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DEVELOPMENT OF EXPLOSIVE POWER: PLYOMETRIC TRAINING

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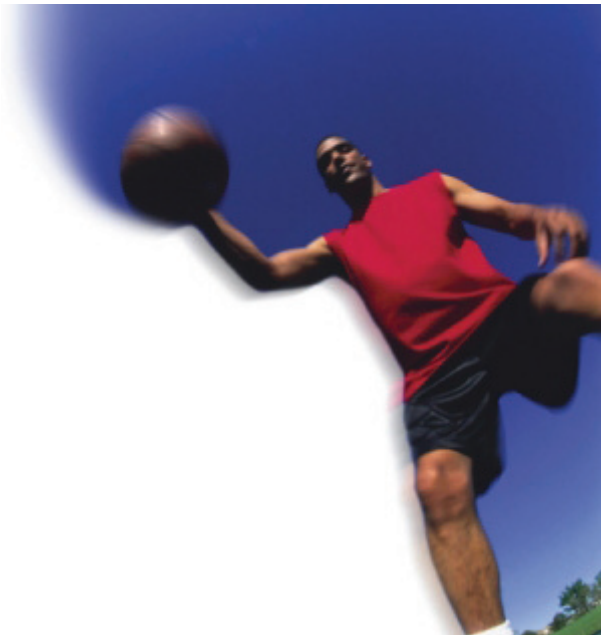
In most sports or events an athlete's ability to produce force quickly in a dynamic movement is of utmost importance. Explosive muscle power has been shown to be a limiting factor in sports performance and is highly related to the muscle's ability to carry out the stretch-shorten cycle (SSC). Several different training methods are commonly used to improve power including resisted sprinting, over-speed training, strength training and plyometrics.

Plyometric exercises train the muscles to effectively carry out the stretch-shorten cycle (SSC) which is a pattern of muscle contraction involving a stretch of the muscle followed immediately by an explosive contraction. Plyometric training is a method of developing explosive power and ultimately, improving athletic performance. Plyometric exercises include jumps, hops, skips, bounds and throws.



Although plyometrics have long been utilized in athletic training and conditioning, the term did not begin to appear in literature until the 1960's. Often an "innovative" training method such as this will be met with some skepticism; however, plyometric training has been adopted by coaches and athletes of all sports and disciplines from pure power athletes to team sports to endurance events such as rowing and long distance running.

Research has shown that the combined effects of strength training and plyometric training can elicit greater performance effects than strength training or maximal power training alone and that plyometric training alone can improve maximal strength in athletes who have not previously participated in strength or plyometric training.

The keys to achieving optimal adaptations from plyometric training are technique, progression, and periodization. This is a highly specific training method designed to

develop explosive power and to be implemented with a well-thought out annual training plan and in conjunction with other proven methods for improving explosive power.

Plyometrics and the Annual Plan

The goal of plyometric training is development of explosive power or "speed strength". In order to achieve this, plyometric training must be included in the annual plan at the appropriate time. The "specific preparation" or "power" phase is generally when coaches can start to add plyometric drills to the workouts, however, this may vary between sports and events. The important thing to remember is that in order to achieve the correct intensity and movement velocity, you should not prescribe plyometrics during periods of extremely high volume training or when athletes are in an overly fatigued state.

As with any training method, the important principles of program design should not be overlooked. The following things should be considered when designing a plyometric training program: frequency, volume, intensity, recovery, and progression.

Frequency: This refers to the number of plyometric workouts per week in a given training cycle. The frequency of plyometric type of training should be between one and three sessions per week depending on the training loads from other areas.

For most team sports, one-two sessions/week will be sufficient and the plyometrics can be combined with strength training workouts or speed training on the field. For track & field or pure power events, two-three sessions is the norm with one or more of those being a combined strength training/plyometric session.

The intensity of the drills will play a role in determining the frequency of the sessions and the rest between sets and/or sessions. It is important to allow adequate recovery between plyometric training sessions. This can be anywhere from 24 to 48 hours depending on the volume and intensity.

Volume: Volume in a plyometric training session is expressed as number of foot contacts. A foot contact is counted each time a foot or both feet together contact the training surface per workout. The following guidelines can be used for assigning volume to a plyometric training program:

Beginner: no more than 80-100 foot contacts/session
Intermediate: no more than 100-120 foot contacts/session
Advanced: no more than 120-140 foot contacts/session

Volume should also be varied based on an athlete's body weight. For example, the total volume of a plyometric training program for a 250+ lb athlete should be 40-50% lower than that for a 150-200 lb athlete. This is a very important consideration when designing programs for groups of athletes varying in size.

Volume can also be expressed as distance (i.e. 30m forward bounds) and as sets and repetitions similar to strength training.

Intensity: Intensity refers to the amount of stress placed on the athlete's body (muscles, joints, ligaments, tendons) during an exercise or movement. Generally, intensity in strength training can be varied by changing the load, however with plyometric training monitoring intensity is more complicated.

For example, skipping, which is plyometric in nature, causes far less stress on the muscles and joints than a depth jump or bounding. Intensity of a drill is related to the following factors:

- The number of feet (1 or 2) that make contact with the ground upon landing. (A single leg take-off and a double leg landing results in far fewer landing forces than a single leg take-off and a single leg landing.)
- The direction of the movement (horizontal or vertical).
- Speed.
- How high the athlete's body mass is raised from the ground. (The higher the height of the drop, the greater the landing forces will be.)
- Athlete's body mass and/or external weight or resistance used.

As with strength training, the general rule is that as intensity and/or complexity increases, volume should decrease.

Recovery: Plyometric drills and power training involve maximal efforts when performed properly. Because of this, adequate recovery between both sets of exercises and workouts is necessary. Extremely high intensity drills such as depth jumps may require short rest periods between repetitions (5-10s) followed by longer rest periods between sets (2-3 min). Allow at least two days recovery between workouts for the same body parts (i.e. upper body vs. lower body).

Progression: Plyometric training, like any other training method, should follow the principle of progressive overload. Even advanced athletes risk overtraining or injury if they are thrown into a high intensity program unprepared.

Plyometric training should progress from lower intensity in-place jumps and hops to medium intensity standing or forward-moving jumps, hops and bounds to higher intensity double and single leg standing, forward or drop jumps, hops and bounds. This progression should happen over the course of 6-12 weeks depending on the athlete and sport or event that you are programming for.

Specificity

Exercises included in a plyometric training program should reflect the concept of specificity. This includes both velocity and direction of movement as well as specific muscle groups. If you want your athletes to jump higher or farther, you must include in the program exercises with those parameters. If your goal is to improve speed in a certain direction, then your athletes must train to utilize high rates of force development and optimize their ability to use the SSC.

The following table lists various categories and types of plyometric drills that can be included in a plyometric training program:

Jumps in Place	Standing Jumps	Hops	Bounds	Upper Body
Squat Jump	Standing Long Jump	Single Leg Zig-Zag Hop	Alternate Leg Bounds	Clap Push-Up
Split Squat Jump	Standing Triple Jump	Double Leg Speed Hop	Forward Bounds (double leg)	Medicine Ball Chest Pass
Tuck Jump	Box Jumps	Single Leg Hop	Combination Bounds (single/double)	Drop Push-Up
Single Leg Tuck Jump				Medicine Ball Side Throw

In order to achieve the desired training effect from the SSC you must find the optimal combination of resistance, speed, and specificity (movement patterns or direction and distance) and pair that with a program that controls closely the frequency, duration, volume and intensity of training. But most importantly, plan for the most important consideration in training for explosive power: RECOVERY.

Recommended reading (for greater detail into the development of plyometric training, sample programs and exercise descriptions):

High Powered Plyometrics: 77 advanced exercises for explosive sports training
James C. Radcliffe, MS
Robert C. Farentinos, PhD
Human Kinetics, 1999

References

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Lyttle, A.D., Wilson, G.J., Ostrowski, K.J. Enhancing Performance: Maximal Power Versus Combined Weights and Plyometrics Training. Journal of Strength & Conditioning Research. 10 (3): 173-179. 1996.

Rimmer, Edwin & Sleivert, Gordon. Effects of a Plyometrics Intervention Program on Sprint Performance. Journal of Strength & Conditioning Research. 14(3): 295-301. 2000.

As described earlier, the cyclic arrangement of load demands refers to periodization, which is composed of two concepts used simultaneously. The first concept is that of cycling the training load by alternating between work and rest. The second concept is that of periods of training with specific, distinct and linked goals. The importance of these periodization concepts lies in the organized and systematic fashion in which training loads can be applied for the improvement of sport performance.