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Determination of the Best Pre-Jump Height for Improvement of Two-legged Vertical Jump

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Original Article

ABSTRACT

Background: Athletic performance in many sports depends on two-legged vertical jump. The objective of this study was to examine the effect of different pre-jump height exercises on two-legged vertical jump and to determine the best pre-jump height(s).

Methods: Subjects included 35 females and 42 males. By matched randomized sampling, subjects of each sex were assigned into four groups, namely, control, 10-cm hurdle, 20-cm hurdle, and 30-cm hurdle. They participated in the same training program for 6 weeks. Statistical analyses were based on one-way and repeated-measure analysis of variance (ANOVA).

Results: Analysis of the data showed that practice over hurdles of 10 cm was better than no hurdle and hurdles of >10 cm. Also, jump attempts over hurdles were efficient for trained athletes, but not for untrained athletes. For both sexes, the rate of spike improvement was much better in the experimental groups than in the control groups; it was independent from the rate of progress in jump, which was relatively less evident.

Conclusions: It is likely that rather than increasing jump height, training over hurdle enabled the players to use a higher percent of their jump potentials.

Keywords: Plyometric training, training hurdle, volleyball

INTRODUCTION

Power means the amount of work a muscle or muscle group can produce per unit of time.[1,2] The explosive power is the ability to use high levels of strength as quickly and as explosively as possible to move the whole body (jumps) or an object (throws). Explosive power is built up on speed strength, which in turn is developed on pure strength. Subsequently, required techniques are developed by plyometric training on simulated movements. High level of explosive muscular power is vital for success in many athletic competitions, which involves vertical and horizontal jumps. This is true for both individual and team sports, e.g. track and field events, gymnastics, diving, basketball, volleyball, netball, and even soccer, rugby, and football. The relationship between leg power (especially in the form of vertical jump) and performance is demonstrated in many sports.[3,4] Therefore, many players work on jumping ability in both the preparation and competition phases of the annual training program.[5,6]

Vertical jump improvement is a progressive and long-term flow that necessitates continual training and maintenance of general and specific power.[7,8] The various training types used to develop explosive power may, respectively, include, traditional heavy weight training, explosive light weight training, plyometrics, combined weights and plyometrics, and maximal power training. Adjustments made by periodization of annual training program are vital in order to maximize the desired effects of every type of training.[9] Success of jump training depends on four attributes of the athlete: 1) No excess body fat, 2) the ability of physiologic system to produce maximum anaerobic energy in shortest possible time, 3) the ability of anatomical system to provide essential biomechanical facilities, and 4) the ability of neurophysiologic system to properly stimulate involved muscular groups. It had been traditionally known that three factors of body composition, muscular strength, and anatomical development should be addressed in conditioning training for jump.[10] Furthermore, recently, the focus was redirected toward neurophysiologic development through plyometrics. This was achieved by the means of identifying target techniques and repeating their simulated movements in practice.[11]

Neurophysiologic development emphasizes on objectives such as coordination, relaxation, customization, and automation. Coordination requires synchronizing the movements of all body parts in an explosive power action. For example, trunk and upper limbs could play a great role in jumping, if properly practiced. Relaxation refers to practices necessary for on time release of antagonist muscles, which prevents strain injuries. Customization indicates proper speed and action of counter movements, which are necessary for efficient use of stretch shortening cycle (SSC). For example, customization for short and high spike is quite different in volleyball. Automation of the skills also creates an opportunity for the athlete to direct his/her attention towards competition tactics.

Nowadays, training for power is considered crucial in a wide variety of sporting activities.[3,12] The focus of this research is two-legged vertical jump. Its examples could be found in volleyball spike and block jumps as well as defending jumps in other team sports. It seems that all two-legged jumps are fundamentally similar. Nevertheless, even in different moves of the same sport players somehow rely on relatively different techniques.[5,6] In this way, we can speak of specificity of jumps. Even in a specific jump in a particular sport, we can speak of individuality of jumps, as different individuals use different jumping styles with different approaches and run ups, which increases or decreases the velocity of their movement. Therefore, training for one type of jumping technique will not necessarily improve performance in another style of jumping.[10]

Some studies have investigated the relationships of leg power and vertical jump,[7,10] or the development of leg power through various forms of weight[1,13] and plyometric training techniques.[1,14] However, there is limited research available in investigating the effects of absence or existence of different forms of short pre-jumps on efficiency and effectiveness of two-legged vertical jumps. The focus of this research was to examine the effects of different pre-jump heights on two-legged vertical jump and to determine the best pre-jump height(s).

METHODS

Experimental approach to the problem

We used a within-subject repeated measures design to compare vertical jump changes in the study groups. Pre- and post-testing sessions were separated by 6 weeks of training.

Subjects

Seventy seven learners of volleyball (35 females and 42 males, aged 19–22 years) signed the informed consent form and volunteered to participate in the study. They were assigned to seven training groups by matched randomized sampling [Table 1]. Every group participated in its own specific training class. Mean (±SD) of weight and height for males and females were 67.3 (±7.7) vs. 55.8 (±5.7) kg and 177 (±5.9) vs. 163 (±4.2) cm, respectively. The study was approved by Isfahan University Research Board.

Procedures

Training schedule

All training classes continued for 6 weeks, including two sessions of 90-min practice per

Table 1: Study groups

Gender	Control	10-cm hurdle	20-cm hurdle	30-cm hurdle	Total
Girl	12	11	12	-	35
Boy	10	11	11	10	42
Total	22	22	23	10	77

week. The only difference among classes was related to 30 min of plyometric drills [Table 2]. The drills were the same, but no hurdle and hurdles of 10, 20, and 30 cm were used, respectively, for control and the corresponding experimental groups.

Plyometric drills

Thirty minutes of practice time was devoted to 9 plyometric drills simulated to volleyball spike and block [Table 2]. The main objective of the drills was neurophysiologic adjustment to volleyball jumps as explained in the Introduction section. In every drill, except drill 9, we enforced a pre-jump for experimental groups by placing a hurdle before the jump point. To make the best use of time and space, we split the volleyball court into 6 separate lines of 1.5 meters width. Every player had a partner and they practiced over the net.

Measures

Height, weight, and age of participants were measured at the start of the study. Vertical jump test was used pre- and post-training program to evaluate the training effects. We administered Standard Sargent vertical jump test (with no pre-jump) as well as three types of three-step vertical jump tests over hurdles of 10, 20, and 30 cm. In the last step of the latter tests, the feet were crossed over the hurdle and placed close together in a pre-jump movement. The Sargent jump test is a common test used for high jump measurement with a validity of 0.78 and a reliability and objectivity of 0.93.[14] We used three-step vertical jump test as it is more similar to spike jump. Using the data of four repeated measures on 77 subjects over a 6-week period, reliability of different three-step vertical jump tests established in this research varied from 0.95 to 0.97.

Statistical analyses

Reliabilities were calculated by intra-class correlation.[15] The differences between groups were statistically analyzed based on one-way and repeated-measures analysis of variance (ANOVA).

Table 2: Simulated plyometric drills for spike and block

N	Drills	Rep
1	Blocking an imaginary ball	10
2	Spiking an imaginary ball	10
3	Blocking a stationary ball (the ball is kept over the net by a player standing on a chair on the other side of the net)	10
4	Spiking a stationary ball	10
5	Imaginary spiking a self-tossed high ball (the ball is caught rather than hit)	10
6	Spiking a self-tossed high ball	10
7	Blocking a ball set from the other side of the net	10
8	Spiking varied sets (high and short)	10
9	Spiking varied sets (high and short), no hurdle	10

N=Number, Rep=Repetitions

RESULTS

The best practice for jump development

Figure 1 summarizes the results of one-way ANOVA for comparing the rate of improvement from pre- to post-tests in different groups of the study.

In girls: Improvements in the 10-cm experimental group was the best, while that in the 20-cm group was the worst (F = 3.50, P = 0.042). It suggests that the use of 10-cm hurdle is the best method for practice.

In boys: There was no significant differences in improvements (F = 0.714, P = 0.550). As 10-cm hurdles consume the least energy for practice and leads to the same rate of improvement, it seems to be the best method for practice.

The best pre-jump for competition

Figure 2 summarizes the results of repeated measure ANOVA. Here, the heights of jumps are outlined on chartline for the control and experimental groups. Interaction of main effects of gender and time of testing was significant ($F_{(3,71)}$ =3.80; P = 0.013). Therefore, differences in each group are discussed separately.

In boys: Chartlines of control and experimental groups followed the same pattern. In general, jumping over hurdles improved the height of jump, but there was no significant difference between hurdles of different heights.

CONCLUSION

Since 10-cm pre-jump consumes less energy,

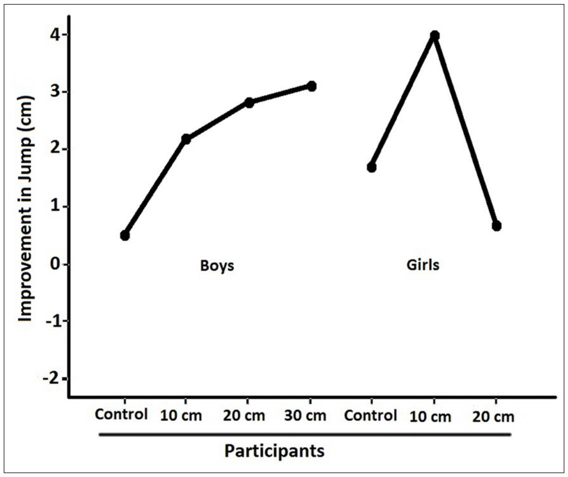

Figure 1: The rate of improvement from pre- to post-tests in different groups

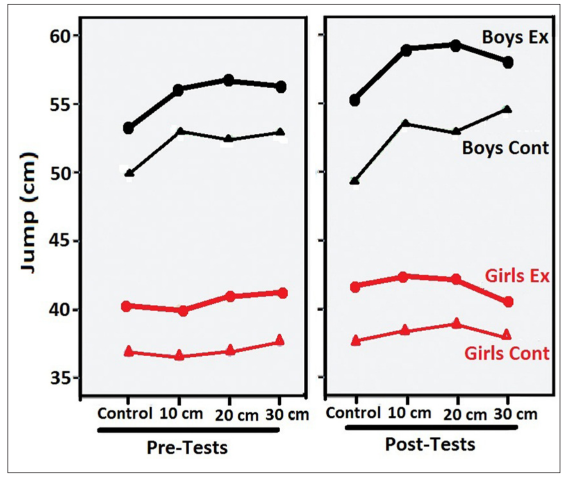

Figure 2: The height of jumps with different pre-jumps

it seems more advantageous. Especially in the competition, where players need hundreds of consecutive jumps, 10-cm pre-jumps will make them less tired.

In girls: Again, chartlines of control and experimental groups followed the same pattern. In general, post-tests were better than pre-tests. In pre-tests, there was no benefit in pre-jumps. But in post-tests, using pre-jumps of both 10 and 20 cm heights improved the height of jumps. Use of 10-cm pre-jumps seems recommendable to trained girls, but not to untrained girls.

DISCUSSION

Present study revealed that pre-jumps over 10-cm hurdle increases the height of the jump and is better than no pre-jump or pre-jumps over hurdles of 20- and 30-cm heights. Also, it was demonstrated that practice over hurdles of 10 cm is better than use of no hurdle or hurdles of 20- and 30-cm heights. Besides these quantitative findings, we qualitatively noticed that, for both sexes, the rate of improvement in blocking and spike skills were much better in the experimental groups than in the control groups. It was independent from the rate of progress in jump height that was relatively less evident in this 6-week study. It is likely that more than increasing jump height, training with hurdles enables the players to use more of their jump potential during a game. For example, it seemed that experimental groups used about 80% of their potential jumps and control group used 60% of their potential jumps for spike or blocking moves. The second probability is a better coordination, resulting from practice over hurdles. A hurdle especially encourages a player to jump exactly on a place, which is determined by the coach.

We found two major contexts that support our findings. First, it has been well documented that the use of elastic and contractile energy is necessary in producing dynamic muscle contractions as required in maximum power sports.[1,3,16] Compared to untrained athletes, trained athletes in jumping technique (e.g., volleyball players) are probably able to utilize a more forceful pre-stretch, resulting in a more efficient SSC.[17] It is suggested that there are two kinds of long and short SSC.[18] Long and short SSC are developed by specific types of training and are mutually exclusive of each other. It seems that training over shorter hurdles enables volleyball players to make a more efficient use of short SSC. Second, effective use of the arms, trunk extension, head movements, and utilization of a countermovement to initiate SSC are all necessary for increased vertical velocity.[18-20] These actions seem instinctive movement during a jump, however, the degree of use depends on the type of practices. Upper extremity and trunk strength have also been shown to be a contributing factor to vertical jump performance.[14,21] The fact that an arm swing is so important in vertical jump indicates that vertical jump is a skill that relies not only on leg power but also on coordination of all body parts.[18] Practice over hurdle reinforces the use of pre-jump, which results in neurophysiologic development and fulfillment of objectives such as[19] coordination, relaxation, customization, and automation.

According to logical and experimental evidences, it might be expected to observe more apparent distinguishes between the control and experimental groups. So, why it was not the case here? There are two probable reasons. First, the training programs of all groups were completely similar and the only difference was the use of hurdles in 30-min plyometric drills. Second, the general volume of training programs was very short. All groups trained 2 sessions per week for 6 weeks. It means that the general plyometric drills lasted for just 6 hours. Such a short volume of training cannot lead to major differences between groups. Nevertheless, our quantitative and qualitative results indicated that training with pre-jumps over 10-cm hurdles had a good effect on height and efficiency of jumps.

Practical applications

The present study demonstrated that the use of short hurdle in spike and block drills is worthwhile. We discussed that the use of short hurdles probably results in some advantages, including a) reinforcing the use of pre-jump, b) customization to a better place for jump initiation, c) a better neurophysiologic development, d) a better use of jump potential, and e) more explosive power. Thus, the use of short hurdles in jump drills of volleyball seems advisable.

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