Plyometrics: Considerations for Safe and Effective Training

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MUCH EFFORT HAS BEEN DEvoted to the study and promotion of plyometrics since it was introduced to the U.S. in 1972 (16). Some might say enough is enough. However, in some areas the picture is still not clear.

This article addresses some unanswered questions about plyometric training in order to provide direction for further research and consideration. We will focus on two important questions that are asked about all forms of training, including plyometrics: effectiveness and safety.

■ Effectiveness of Plyometrics

The case for plyometric training is supported with testimonials from coaches and athletes, and by a number of training studies (2, 3, 6, 8, 9, 11, 13). It is becoming a bigger part of conditioning for many sports. Therefore, scientific investigation and clinical observation have become even more important. We believe the following kinds of well-controlled studies should be conducted to answer questions about the overall effectiveness of plyometric training for improved performance:

1. Studies that identify effective protocols for plyometric training;
2. Studies that compare plyometrics to more conventional training;
3. Studies that combine plyometrics with other training methods;
4. Studies that test plyometric exercises other than depth or drop jumps;
5. Studies that test plyometrics using joint specificity;
6. Studies that test the effectiveness of plyometrics over an entire training cycle.

Few studies have been conducted to identify the ideal protocol for plyometric training. Plyometric training, particularly with depth jumps (DJ), has been labeled as being high intensity. As a result, plyometric protocols have been influenced more by concerns for safety rather than by concerns for effective training.

For example, Wilt (16) recommended a maximum of 40 repetitions of plyometric DJs per session for safe training. Even though it appears Wilt had no evidence to support this, his recommendation has been widely adopted. Studies should be developed to determine the most appropriate intensity, numbers of sets and reps, rest intervals, and recovery for plyometric training. These protocols should be manipulated and tested with considerations for a variety of sports.

Many studies have tested the effectiveness of plyometric training. However, few have been well-controlled studies, and many of the results are inconclusive. If plyometrics are to be recommended over other training methods, the relative effectiveness must be demonstrated through research. This will only be possible when optimal protocols are identified and become standards for training studies.

Plyometrics have been touted as a superior training method compared to more conventional methods. This may lead some coaches and athletes to use plyometrics in lieu of other methods. Yet most plyometric exercises are specialized, relatively high-intensity training used to develop power.

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Therefore plyometrics should be combined with other methods of training to develop all components required for improved performance. The effectiveness of such a program should then be used in a practical setting and tested with scientific investigation.

Most plyometric training studies use the DJ, which is the most popular form of plyometric exercise (4, 14), and effectiveness is typically based on improvements in power and the vertical jump (VJ). However, the development of plyometrics has led to training regimens for the upper extremity, and for a variety of sports.

The effectiveness of these plyometric programs is based solely on theory, and on anecdotal testimonials from athletes and coaches who use them. The effectiveness of programs using a variety of exercises for the upper and lower extremity should be tested.

Holcomb et al. (7) developed a plyometric program to improve the VJ and power in the lower extremity. It included three types of DJs and manipulated joint angles to isolate the extensors of the ankle, knee, and hip. The program's effectiveness was shown to be "practically significant," but not statistically different from more conventional methods (8). The practice of joint angle manipulation to isolate muscle groups needs to be further tested with training studies using exercises for both the upper and lower extremity.

Most plyometric training studies span 8 to 12 weeks. This is typical of training studies and is often necessary to ensure maximum control of the study, yet it provides little information about the effect of plyometrics as part of an athlete's overall conditioning.

Research on the effect of plyometric training as part of a training cycle would represent a major undertaking but would certainly provide valuable information for those who incorporate plyometric training in the conditioning of athletes.

Safety Considerations

Strength and conditioning professionals should always be concerned with safety in training, particularly with high-intensity training techniques such as plyometrics.

Plyometrics can be performed safely, but as with any exercise there is always the risk of injury. To avoid injury, risk factors must be identified and efforts made to reduce risk. Strength and conditioning professionals should be as concerned with identifying risk factors as they are with enhancing performance, since an athlete who is injured in training will not be able to perform well. As with the guidelines for effective training, the guidelines for safety should be validated with scientific research.

The following is a list of factors that should be considered to improve safety with plyometric training:

- Age
- Body weight
- Strength prerequisite
- Experience
- Previous injury
- Jumping surface
- Warm-up
- Progression
- Recovery
- Frequency

Prepubescent athletes should not engage in higher intensity plyometric exercises such as DJs, due to skeletal immaturity and open physes (1, 10). Until epiphyseal plates are closed, any type of high intensity explosive exercise is contraindicated. Injury to an open epiphyseal plate can cause premature closure and discrepancies in limb length.

Although no studies have been reported to support this, some consideration should be given to the older athlete planning to undertake plyometrics. There is probably an ideal age range for safe participation in plyometrics, although it is not currently known.

Because of the high impact nature of most plyometric exercises, obese (usually >30% body fat) individuals should be cautioned against plyometrics. In addition to obese individuals, well-muscled athletes weighing more than 220 lbs should also be advised to limit DJs to 18 in. or less (12).

Plyometrics should be considered an adjunct to other modes of training. We do not recommend that an untrained individual undertake a plyometric training program without an adequate base of speed and strength. It has been suggested that strength in the squat and bench press be evaluated before prescribing plyometric exercises. It has been specifically suggested that the athlete's 1-RM squat strength be greater than 1.5 times his body weight. And for upper extremity plyometrics, the athlete's 1-RM bench press should be 1.0 to 1.5 times his body weight (15).

These guidelines are appropriate for male athletes but probably not for females. Adjustments should be made to account for average strength differentials between male and female athletes; these adjustments should then be examined through scientific research.

Only experienced athletes who have a solid base of strength and speed training should use plyometrics. A simple prerequisite for DJ training is to compare jump height during the DJ to that of a countermovement jump (CMJ). The athlete is first measured for jump height using the CMJ, then executes a DJ from a height of 18 in. If DJ height is equal to or greater than CMJ height, the athlete is ready for plyometric DJ training (5).

Plyometrics can be used when reconditioning after injury, but only in the final stages of rehab. Plyometric exercises should not be prescribed for athletes with previous injuries such as muscle strains, ligamentous or capsular injuries with associated laxity, and spinal compression injuries including disk related disorders.

Plyometric exercises should not be performed on hard surfaces such as concrete and asphalt. However, at the other extreme, soft surfaces that absorb a great amount of shock will diminish the effectiveness of the training. A surface with some shock absorption, such as a suspended floor, rubber mats, polyrobic runways, or firm natural grass may be best.

Uneven surfaces, which are always a potential hazard, and surfaces with a high coefficient of friction such as artificial turf should probably also be avoided, although we are unaware of any research to support these recommendations.

It is important to warm up and stretch prior to any conditioning activity, of course, but especially in plyometrics, due to the high-intensity eccentric movements. The warm-up increases the sensitivity of the muscle spindle which activates the stretch reflex to protect the muscle from being overstretched. In addition, activation of the stretch reflex will further increase the force of contraction produced with plyometric exercise.

The warm-up and stretching will also increase the extensibility of muscles and tendons, allowing greater tolerance of the forceful eccentric movement in the stretch-shorten cycle.

When beginning plyometrics, one should use low-intensity, higher volume exercises with a gradual progression of intensity. Because plyometrics are now used for all body parts and are becoming more sport-specific, this principle of a slow rate of progression should be followed when any new type of plyometric exercise is implemented. Regardless of the type of exercise performed, the risk of injury increases with more complex movements.

There must be complete recovery between sets to realize maximum benefits from plyometric training. No specific guidelines have been identified in the research, but the required recovery time should be similar to that of more conventional high-intensity exercise. Rest intervals should be increased if the athlete is unable to maintain consistent high intensity throughout the training period. Insufficient recovery will lead to fatigue and greater risk of injury.

The more complex movements that require skill and technique will be most affected by fatigue. Recovery between subsequent workouts is also important for safe and effective training. Plyometric exercise should never be completed for the same body part on subsequent days. The recommended frequency for DJ training is two times a week (10).

■ In Short . . .

Plyometric training has developed tremendously since being brought to the U.S. in 1972. When performed properly and when gradually integrated into total conditioning programs using the technique of periodization, we believe plyometrics can be beneficial and can be undertaken with minimal risk of injury.

However, further research is warranted to identify the methods required for safe and effective training. Given the difficulty in conducting well-controlled studies, it is also necessary for practitioners to evaluate and report the safety and effectiveness of plyometric training protocols. ▲

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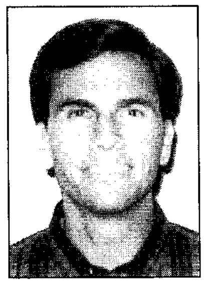

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