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Article

Equipment-assisted training to improve the explosiveness and agility of football players

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Abstract: Main: Football players need to release power in a short time when they dribble or shoot quickly, so they need explosive power. Explosive power comes from muscle strength, and muscle strength comes from muscle mass. **Result:** Football players can increase leg muscle mass to increase the upper limit of muscle strength, the upper limit of explosive power, and the upper limit of jumping ability. **Discussion:** Agility ladder training (rope ladder) is mainly used to practice coordination, balance and agility. It can enhance the speed of lateral displacement, and also enable the feet to move faster and increase the frequency of steps. Football players need to do this training. During training, the toes should be stepped on the right rhythm, and the hips can be swung while stepping, allowing the body to twist to any angle. Combined with cross steps and single-foot in and out, it can greatly increase the flexibility of both offense and defense. Rope ladder training. It provides a great multi-plane dynamic warm-up, which can develop the connection between the brain and muscles, and is also good for eccentric contraction and stability. In addition, it can also enhance the reaction time to the ball and exercise the muscles of the feet. **Methods:** Short-distance sprinting can increase the activity of fast-twitch muscle fibers, which contribute most to explosive power. At the same time, dynamic weight training such as squats and box jumps can significantly increase the strength of lower limb muscles for football players. The increase in weight and number of repetitions in strength training should be gradual according to individual ability to avoid muscle damage. Focusing on strengthening the stability of the core muscles can effectively support the development of explosive power in the leg muscles. **Conclusion:** Football explosive power training can train the ability of muscle cycle lengthening and shortening, effectively utilize the elastic potential energy stored in the soft tissue during the lengthening process, reduce the energy consumption of direct muscle contraction, and improve explosive power energy.

Keywords: equipment assistance; athlete explosiveness; agility training; core strengthening; physical training

1. Main

The explosive force training method is a step-by-step training method. First, develop the maximum muscle strength, and then adjust the training method according to the needs of each sport. Jumping is an explosive force movement of the legs. As for leg training, squatting is the main movement. Although weight training increases the maximum muscle strength of the legs, in actual conversion, it can only exert the maximum muscle strength to a limited extent. Football players need to have a certain amount of muscle mass in their legs. The leg muscles must have a certain amount of muscle strength, and then convert this muscle strength into explosive power, which is the power that the muscles can release in a short time and at a faster speed.

Explosive power and maximum muscle strength are closely related ways of muscle operation. Explosive power is "speed" multiplied by "muscle strength", and "how fast" can be used to exert "maximum muscle strength". In simple terms, explosive power is the combination of speed and muscle strength, but the "intensity" of explosive power is related to "maximum muscle strength". If the maximum muscle strength is not strong, the explosive power is relatively weak. This is why football players must first develop maximum muscle strength before training explosive power [1].

When football players need to improve their maximum strength, they must use "enhanced training" or "specialized training" to increase the maximum strength conversion rate and increase the explosive power when jumping. That is, after squatting, do jumping movements. After football players have completed strength training, they do enhanced training to get their bodies used to such movement conversions, so that they can exert the effect of maximum strength training.

A basic strength training program for soccer players should target both strength and muscle. 2–4 sets of 8–15 reps each. Strength training ensures that your lower body, upper body, and core are trained, while being careful not to lift too heavy or too light. This phase will lay the foundation for your training for other goals. In order to develop maximum strength [2], soccer players should use the heaviest weights, the fewest repetitions, and the longest rest periods. For example, use a 5 × 5 system, which is 5 sets of 5 reps each. Use relatively high loads (heavier weights) and rest for a long time between sets (about 3–5 min).

Football players typically use moderate weights, high repetitions (8–12) and low rest periods to increase muscle size. They stimulate the muscles through resistance training and then use proper rest and nutrition to help the muscles repair, and the muscles get bigger in the process. A typical number of repetitions and sets is 3 sets of 8–12 repetitions.

Explosive power is related to muscle development and body composition. By improving explosive power, muscle strength can be increased, while improving body composition, reducing body fat, waist circumference, body mass index, etc. Therefore, explosive activities can enhance bone strength and promote muscle development, have a positive impact on human health, prevent injuries and diseases, and improve the quality of life of the human body.

Explosive power is the product of muscle strength and speed (P = FV), which can also be understood as the ability to generate force at the fastest possible speed [3]. In the "Strength and Speed Curve" graph, the red line shows that when the maximum explosive power is output, it does not require a lot of muscle strength and a fast speed (**Figure 1**).

In terms of application, explosive power can be targeted at:

1) The time required to generate the highest speed (acceleration);
2) The shortest time to complete the action (maximum speed).

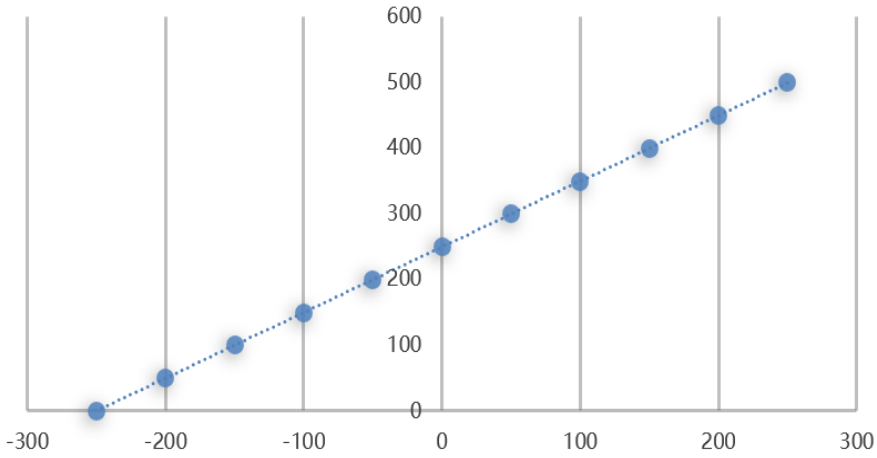

Figure1. Force-speed curve.

Maximal strength: Training with heavy loads at low speeds (high intensity) develops maximal strength, which is essential for weightlifting and sports where raw strength is critical.

Speed: Training with lighter loads at high speeds (low force) develops speed and power.

For acceleration: Football players use higher speed resistance training to adapt their bodies to faster repetitive movement speeds and can be considered to fall into the intensity range of "speed-dominated strength training" to "peak training" (see **Table 1**).

Table 1. Force and power characteristics.

Exercise	Peak Power (W)	Peak Force (N)	RFD
Power Clean	25,913	22,644	8.6561
Isometric Mid-Thigh Clean Pull	N/A	31,872	220,482
Hang Power Clean	31,835	24,781	102,141
Mid-Thigh Power Clean	3.6866	28,631	154,491
Back Squat	26,376	2.9411	54,832

OTE: The data within this table is based on lifts at 60% and 70% of 1RM and is compiled from several resources. (1) Data extracted from (14): 60% of 1RM-Elite male rugby league players; (2) Data extracted from (11): 60% of 1RM -Elite male collegiate weightlifters; (3) Data extracted from (12): 70% of 1RM -Male powerlifters; (4) Data extracted from (13): 70% of 1RM - Male powerlifters and rugby union players; (5) Data extracted from (15): Unloaded-Trained male university students. Data extracted from (16): 80% of 1RM-Athletically trained males.

Targeting maximum speed: Football players use heavy resistance training to improve their body strength, and at the same time need to take into account the performance of speed. Therefore, athletes use "strength-dominated speed training", especially strength, football and other related training, which is considered an ideal means of training explosive power.

However, the benefits of explosive power training for football players cannot be sustained for a long time, so it is not recommended as a long-term continuous training goal. At the same time, explosive power training for football players is more suitable

for those who already have a certain sports foundation, have sufficient muscle strength, and can continuously maintain high core stability of the spine in neutral position for sports movements. Otherwise, the benefits of explosive power training will not only be greatly reduced, but also increase the risk of injury.

Agility in football players can also reduce the risk of injury during the sport. Muscle strength, power and stability are key to agility, and these physical factors help football players become more adept at their competition. Agility not only allows a footballer to move his body, but it also allows the brain to connect with the body. Agility requires a lot of awareness and very high mental acuity. When footballers do multi-directional training [4], they are definitely not relaxing and just doing it mechanically. This training forces footballers to pay attention to their movements at all times, which is the key to improving body awareness in footballers' training. It also helps reduce the risk of future injuries.

Speed and agility training follow the principle of specificity, suggesting that straight-line (linear) speed training can improve straight-line speed with little effect on agility, and vice versa [5]. Therefore, it is important to train these elements as separate components to ensure maximum improvement in speed and agility. Eight weeks of sprint training improved performance during the top velocity phase of the sprint (20–40 m), and resistance sprint training (pulling a 5 kg sled) improved the acceleration phase of the sprint (10 m). Research further showed that agility training improved soccer players' ability to change direction (agility).

2. Result

The formula for explosive power can be expressed as P = FV.

F: Net muscle force, or it can be understood as "power" itself, and muscle strength can be calculated by the formula F = MA

V: Vector speed, which is different from the general understanding of speed. The general speed refers to "rate", which calculates the time required for the total distance from point A to point B. V is vector speed, which is different from speed in that vector speed only calculates the time generated by the shortest distance from point A to point B. However, in the following explanation, V will be mainly expressed as "distance".

Based on the above formula, the factors that affect explosive power can be divided into three sub-items:

Muscle mass: The element of muscle net power is the product of muscle mass and acceleration. Therefore, among the factors that affect explosive power, muscle mass specifically refers to "the amount of muscle involved in the action". The more muscle mass a football player can use, or the higher the quality of the muscle itself, the better the strength will be. Therefore, strength training is particularly effective in this area.

Acceleration: Another element of muscle net force is acceleration. Acceleration focuses on the change in speed, not a uniform speed. Therefore, a soccer player can increase the time it takes to go from zero speed to maximum speed, which is the change in acceleration.

Vector velocity: The formula for vector velocity is "displacement distance divided by time" (D/T). However, in order to explain the explosive force in motion, I

will assume that this element is "change in distance". Based on the fact that acceleration and speed remain unchanged, the shorter the distance, the shorter the time will be in theory, which means that the vector velocity will be faster.

Therefore, the formula for explosive power in combat sports can be understood as follows:

Explosive power = muscle mass × acceleration × distance change,

$$P = MAV.$$

In explosive training, when football players need to do specialized strength training and develop the explosive power of local muscle groups, the load can be increased to 70%–90% of their maximum weight; and in special technical training, the load can reach 30%–50% of their maximum load. The number of repetitions for each strength training of football players should be chosen to promote the growth of their own strength, while not changing the original action, and should ensure that the efficiency and action standards are not reduced when completing the action. The general number of repetitions is 3 to 6 sets. The number and time of repetitions mainly depend on the load size, the training level of the football players, and the action. At a certain difficulty, the total amount of exercises arranged by football players during each training session should not be too large (**Figure 2**), and the explosive training time should usually be within 20 min.

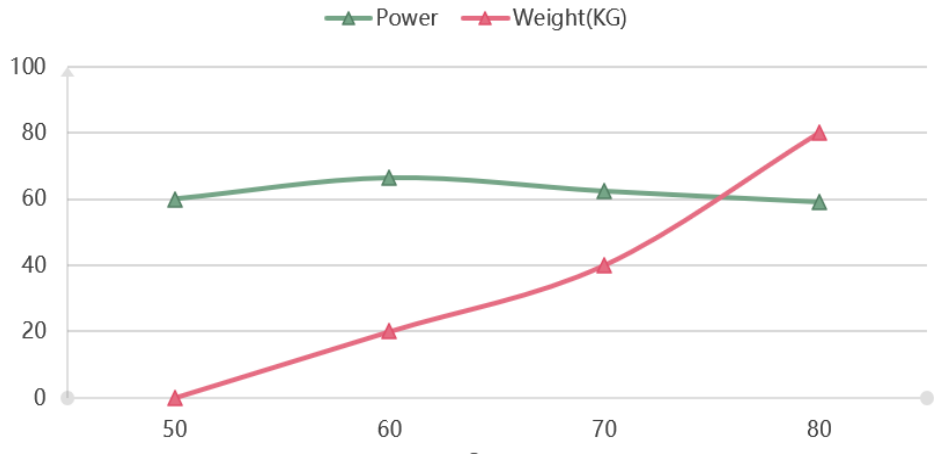

Figure 2. Explosive training intervals.

The explosive force training method is a gradual training method. Football players first develop maximum muscle strength, and then adjust the training method according to the needs of each sport. Jumping is an explosive force movement of the legs, and leg training is mainly based on squatting. Although weight training increases the maximum muscle strength of the legs, in actual conversion, it can only exert the maximum muscle strength to a limited extent.

When football players really want to improve their maximum strength, they must improve their maximum strength conversion rate through "strength training" or "special training". They want to increase their explosiveness when jumping, which means they do jumping movements after squatting. After the body has completed strength training, they do strength training to get the body used to such movement conversion, so that the maximum strength training effect can be exerted.

A proper agility training program for soccer players should have the following phases:

1) Warm-up/preparation;
2) Agility or speed training;
3) Strength training;
4) Metabolism;
5) Cool-down.

Agility training is crucial in all kinds of competitive sports because it allows football players to accurately and quickly adjust the direction of movement in rapidly changing situations, improve reaction speed, and enhance structural coordination and stability. Through this training, football players can not only improve their performance in the game, but also help them maintain their body flexibility in competition and reduce the risk of falling or injury. In addition, agility training can effectively optimize movement efficiency and improve the body's ability to cope with sudden environmental changes or unstable factors, allowing people to handle various situations with confidence.

3. Discussion

Strength and speed are inversely related, that is, when the muscles need to output maximum force, the speed will be the slowest; conversely, the faster the speed, the smaller the muscle force output (**Figure 3**).

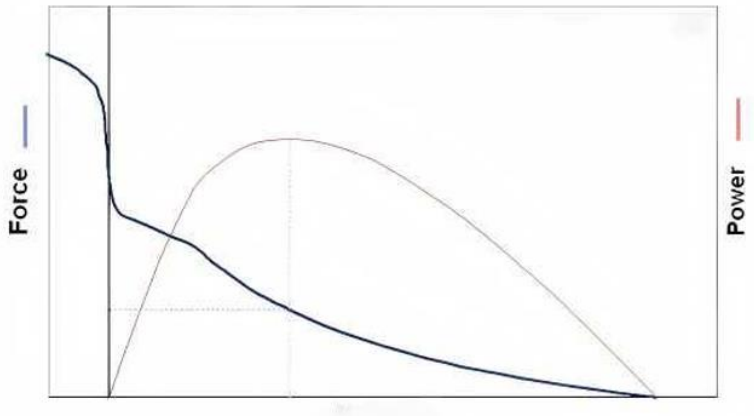

Figure 3. Force-velocity relationship.

Therefore, based on the relationship between speed and strength, speed-based training can be divided into five categories:

Maximum strength training: The slowest speed but the highest force training, such as maximum muscle strength training;

Strength-dominated speed training: Training at the speed of exerting maximum strength, such as weightlifting training;

Peak power training: Targeting the balance point between strength and speed, such as throwing medicine balls;

Speed-dominated strength training: Strength training that tends to exert speed, such as plyometric stretching (or rapid stretching and contraction compound training);

Maximum speed training: Training with the smallest load weight to exert the highest speed, such as decline sprints or assisted sprints.

Football players usually demonstrate agility in a very short time, so there are many factors that affect agility, and they are subtle. It is divided into the following five items:

(1) Muscle strength

Football players' agility movements generally include three processes: Starting, stopping suddenly, and changing direction quickly. If muscle strength is increased in a timely manner, it is easier to overcome the resistance during these movements [6]. Moreover, better muscle strength means that the muscles can contract faster, thereby achieving faster speed. At the same time, it also enhances agility.

(2) Speed

A football player's agility includes running, so speed is also one of its influencing factors. The extent of its influence depends on the distance they run. The longer the distance, the greater the influence. The biggest difference between speed and agility is that the latter includes the ability to change direction quickly. So strictly speaking, speed can be said to be a type of agility.

(3) Reaction time

Reaction time refers to the time from the onset of stimulus to the generation of muscle movement. In actual sports situations, reaction time can be divided into two categories. One is the simple reaction time, which is to anticipate the sudden stimulus in advance and make regular action responses, such as the start of track and swimming competitions when the gun goes off [7]; the other is the complex reaction time, in which the action is not specified and different action responses are made according to the stimulus conditions. There are many sports that need to determine the next action based on the direction of the ball, such as football, basketball, tennis, etc., all belong to this category. In terms of the impact on the agility of football players, complex reaction time is obviously more important than simple reaction time.

(4) Explosive power

Explosive power is a combination of strength and speed. Since football players will constantly start and restart in their agility performance, it is natural for football players to have good explosive power, which is an important condition for improving agility.

(5) Coordination

When a football player changes direction quickly, the dynamic balance of the body is the most important factor affecting the agility of coordination. At this time, the player's body integrates the nerve and muscle systems [8], allowing the muscles to contract and relax quickly through the interaction of the nervous system, so as to produce correct, harmonious and elegant movement ability.

4. Methods

4.1. Explosive training methods

(1) Improve linear speed and explosive power

Training methods: Linear sprint, short-distance acceleration run, step jumps (plyometric jumps).

Recommendations: Football players mainly sprint short distances (10–20 meters) and keep sprinting at full strength each time. They can gradually shorten the rest time to increase endurance and speed. Step jumps help strengthen the explosive power of lower limb muscles. It is recommended to do 2–3 times a week, 3–5 sets each time, 10 times per set.

(2) Improve lateral movement ability

Training methods: Lateral sliding, lateral movement on agility ladder.

Suggestion: Lateral sliding can improve the stability and speed of lateral movement, which is suitable for competitive football. Lateral movement training on agility ladder can further improve the flexibility of steps [9]. It is recommended to perform 2–3 times a week, 3 sets each time, 15–20 s per set, focusing on stability and speed.

(3) Strengthen the ability to move backwards

Training methods: Backward running, backward agility ladder, backward jump

Suggestions: Backward running can improve the flexibility and control of the backward steps, especially for football and defensive athletes [10]. Backward agility ladder training helps to improve the accuracy and stability of the backward steps. It is recommended to train twice a week, 3–4 sets each time, 20–30 s per set.

(4) Shock squats

For squat training, most football players recommend that you maintain tension and squat and stand up in a controlled manner. This is a relatively safe method and the most effective way to squat.

Ballistic squats and stretch-contraction cycles.

Football players increase their explosiveness by using a controlled rebound when squatting. By using your body's stretch reflex, your muscles are able to store energy on the way down (eccentric contraction) and release it with a quick turn, exploding upwards at a much faster rate!

Rapid stretching causes muscles and tendons to create and store elastic energy. This stored energy is released by a quick concentric movement after the stretch. This works like a rubber band, where when a muscle is stretched from rest [11], it allows us to generate more force. It will naturally return to its original length. The component of the muscle and tendon that acts as a spring is called the series elastic component.

4.2. All-round agility

Training method: Mixed agility training: Recommendation: Combine multiple agility trainings into a complete circuit training to comprehensively improve the straight, lateral and change of direction ability of football players [12]. It can start with agility ladder to improve the flexibility of steps (**Figure 4**), followed by cone running and emergency stop and turn training. It is recommended to do it 2–3 times a week, 3 sets each time, 5–10 minutes per set.

Figure 4. Agility ladder training.

The following training parts: Lower body training, mainly training speed, explosive power, agility, coordination.

(1) Rope ladder lateral jump

Step 1: Stand on the left side of the first square of the ladder, spread your feet apart, squat, then jump up from the ground and jump into the diagonal ladder square.

Step 2: Then immediately jump up from the ground, jump to the right side of the ladder, and continue to move forward quickly [13].

Step 3: After jumping to the end of the ladder, run back to the starting point and repeat the action.

(2) Two forward jumps, one backward jump

Step 1: Stand on either side of the first square of the ladder with your feet shoulder-width apart, knees bent, upper body leaning forward.

Step 2: Then jump forward from the ground to the second square of the ladder, then immediately jump back.

Step 3: Then continue to jump forward two squares, then back to the back square. After jumping to the end of the ladder, run back to the starting point and repeat the action.

(3) Squat/jump

Step 1: Stand on either side of the first step of the ladder with your feet shoulder-width apart.

Step 2: Jump forward one step and do a squat jump, then stand up and quickly jump down one step and do a double squat jump [14].

Step 3: After jumping to the end of the ladder, run back to the start and repeat.

(4) Single-foot forward jump

Step 1: Stand in front of the ladder, lift your left foot off the ground, and then jump one square at a time with your right foot.

Step 2: After jumping to the end of the ladder, run back to the starting point and repeat the action. Do it for 30 s on each foot.

(5) Sideways lunge

Step 1: Stand on the side of the ladder, with your right foot on the first square, and your left foot behind to lunge outside the ladder.

Step 2: When passing each square, cross your feet and jump, right front, left back, left front, right back, jump to the end of the ladder, and then run back to the starting point.

(6) Sideways lunge

Step 1: Stand on the side of the ladder, with your right foot on the first square and your left foot behind to lunge outside the ladder.

Step 2: As you pass each square, cross your feet and jump, right front, left back, left front, right back, jump to the end of the ladder, then run back to the start and repeat.

(7) Side steps with toes touching the ground

Step 1: Stand on the left side of the ladder, facing the ladder, with your knees slightly bent. Jump forward two squares with your right foot, hook your left toes and kick toward your right ankle, then jump back one square with your left foot [15].

Step 2: After jumping to the end of the ladder, run back to the starting point and repeat the action. Do it for 30 s on each foot.

(8) Slide with toes touching the ground

Step 1: Stand on the left side of the ladder with your back to the ladder.

Step 2: Jump to the right and back with your right foot, with your toes in the square, then switch to the left. Alternate and continue jumping for 1 minute.

(9) Plank jump

Step 1: Open your feet to shoulder width and place your palms in the square to prepare.

Step 2: After jumping your feet outward, put your left and right hands into the next square respectively, and move your back with them, and repeat the above movements.

Step 3: After jumping to the end of the ladder, run back to the starting point and repeat the movements.

(10) Rope ladder push-up

Step 1: Kneel on both knees in the rope ladder square, put your hands on both sides of the ladder to prepare, and prepare in the push-up position.

Step 2: Lower your chest to the ground, stay for 2 s, then push back, then put your left and right hands into the ladder grid respectively, then extend your hands and repeat the above movements [16].

(11) Quick feet

Step 1: Stand on the right side of the ladder, bend your knees slightly, and lean your upper body forward to prepare.

Step 2: Point your left toe into the rope ladder grid on the left, then take a step forward with your right foot and continue moving forward.

Step 3: After jumping to the end of the ladder, run back to the starting point and repeat the action. Do each foot for 30 s. When changing sides, change the right toe to point into the rope ladder grid.

4.3. Core training

(1) Core stability is the training focus for runners. Football players are required to keep the spine and pelvis as little as possible during the training process, and keep the core stable while moving other parts of the body [17]. The training mainly includes "trunk stability, limb activity" type movements. Support is a technique to maintain core stability, that is, consciously keep the core muscles contracted.

(2) In core strength training, the movements involve more movement of the spine through the full range of motion, while practicing the techniques learned in core

stability training (breathing and support). The goal is to improve functional strength and dynamic stability of the whole body. Training mainly includes traditional abdominal training (such as crunches) and weight-bearing strength training.

5. Conclusion

The performance of speed and strength in football constitutes explosive power, while speed and endurance constitute speed endurance. Understanding the relationship between these physical characteristics and then designing a special physical training plan must first start from the basic physiological basis of various physical characteristics. Muscle strength training is an indispensable and important link for all sports performances. Football explosive power training can train the ability of muscle cycle lengthening and shortening, effectively utilize the elastic potential energy stored in the soft tissue during the lengthening process, reduce the energy consumption of direct muscle contraction, and improve explosive power energy.

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Conflict of interest: The authors declare no conflict of interest.

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