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Effects of progressive depth jumping on vertical jump performance

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Abstract. The purpose of present study was to investigate the effects of progressive depth jumping on vertical jump performance of male athletes. Purposively selected 80 volunteer male athletes randomly assigned to vertical depth jump training, horizontal depth jump training , combination of both and control group. Experimental groups trained twice weekly for 10 weeks, performing 6 sets of 10 repetitions per session. Dropping height was progressed from 20 to 40 centimeters according to step method. Vertical jump was measured before and after 10 weeks. Analysis of covariance was applied to compare scores. A pair-wise comparison was done by using the Scheffe's post-hoc test at 0.05 level of confidence. The results showed that three training groups improved significantly; vertical group improved significantly as compared to horizontal group. However, no significant difference existed between vertical and combination group; horizontal and combination group. In conclusion, progressive depth jumping is effective but induces specific adaptations.
Key words: *plyometrics, vertical depth jump, horizontal depth jump, step progression.*

Introduction

The step method requires a training load increase followed by an unloading phase during which the body adapts, regenerates and prepares for a new increase. The frequency of the increase in training load must be determined by each individual's needs, rate of adaptations, and competitive calendar. Do not interpret the step approach of increasing the training load as a steady increase of equal quantities of work in each training lesson, through an arithmetic addition. One training lesson is insufficient to provoke visible physical or mental changes in the athlete that lead to an adequate adaptation. To achieve such adaptation, the same type of training loads must be repeated several times. Often training sessions of the same type are planned for an entire week, followed by an increase in the training load. The load increases gradually in the first three steps. The third step was followed by a lower step, or uploading phase. The uploading phase represents the new lowest step for the next macro cycle. Since the body has adjusted to the previous loads, this new low step was of new greater magnitude than the previous low, but is nearly equal to the medium one. The shorter the adaptation phase, the lower the height, or the amount of increase, in training load. A longer adaptation phase may permit a higher increase (1).

Training load can be progressed by increasing training volume or intensity or both and by reducing recovery time (2). Emphasize intensity for improving speed and power, and volume for endurance sports (3). During depth jumping, one can increase the stretch load imposed on the muscles by increasing the dropping height or by attaching the additional weights to the body of athlete. Depth jumps with additional weights have not proved to be effective (4). Thus, the dropping height was the selected variable to be increased for the progression of training load in the present study, while volume and recovery time remained constant throughout the 10 weeks of training programme.

Depth jump training is a common and most searched form of plyometric drill. Depth jumping requires athletes to drop from a height and upon landing, immediately perform a jumping movement (5). Depth jumps use the athlete's body weight and gravity to exert force against the ground (6).

An elevated surface is required for this exercise. The landing surface should be forgiving, yet resilient; grass gymnastic flooring or cushioned turf will work well. The depth jump is a shock-method exercise and comes in the final portion of the training continuum. Therefore, progression into this drill is a must, as well as progression within it. Apply the shock method by using the elevated platform and a drop or fall to the takeoff surface. The key is to initiate a rhythm of landing. The landing is the precise phase we are negotiating, to create as efficient a performance as possible. This requires handling the surprise of landing and subsequent takeoff in as optimal execution as possible. This aspect makes the depth jump elite in its strength, speed and quickness. It also can be a source of problems if you do not progress into it properly (21).

In practical terms, the task of determining a proper depth jump height centers on the ability to achieve maximal elevation of the body's centre of gravity after performing a depth jump. If the height is too great for the strength of the legs, then the legs spend too much time absorbing the impact of the landing and cannot reverse the eccentric loading quickly enough to take advantage of the serial elastic component of muscle and the stretch reflex phenomenon. The result is a slow jump dependent on strength and devoid of power. Coach and athlete should work to find the proper height; one that lets the athlete maximize the height jumped plus achieves the shortest amortization phase (8).

Countermovement vertical jump height has been used as a test protocol to measure successful depth-jump performance. An athlete is made to carry out a standing high jump after flexing his legs and the maximum height is reached with his hand on a graduated board (Vertical Jump Test). The highest reading of three jumps is registered. The athlete is made to carry out the same operation, landing on the same point from a height which is progressively higher by 20-40-60 centimeters and from each different height of fall; the subsequent jump is read off of the graduated board. The value of the greater height reached in the subsequent jump (after landing) which should be higher than that of the jump from level '0' (standing jump) determines the optimum height of fall for that particular athlete at that moment of training process (30).

By using boxes of different heights or a stair-step apparatus, the athlete drops from levels between 12 and 42 inches onto grass or a firm but resilient mat. Upon landing, the athlete immediately jumps upward or reaches or surpasses the mark placed on the wall during the Vertical Jump Test. The athlete continues to move to a higher drop until he or she can no longer attain the same height as in the vertical jump. Allow one or two minutes of rest between each trial for the muscle systems to recover. The point of the depth or drop height when the athlete attained maximum vertical (rebound) height is the approximate height to train for in this type of plyometric exercise (21).

There are two major categories of depth jumping according to the purpose of achieving maximum vertical height or horizontal distance after taking-off. One type of exercise is performed by taking step off from the box and drop to land on both feet. Try to anticipate the landing and spring up as quickly as possible, keep the body from "settling" on the landing and make the ground contact as short as possible. The second category is performed by taking step off from the box and drop to land on both feet. Upon landing, jump immediately as far forward as possible, again landing on both feet (8). Therefore, the purpose of this study was to investigate the influence of vertical depth jump training; horizontal depth jump training and combination of both vertical and horizontal depth jump training on vertical jump performance of college level male athletes by applying depth jumping from optimal dropping height and progressed according to the step method.

Materials and Methods

Experimental approach to the problem. Eighty subjects were randomly assigned to three experimental groups and one control group. Group VD (n=20) trained with vertical depth jumping on Monday and Thursday; Group HD (n=20) trained with horizontal depth jumping on Tuesday and Friday; Group CD (n=20) trained with vertical depth jumping on Wednesday and horizontal depth jumping on Saturday throughout 10 weeks of training with identical intensities and volumes. Group CG (n=20) served as control group. The gymnastic mat was the landing surface to perform depth jumping. All subjects were attending classes according to the college curriculum, except the session for training. Vertical jump performance was measured before and after 10 weeks for subjects of each group. The subjects participated in an instruction session before the pre-test to ensure proper technique and comprehension of the testing process. Test was demonstrated by the trained athlete. To ensure uniformity in the testing conditions, the subjects were tested in the morning sessions by the same testers, under the supervision of the Investigator.

Participants. Purposive sampling technique was used to select eighty (n=80) male Physical Education students of age ranged between 18 to 21 years. They were medically fit to undergo the type of training program and signed an informed consent form prior to participate in the present study. They were tested for proper execution of depth jump performance (*M*=17.44 inches, *SD*=±2.02) from dropping height of 18 inches. The Joint Research Board of the university has approved all procedures for this study.

Procedures. Dropping height of 20 centimeters from which depth jump performance was maximum and higher than vertical jump performance was the initial training intensity (8, 21, 30). All subjects were trained twice a week for 10 weeks, performing 6-sets of 10-repetitions per session (10). 15s rest-walk was given for recovery between repetitions (22). 1.5-2 min slow jogging for 220m was given for recovery between sets (29). Dropping height was progressed according to the step method from the height with maximum depth jump performance (20 cm) up to the height from which performance was remained higher than vertical jump performance (40 cm) during the 10 weeks of training (Table I).

WEEK	Dropping Height (in centimeters)	Sessions per week	Number of sets per session	Number of repetitions per set	Total foot contacts in a week
I	20	2	6	10	2x6x10=120
II	25	2	6	10	2x6x10=120
III	30	2	6	10	2x6x10=120
IV	25	2	6	10	2x6x10=120
V	30	2	6	10	2x6x10=120
VI	35	2	6	10	2x6x10=120
VII	30	2	6	10	2x6x10=120
VIII	35	2	6	10	2x6x10=120
IX	40	2	6	10	2x6x10=120
X	35	2	6	10	2x6x10=120

Table I. Schedule for 10 weeks training

Training was administered by dividing 20 subjects into four groups, 5 subjects in each group. After warm up, they were trained simultaneously at four stations. Rest walk between repetitions was given by placing a cone 11 and 12.1 meters ahead of the dropping height for vertical (figure 1) and horizontal (figure 2) depth jump training, respectively.

Slow jog between sets was given by placing another cone at 220m from first cone. Subjects participated in cool-down program after training.

Figure 1. A group of five subjects during vertical depth jump training

Figure 2. A group of five subjects during horizontal depth jump training

To measure vertical jump performance, a black-board of 2 feet breadth and 4 feet length painted with red lines parallel to the ground, one inch apart. The board was fixed firmly to a wall above the ground according to the reach point of the subject with shortest height. The subject was asked to stand with one side toward the wall, heels together and raised the fingertips marked with chalk powder to a maximum height on the black-board without lifting the heels so as to mark his maximum reach point. This reach point was recorded in inches to the nearest half inch. Then, the fingertips were re-chalked. With the chalked hand side toward the wall, the subject performed vertical jump as high as possible by bending knees and swinging arms as demonstrated by the earlier trained helper to make another mark at the maximal height of the jump (figure 3). This jump point marked on the black-board was recorded in inches to the nearest half inch. Three trials were given and the maximum difference between reach point and jump point was considered as score in inches.

Figure 3. A subject marking Jump height in vertical jump test

Statistical Analyses. Analysis of covariance was applied to find significance of differences among various groups. The pre-test scores were used as the covariate and post-test scores, adjusted for covariance, were the dependent measures. When significant 'F' value was encountered, a pair-wise comparison was done by using the Scheffe's post-hoc test to identify significant differences between groups. The alpha level was set at 0.05.

Results The mean values of vertical jump performance of three experimental groups and control group from Pre-test and post-test are exhibited in figure 4.

Table II shows significant differences among groups as 'F-value 33.93 was found greater than the tabulated value 2.73 with degree of freedom (3.75) at 0.05 level of confidence. Further, the Scheffe's post-hoc test was applied to study significance of differences between the paired adjusted final means.

Table III shows significant improvement in three experimental groups as compared to control group; vertical depth jump training group improved significantly as compared to horizontal depth jump training group. However, the difference between vertical depth jump training and combination depth jump training; horizontal depth jump training and combination depth jump training was found insignificant.

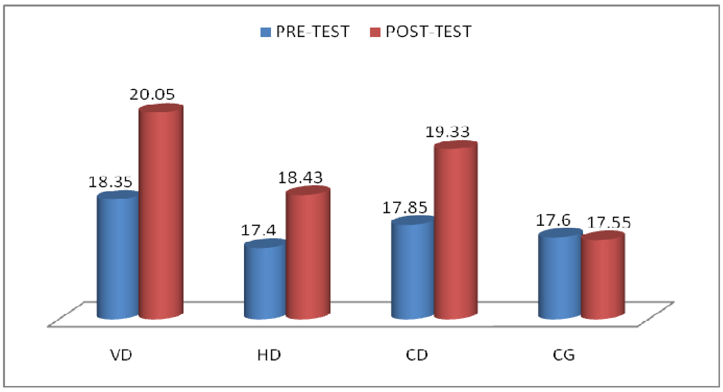

Figure 4. Pre-test and post-test means of three experimental groups and the control group in vertical jump performance (inches)

Table II. Analysis of covariance for three experimental groups and the control group with regard to vertical jump performance

Source of variation	Sum of squares	Degrees of freedom	Mean Sum of squares	F-ratio
Between groups	40.42	3	13.4733	33.93*
Within groups	29.78	75	.3971	

*Significant at .05 level; F.05 (3.75) = 2.73

Table III. Significance of differences of paired adjusted final means for experimental groups and control group (inches)

Means				Difference between means	Scheffe's critical difference
Group-VD	Group-HD	Group-CD	Group-CG		
19.6028	18.7505			0.8523*	0.5699
19.6028		19.2843		0.3185	0.5699
19.6028			17.7126	1.8902*	0.5699
	18.7505	19.2843		0.5338	0.5699
	18.7505		17.7126	1.0379*	0.5699
		19.2843	17.7126	1.5717*	0.5699

*Significant at .05 level

Discussion

Analysis of data reveals that all the three experimental groups were found to be significantly different as compared to the control group. Thus, the depth jump training as progressed in the present study leads to significant increase in vertical jump performance. Similar findings pertaining to the depth jump training for improvement of vertical jump performance have been reported (1,2,6,9,11,18,19,20,24,27).

These vertical jump performance findings revealed that vertical depth jump training; horizontal depth jump training as well as their combination is effective in bringing about a significant training effect. These findings may be attributed to the fact that the Plyometric depth jumping as an activity that acts to increase the neuromuscular systems ability to perform concentric contraction more effectively because the forces encountered in plyometric exercises leads to greater synchronous activity of motor units and earlier recruitment of larger motor units via the myotatic reflex (17). Plyometric training improves neuromuscular adaptations such as increased inhibition of antagonistic muscles as well as activation and contraction of synergistic muscles may account for the improvement in increased vertical jump height (18). The depth jump is thought to enhance vertical jump performance through the quickening of the amortization phase which is the electromechanical delay initiation of eccentric to the initiation of concentric muscle actions of the movement (19).

Plyometric training exercises are believed to induce enhanced training responses through the activation of the proprioceptive reflexes and re-use of stored elastic energy (20).

Plyometric training results in an increase in the overall neural stimulation of the muscle and thus improves output, however, qualitative changes are also apparent. In subjects unaccustomed to intense Stretch-Shorten Cycle loads, there is a reduction in Electromyography activity starting 50-100 ms before ground contact and lasting for 100-200 ms (21). It has attributed to a protective mechanism by the Golgi tendon organ reflex acting during sudden, intense stretch leads to reduce the tension in the tendomuscular unit during the force peak of the Stretch-Shorten Cycle (21). After a period of plyometric training the inhibitory effects are reduced, termed as disinhibition, and increased Stretch-Shorten Cycle performance results (22). It is further supported by the fact that plyometric training stimulates chemical, mechanical and neurological factors that influence the force and stiffness of the contracting muscle (23).

Also, the mean difference between groups VD and HD was greater than critical difference value of 0.5699 in favour of group-VD. This finding pertaining to the significance difference between groups VD and HD may attributed to the specific effects of plyometric training. Plyometric training should closely resemble the skills necessary for success in the sports, plyometric work should focus on developing vertical component of jumping for vertical lift (6). These results are in contradiction to the general training effects of vertical and horizontal plyometric trainings (24). This may be due to the differences in age groups of subjects of these two studies as research demonstrated that the maturity or immaturity of both the nervous system and skeletal system affect tolerance to plyometric training (25).

Conclusion

It is concluded from the above findings that depth jump training load progressed according to the step method from the dropping height with maximum depth jump performance (i.e. higher than vertical jump performance) upto the height from which performance was remained higher than vertical jump performance during ten weeks is effective for significant improvement in vertical jump performance but induces specific adaptations. Thus, depth jump training should be progressive and specific according to the requirement of targeted motor performance.

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