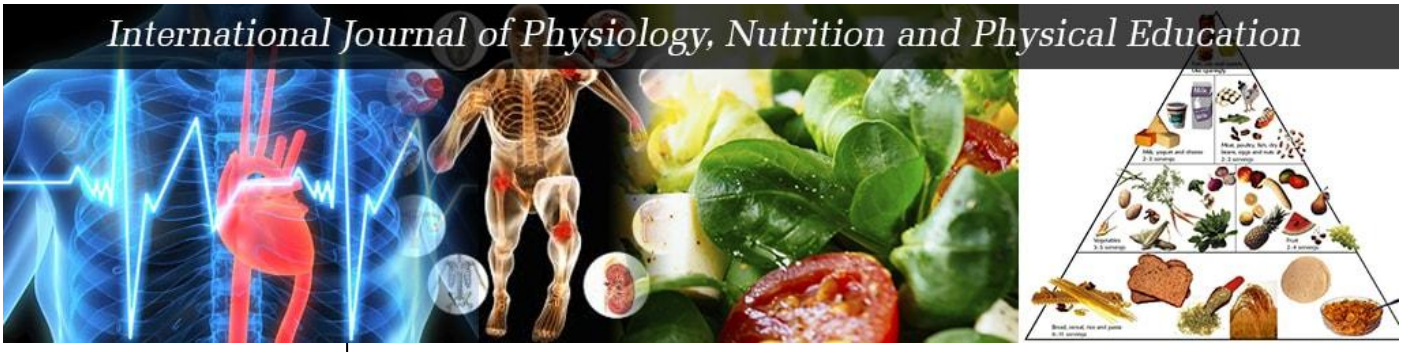

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R Priyesh
MPhil, Scholar, SRM IST
Chennai, Tamil Nadu, India

Dr. R Mohanakrishnan
Assistant Professor, SRM IST,
Chennai, Tamil Nadu, India

Correspondence
R Priyesh
MPhil, Scholar, SRM IST
Chennai, Tamil Nadu, India

Explosive power in volleyball

R Priyesh, Dr. R Mohanakrishnan

Abstract
Volleyball athletes need to read and react in order to spike the ball onto opposing defenders. Speed and agility are critical attributes on the court, but if you don't have the power to hit the ball once you run it down, your team will suffer.
If you want to put power behind your spikes, you have to do more than simply work a few arm exercises into your daily routine. You need to work from the ground up.
"Volleyball is a power sport," says Ray Weisenbarger, UCLA volleyball strength and conditioning coach. "It is explosive, [and] it's fast. That's the way the game has to be played." Yet, when players are preparing during the off-season, strength and power training are often overlooked.

Keywords: power in volleyball, volleyball athletes, critical attributes.

Introduction
Volleyball athletes need to read and react in order to spike the ball onto opposing defenders. Speed and agility are critical attributes on the court, but if you don't have the power to hit the ball once you run it down, your team will suffer.
If you want to put power behind your spikes, you have to do more than simply work a few arm exercises into your daily routine. You need to work from the ground up. That's just what UCLA Bruin volleyball players do during the off-season to add extra force to their hits.
"Volleyball is a power sport," says Ray Weisenbarger, UCLA volleyball strength and conditioning coach. "It is explosive, it's fast. That's the way the game has to be played." Yet, when players are preparing during the off-season, strength and power training are often overlooked.

Power
When examining the relationship between force and velocity, it is clear that the ability to develop high levels of force is important when attempting to maximize power output. Although they are related, it is likely that there are limits in one's ability to increase unloaded movement velocity and that there is a greater potential for increasing muscular strength. Because power-generating capacity is based on the ability to express both force and velocity, both of these factors need to be considered in any training program that attempts to develop muscular power
When examining muscular power, it is important that one considers the highest instantaneous power found during a range of motion, under a given set of conditions, as representing the individual's peak power. Peak power-generating capacity is typically related to success in explosive activities such as jumping, sprinting, and weightlifting movements. Because these activities are also related to volleyball playing ability. it is clear that training interventions designed to enhance success in volleyball must target the development of peak power output.
In sports like volleyball the ability to repetitively express peak power outputs also appears to be of particular importance. This ability should be considered as a function of the athlete's high-intensity exercise speed. It is important to realize that in sports like volleyball, the ability to express high-power outputs should not be compromised by efforts to improve movement speed.

Factors Effecting Power Production
The muscle's cross-sectional area and fiber type appear to contribute to an athlete's ability to

express higher power outputs. It is well documented in the scientific literature that an increase in muscle cross-sectional area can contribute to increased strength gains and that increases in cross-sectional area lead to changes in force production capabilities, which then serve as the foundation for the expression of high-power outputs. Additionally, muscular architecture changes that underlie the hypertrophic changes to the muscle can play a role in the relationship between cross-sectional area and power generation. The type of contraction used during resistance training can modulate muscle cross-sectional area. Specifically, activities that use a large amount of stretch to the muscle, like plyometrics and weightlifting exercises that significantly engage the stretch-shortening cycle have the potential to significantly increase the number of sarcomeres added in series, whereas combinations of eccentric and concentric muscle actions result in a significantly larger increase in the number of sarcomeres in parallel Collectively, these data suggest that there is an orderly process by which resistance training can be used to alter the skeletal muscle size and architecture to optimize the muscle machinery necessary for producing peak powers.

A second factor that contributes to a muscle's ability to generate power is its fiber type. Type II muscle fibers express a higher velocity of shortening, force output, and power output when compared with type I fibers. Additionally, the muscle's ability to generate peak power outputs is significantly correlated with the individual's percentage of type II fibers and particularly with total type II cross-sectional area. Indeed, it is quite advantageous to have a high type II:I fiber type ratio. One possible explanation for the peak power output of the type II fibers exceeding the type I fibers is related to the overall higher cross-bridge cycling rate possessed by these fibers.Additionally, the higher cross-bridge cycling rate attained by the type II fibers has been suggested to be a major contributing factor in the ability to express maximal rates of force development. Based on these relationships, it is clear that the muscle fiber type composition is tightly related to the rate of force development the individual's maximal force-generating capacity, and the overall power-generating capacity.

the muscle will increase its cross-sectional area, then its maximal strength, and then its power-generating capacity.

Explosive Exercise Training

Explosive exercises such as the weighted jump squats and bench press throws can be beneficial when attempting to elevate a football player's power-generating capacity. Overall, it is well established that stronger individuals have higher power-generating capacities and that increases in strength parallel increases in power-generating capacity. However, it appears that weaker individuals can increase power output without focusing on specific power-based training such as weighted jump squats. When looking at jump squat training, Cormie *et al*. clearly demonstrate that with weaker athletes (<1.5 × body mass in the back squat 1RM) focusing on strength development is equally effective at improving jumping performance when compared with specialized power development training. With stronger individuals (≥1.7 × body mass back squat 1RM), it was noted that specialized power-based training (weighted jump squats) resulted in a more pronounced improvement in power-generating abilities when compared with weaker individuals.

Typically, it has been reported that power output is highest in the jump squat at a 0 kg load, which would essentially make the jump squat an unloaded plyometric activity (see discussion on plyometrics). Although methodological differences may play a role, several researchers have clearly demonstrated that with stronger athletes, such as advanced football players, having a back squat 1RM ≥ 1.7 × body mass, that power output is optimized at higher loads.

Conceptually, it is very likely that increasing muscular strength results in a rightward shift of the strength-power relationship because the stronger athlete can express higher velocities of movement with higher forces. Taken collectively, the literature clearly indicates that weaker individuals need to develop an appropriate strength base, and as they get stronger, specialized power training can be used with loading paradigms that consider the athletes overall strength. If integrated into a periodized training plan, it is likely that including these specific power-based exercises with an appropriate load can maintain power output in team sport athletes during a season.

Exercises for Devoloping Explosive Power in Volleyball Players

Box Jumps

- Assume athletic stance an arm's length away from plyo box
- Lower into quarter-squat, then explode through hips, knees and ankles and jump for maximum height
- Land softly with bent knees on top of plyo box
- Step down slowly; repeat for specified reps

Sets/Reps: 4x5

Always start jump on balls of feet

Hang Clean

- Grip bar slightly wider than athletic stance
- Begin holding bar just above knees with back locked, shoulders up, and abs and chest flexed
- Explode by forcefully shrugging and fully extending hips, knees and ankles
- Pull bar up, keeping it close to chest
- Drop under bar and catch it in front of shoulders in athletic stance with knees bent

Sets/Reps: 5x5 with two warm-up sets

Keep bar close to body, Use lower body to explode weight up, Focus on form rather than amount of weight

Dumbbell Forward Lunge

- Hold dumbbells at side
- Step forward into Lunge position without touching back knee to ground
- Using front foot, push back into standing position
- Repeat for specified reps
- Lead with other leg

Sets/Reps: 4x4 each leg

Keep back flat and chest up, Don't over stride on Lunge, Don't allow knee to touch ground

- **Military Press**
- Grip bar at shoulder-width and lift to slightly under chin
- Press weight directly over head until arms are straight
- Bring back down to start position
- Repeat for specified reps

Sets/Reps: 3x8

Use a spotter, Focus on pressing weight straight up, Start with light weight until comfortable performing the lift, Use dumbbells if unable to lift bar

- **Single-Arm Dumbbell Snatch**
- Begin in athletic stance with feet shoulder-width apart; hold dumbbell in one hand between knees
- Squat slightly, then quickly press off ground using jumping movement
- Extend ankles, knees and hips while pulling dumbbell up
- Allow momentum to carry dumbbell up and over shoulder
- Catch Dumbbell overhead and hold fully extended position for one second, then lower
- Repeat for specified reps
  Sets/Reps: 3x5 each arm
  Keep weight close to body, Bring weight up in straight line, Use lower body to explode up

- **Double Leg Bucks**
- Lie on back with knees bent and feet flat on floor
- Place arms out to sides with palms on floor
- Squeeze glutes and thrust hips up as far possible
- After full glute contraction and hip extension, lower back and hips to start position
  Sets/Reps: 3x10
  Pull heels in as close to butt as possible, Push hips all the way through

- **Reverse Hyper** (performed using a Glute-Ham Machine)
- Start with upper body facing down on machine, with legs hanging perpendicular to floor
- Raise legs until parallel to floor; pause, then lower with control
- Return to start position
  Sets/Reps: 3x10

Keep legs and heels together, Maintain flat back

- **Med Ball Russian Twists**
- Sit on ground with legs crossed and feet above floor
- Twist to one side, then twist to other side with med ball in hands (one rep total)
- Repeat movement for specified reps
  Sets/Reps: 3x20
  Don't let feet touch ground, Increase weight for added difficulty

Conclusion

In the light of the findings of the present study the following conclusions have been made.The training model used in this study were well structured based on the principles of training. In developing the explosive power. the paper lead to conclude that while formulating the explosive power training, in volleyball make a better result in spiking, blocking, digging and moving around the court. This exercises in the paper can be applied for youth and senior volleyball players.

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