

Training to Improve the Vertical Jump

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Many coaches and athletes are uninformed about what type of training is needed to develop lower body power as a means to help improve sport specific performance. A multitude of sports require lower body power, used in skills such as sprinting, change of direction, acceleration and jumping ability. Many successful strength and conditioning coaches believe that the musculoskeletal system should be trained in such a manner that it mimics related sports actions in order to improve performance on the court or field. This 'specificity principle' of training is considered central to the success of sport specific training. Studies indicate that training using jumping movements has produced significant gains in lower-body movement efficiency.^{3,7,8,9} This article will review the importance of improving jumping ability and discuss specific aspects of training that will help athletes improve lower body strength and power to jump higher.

Lower body power, thought of in terms of speed strength or strength speed, can be improved by a systematic program that recruits a large proportion of muscle fibers in the shortest amount of time (high rates of force development), which is often expressed as explosive muscular movement during athletic events. ¹ With repeated and properly performed practice, the muscles will be more effectively recruited by the central nervous system to contract with greater efficiency in the proper sequential patterns. The end result will be a greater power output by the associated musculoskeletal system. Coaches and

athletes should remember that training adaptations by the neuromuscular system and the demands placed upon it are highly specific. Therefore training activities should reproduce these desired movements as closely as possible within the program.^{3,8} As with any other biomotor skill, an athlete who desires to improve his or her jumping abilities will have to practice jumping!

The vertical jump has long been recognized as an accepted test to assess and even track levels of an individual athlete's lower body power. This movement is a triple-joint extensor movement because it involves the muscles, bones and connective tissue of the hips, knees and ankles. This triple joint extension is a very common trait in athletic events and movements, including the actions of sprinting, bounding, diving, tackling, blocking and of course jumping actions in both the sagittal and frontal planes. The vertical and long jumps are used extensively in the assessment of athletic ability in talent identification programs for a variety of Olympic sports as well as a measurement device in the high school, collegiate and professional levels of sport.

In recent years, the vertical jump has been highly associated with the annual football and basketball professional scouting combines, as seen on television and Internet sports networks around the country.

Recognizing the importance of scoring well on this performance test, many coaches have worked to put together the 'perfect' combination of jumping activities, strength training and flexibility work to improve the vertical jump.

Research has suggested that a combination of Olympic-Style weightlifting movements and plyometric training seems to be the best way to improve the vertical jump.^{5,8} Plyometrics can be thought of as an explosive-reactive system of drills that

stress both the central nervous system and mechanical actions of the musculoskeletal system via a combination of repeated bounds, hops, and jumps in a variety of movement planes. Weightlifting exercises (as used in the competitive Olympic Sport) include the Snatch and Clean & Jerk, as well as their related movements. These movements also involve the central nervous system as well as the musculoskeletal system and are often associated with the development of explosive power and speed.

Many ill-informed coaches are hesitant to include these exercises in the power development programs of their athletes. It is the opinion of the authors that this hesitancy is due to their misunderstanding of the proper teaching and coaching techniques as well as a misinterpretation of the available data in the research field.

It is also the opinion of the authors that these same coaches tend to oversimplify the principles of strength training and conditioning, in particular a tendency to misinterpret the principle of specificity. The authors would like to respectfully recommend that those same coaches refer to the peer-reviewed specific work on explosive exercise movements of Dr. John Garhammer, Dr. Mike Stone, Dr. Ronald Byrd, Dr. Kyle Pierce, and Dr. Vladimir Zatsiorsky as well as the general strength training studies performed by Dr. William Kraemer, Dr. Steven Fleck, Dr. Don Chu, and Dr. Avery Faigenbaum.

The 'quick lifts' associated with Weightlifting, such as the snatch, clean, jerk, power clean, power snatch, clean pull, snatch pull and push press, are relatively simple to learn when taught by qualified USA Weightlifting certified coaches and instructors. USA Weightlifting has devised a comprehensive, and easy to learn technical and tactical approach to teaching and coaching these lifts safely and effectively. Their coaching

certification course seems to be well regarded by many of the top strength and conditioning and high performance coaches in the country.

Weightlifting exercises closely resemble the actions of the vertical jump, because the second pull phase of the lift requires the athlete to perform a smooth, sequential triple joint extension movement of the hips, knee and ankles which in turn results in a very high power output. Canavan looked at the difference between a snatch movement from the hang position and a non-countermovement vertical jump and found that they are kinetically similar.³ This finding reported that proper usage of the Olympic lifts can facilitate the neuromuscular system to enhance performance.

It is the opinion of the authors that weightlifting movements can be a very effective means of improving not only general lower power production and high rates of force development, but also with specific vertical jumping abilities. However, this would only hold true when the exercises are performed correctly and with proper levels of volume, intensity, loading, and frequency. It is also important to remember that these parameters be balanced with those of the other strength and conditioning drills of the program.

To maximize training for improved jumping ability, coaches should incorporate plyometric activities that properly utilize the concentric and eccentric muscle actions that occur during the stretch-shortening cycle. This cycle is characterized by a rapid eccentric muscle action, followed by an immediate and forceful concentric contraction. Properly performed plyometric training can improve an athlete's ability to minimize the amortization phase between the deceleration phase (force reduction, eccentric loading actions) and the following shortening, force producing concentric actions). It has been

theorized that the shorter the amortization phase, the greater the resulting power output of the concentric action.

In addition, the capacity for force production during eccentric muscle actions can provide the muscle with the ability to control movement, thus possibly protecting less compliant structures of the neuromuscular system from damage resulting from high-impact forces or repeated, low-force activity. As eccentric muscle actions may be 20-30% greater than concentric actions, a technique called eccentric loading can be used to increase one's ability to generate force quickly. ⁶ Moore looked at various studies that support eccentric loading during countermovement jumping that showed an increase in recruitment for greater force production, thereby improving jumping performance. ⁶

Another method of training for lower body power has been termed Complex Training. This method has also been referred to as post activation potentiation. ^{4,5} Complex training involves alternating between two biomechanically similar exercises of high-load strength training and plyometrics, set for set, within the same workout. It has been theorized that is a convenient and effective strategy for the development of sport-specific explosive power because it takes advantage of the contrast between heavier, mechanical loading activities and lighter, high force (often ballistic) jumping, throwing, pushing and pulling activities. The pairing of these different, yet kinetically similar actions also allows for adequate time for recovery. An example of this type of training would be back squat paired with vertical or even depth jumps. ⁵

It is also very important to remember that some athletes will lack proper foundational strength of the core musculature as well as the limbs. For athletes who lack a solid base level of strength, basic strength development using general exercises will

have a significant positive effect on the increase of lower body strength. This increase in base strength or force production will also have a positive effect of the ability to produce explosive power. Maximum Strength is related to maximum power, as strength x speed = power. Therefore an increase in the athlete's strength base can have a positive influence on the total lower body power. ¹ The authors recommend that once the athlete increases his/her strength base, power development through specific training exercises should then become a greater part of the vertical jump training program.

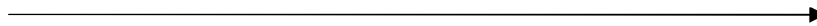
To determine whether an athlete has an appropriate strength base, the authors recommend that a comparison be made between a static vertical jump and a countermovement vertical jump. To perform a static jump, the individual squats to parallel, pauses for two seconds then jumps. To assess the countermovement jump, the athlete rises up on the toes and balls of the feet reaching up with both arms as quickly as possible. They immediately fire the arms down while flexing at the hips and knees to eccentrically load the body and then quickly reverse the action and as they leap up into the air. As stated earlier, this quick turnover from eccentric deceleration to explosive concentric action is an example of decreased amortization time.

An athlete that has a similar measurement between the two could be interpreted that the strength base is good, but the plyometric and central nervous system recruitment is not as efficient and the athlete needs more explosive reactive and ballistic power (quicker turnover). If there is a significantly greater difference between the static and countermovement jump, the athlete may very well have the central nervous system efficiency to maximize and recruit motor units and muscles at very high rates of force production, while being able to take advantage of the benefits of the strength-shortening

cycle. Thus, he/she may further benefit from increasing base strength while maintaining central nervous system and neuromuscular efficiency as it relates to recruiting fast twitch motor units that contribute to explosive power production.

The authors suggest a continuum of general, specific and special exercises going from basic strength leading to more explosive exercises and advanced (special) types of training.

General	Specific	Special
Back squat	Snatch	MB Throws and Releases
Front Squat	Clean	Ballistic Weighted Implement Throws
Clean& Snatch Pulls > 85% 1RM	Clean& Snatch Pulls @ 60-80% 1RM	Plyometric Jumps. Bounds, Hops
Conventional Deadlift	Push Press	Resisted Vertical Jumps
Step-Ups	Power Jerk	Complex training/ Potentiation
Military Press	Power Snatch	Weight Vest jumping
	Power Clean	Tubing Resisted jumps
	Block or Hang Work	Soft surface jumping



In the preparatory stages of the program, an athlete would devote more of the training time and efforts to general exercises and then move toward the specific and ultimately special exercises in the continuum.

It is important to note that the authors stress that a certain amount of general exercises (i.e. squatting) and specific exercises (i.e. power cleans and pulls) remain in the program throughout the entire process, although the volume and intensity levels will change as the program progresses. An effective manner of accomplishing this objective can revolve around the Complex or Potentiation training methods of special exercises, as with squats being paired with vertical jumps or box jumps.

In the OPTI Sports and Fitness Combine – Pro Day Preparation program, our coaches have successfully incorporated these principles and methods into the training program of professional and collegiate prospects with very positive results.

To illustrate how such activities might be performed, an example of a complex squat and box jump pairing that one of our athletes performed this past season follows.

This aspect of the training program took place three weeks out from the athlete's pro day testing on a Monday. To keep proper focus on the objectives of the article, we will not include the rest of the training session.

*Dynamic warm-up phase 1 ea x 2 x10 yds

Dynamic warm-up phase 2 ea x 2 x 10 yds

Dynamic warm up phase 3 ea x 1 set x 10 reps

Back squat complexed with vertical jumps on turf

BACK SQUAT	VERTICAL JUMP (on turf)	REST PERIODS
30%x6	3 jumps	2 min
45%x5	3 jumps	2 min
60%x3	3 jumps	2.5 min
70%x3	3 jumps	3 min
80%x3	3 jumps	4min
85%x2	2 jumps	4 min
90%x1	2 jumps	4 min

A second training session later in the week looked like this; in respect to the improvement of vertical jump ability.

*Dynamic warm-up phase 1 ea x 2 x10 yds

Dynamic warm-up phase 2 ea x 2 x 10 yds

Dynamic warm up phase 3 ea x 1 set x 10 reps

Power Clean from low blocks (2 inch high blocks)

POWER CLEAN (% best power clean)	REST PERIODS
30%x3	1.5 min
50%x3	1.5 min
60%x2	2 min
70%x2	2.5 min
75%x2	3 min
80%X1	3 min
85%x1	3 min

Front Squat + Push Press (% best push press)	REST PERIODS
25%x1+1X3	1.5 min
40%X1+1X3	1.5 min
55%X1+1X2	2 min
65%X1+1X2	2 min
75%x1+1X2	3 min
75%x1+1X2	3min
75%x1+1X2	3 min

An example of a third method used two weeks out from the scheduled testing day is also illustrated below.

*Dynamic warm-up phase 1 ea x 2 x 10 yds

Dynamic warm-up phase 2 ea x 2 x 10 yds

Dynamic warm up phase 3 ea x 1 set x 10 reps

Vertical Jump with Vertec (while wearing 10 lb wt vest)	REST PERIODS
3 jumps	1 min
3 jumps	1 min
3 jumps	1 min
3 jumps	1 min
3 jumps	1 min

Note: while a more lengthy rest period would have been more appropriate when trying to achieve max power output on each jump with a more ‘fresh’ CNS state, we also have to be specific to the demands of a typical pro-day testing environment, which often entails an athlete moving from one test to the next, with very little rest between testing attempts.

Thus, the shorter recovery ratio of work to rest above.

Kettlebell / Iron Shot Granny Throws for Max Height	REST PERIODS
10 lb shot x 3 throws	1 min
10 lb shot x 3 throws	1 min
10 lb shot x 3 throws	1 min

The second workout performed two weeks out revolved around Olympic Lift type jumps with a light load that focused on MAX RFD and Explosiveness in the Triple Joint Extensor movement.

Dynamic warm-up phase 1 ea x 2 x10 yds

Dynamic warm-up phase 2 ea x 2 x 10 yds

Dynamic warm up phase 3 ea x 1 set x 10 reps

Snatch Pull Jump	REST PERIODS
20%x5	1.5 min
30%x 3	1.5 min
30%x3	1.5 min
30%x3	1.5 min

This movement involves a conventional pull with the barbell that aims for the athlete to jump straight up, leaving the platform while fully extending the hips, knees and ankles. The athlete would land, reset and perform the next rep.

The above exercises are simply aspects of a total conditioning and performance program. Only the activities that directly dealt with the improvement of the vertical jump were illustrated above, and not the entire program. Please do not try and simply place these exercises into your own programs without proper respect for the training level of the athlete, his or her objectives, and the remainder of the strength and conditioning activities that are part of the plan.

It is the authors' hopes that you will use the information contained in this article to put together your own plan for your own individual athletes. It is inherently dangerous to try and 'cookie cutter' one part of a program into someone else's training.

In closing, we wish you the best of luck in utilizing the scientific data in the field to devise a training program that helps you and your athletes safely and effectively achieve your goals.

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