. L.T.Twomey, Churchill Livingstone. New York. p253-78.
22. Kendall F.P., McKCreary E.K. and Provance P.G. (2005): Muscle Testing and Function with Posture and Pain. 5th ed. Lippincott Williams and Wilkins, Baltimore, MD. p.50-54., p19-22, p.35.
23. Khayambashi K., Mohammadkhani Z., Ghaznavi K., Lyle M.A., & Powers C.M. (2012): The effects of isolated hip abductor and external rotator muscle strengthening on pain, health status, and hip strength in females with patellofemoral pain: a randomized controlled trial. J Orthop Sports Phys Ther. 42(1):22-9.
24. McGill S. (2010): Core Training: Evidence Translating to Better Performance and Injury Prevention. Strength & Cond J. 32 (3): 33-46.
25. Neumann D.A. (2010): Kinesiology of the Musculoskeletal System: Foundations for Rehabilitation. 2nd ed. Mosby/Elsevier. St Louis, MO.
26. Niemuth P.E., Johnson R.J., Myers M.J., & Thieman T.J. (2005): Hip muscle weakness and overuse injuries in recreational runners. Clin J Sport Med. 15(1):14-21.
27. Page P., Clare C.F., and Ladner R. (2010): Assessment and Treatment of Muscle Imbalance. The Janda Approach. Human Kinetics, p50-54,123.
28. Petrofsky J.S. (2001): The use of electromyogram biofeedback to reduce Trendelenburg gait. Eur J Appl Physiol. 85(5):491-5.
29. Presswood L., Cronin J., Keogh J. & Whatman C. (2008): Gluteus Medius: Applied Anatomy, Dysfunction, Assessment, and Progressive Strengthening. Strength Cond J. 30, 41-53.
30. Rabin A. & Kozol Z. (2010): Measures of range of motion and strength among healthy women with differing quality of lower extremity movement during the lateral step-down test. J Orthop Sports Phys Ther. 40(12):792–800.
31. Ruska R. (1998): Reprint. https://www.posturalrestoration.com/resources/.../Pelvic_Stability.pdf