Science corner: Plyometric Training

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In the previous issue of R4YL the importance of running economy to performance was discussed. It was demonstrated that running economy could be improved by various training interventions, one of these being plyometrics, which improved running economy by up to 4%. Plyometrics is the use of explosive strength exercises such as bounding, jumping, and hopping to enhance the muscles ability to generate power by exaggerating the stretch shorten cycle (eccentric muscle contraction immediately followed by concentric contraction). This feature will focus on why plyometrics is beneficial to improving running economy and running performance, as well as describing specific plyometric exercises used at the AIS. Plyometric training has been reported to invoke specific neural adaptations such as an increased activation of the motor units (nerve and group of muscles it innervates), without increasing muscle size as typically observed after heavy-resistance training. Plyometrics also has the potential to increase the "stiffness" of the muscle-tendon system so that the body can store and utilise elastic energy more effectively. Both of these adaptations can improve running economy by generating greater force from the muscles without a proportionate increase in the metabolic energy requirement. Plyometrcis can also cause alterations in running mechanics that allow for better coordination and timing of muscle contractions during contact and take off.

Plyometric exercises

Below is a description of the plyometric exercises performed in the AIS study mentioned in Issue 1 of R4YL. Note that most exercises can be done on a soft surface such as grass, and some can be done in the gym. It is possible to perform all exercises outdoors with the use of equipment such as sand-filled tyres for squats and elastic ropes for hamstring and hip flexor exercises.

Half Squat: 10 x 10kg-40kg, 4 x 8 x 30-80kg - fast squats, rest 1-2 min. These are performed on a smith machine in a gym with emphasis on good technique, i.e. looking forward, straight back and tight abdominal muscles. The idea is to slowly lower the weight by bending at the knees until a knee angle of approximately 90 degrees is reached, then push up explosively, activating all muscle groups finishing up on the toes. It is also possible to perform these squats outdoors using a half-tyre filled with sand over the shoulders.

Leg Press: 10 x 30kg-80kg, 4 x 8 x 40-120kg - fast movement, rest 1-2 min. This is an alternative to the half squat and is done on a seated leg press machine in a gym. The principal is the same, lowering the weight slowly by bending the knees and then exploding through the lower body muscles to push the weight back up.

Hamstring curls: 3 x 10 – low resistance/fast, rest 1 min. These can be performed on a hamstring machine (hydraulic or weighted), with weights tied to the ankles or using elastic ropes tied to a fence. The exercise is performed lying face down, exercising one leg at a time. Start with the leg bent (this means weight needs to be initially lifted) and slowly lower your foot towards the ground by straightening your leg, just before your foot reaches the ground, activate your hamstring and quickly pull your leg back so that your foot ends up near your bum. You can progress to alternating legs if doing with ankle weights or elastic ropes.

One-legged ankle jumps: 4 x 20m/leg, rest 1 min. These are similar to the two-legged ankle jumps mentioned above, except that there is a progression forward and it is performed one leg at a time holding the other leg up at the bum. The aim is not maximum distance or height in each jump but very fast contacts and minimal time spent on the ground.

Following are a selection of R4YL's favourite plyometric exercises that were also part of the AIS study. The supporting images should act as a gude to help you perform each one accurately. If possible do them while supervised by a qualified or experienced coach that can correct any mistakes in your action.

If you have not completed plyometric training previously, it is imperative that you exercise caution and initially perform all of these exercises with minimal or no weight. Due to the explosive nature of these exercises, you can expect to sustain muscle soreness following several of your initial sessions.

Two-legged ankle jumps: 3 x 10 jumps - bounce jumps with small change in knee angle, rest 1 min. These are straight-legged jumps using mainly the calves, focusing on maximum height with least possible contact with the ground.

Counter Movement Jumps (hands on the hips): 3 x 6 jumps as high as possible, rest 1 min. This exercise is similar to the half squats except that it is done initially with no weight. The idea is to bend at the knees until approximately 90^{o} is reached and then explode vertically in the air. You can progress to using weight to do these jumps.

Expert advice

Skip for height: 4 x 30m, rest 1 min. This exercise is skipping with exaggerated knee lift and getting as much height with each skip as possible.

Bounds: 4 x 10 bounds, rest 1 min. After a 3 step run up, bound keeping the back leg straight and front leg lifted up to a 90^{o} knee angle. As soon as the lead leg lands, it becomes the back support leg and the alternate leg is lifted up. Emphasis should be on fast ground contact and maximum horizontal distance.

Hurdle jumps (low hurdles): 5 x 5 jumps, rest 1 min. Five low hurdles or some other obstacle to jump over are set a few feet apart making sure that there is enough room to land between hurdles so as you can jump, land and jump the next hurdle in the same motion with fast ground contact. You should be exploding up with just enough horizontal distance to position yourself for the next hurdle.

Scissor jumps for height: 5 x 8 jumps, rest 1 min. This is done by jumping vertically in the air and stretching one leg out, the other back and changing in mid air so that the back leg goes forward and the front leg in goes back in a scissor fashion.

Knee lifts (technical): 3 x 20m, rest 1 min. This is a drill done by lifting alternate knees to approximately 90 degrees, activating the hamstrings and gluteal muscles in the support leg by keeping it completely straight and pushing onto your toes, with a small skip forward before alternating legs.

Note: You shouldn't perform all of these exercises in a single session. The idea is to minimise the amount of ground contacts in each session to avoid injury and prevent fatigue during the session. It is advisable to perform 2 to 3 x 30 min sessions per week. A suggested set of exercises for 2 sessions is given below.

Session 1 – Half squat or leg press, hamstring curls, counter movement jumps, two-legged ankle jumps and knee lift drill.

Session 2 – Bounds, Hurdle jumps, one-legged ankle jumps, skip for height, hurdle jumps and scissor jumps.