THE EFFECT OF EIGHT WEEKS TRAINING WITH EXTRA WEIGHT ON STANDING LONG JUMP PERFORMANCE

Chih-yu Lin, Ray-hsien Tang and Chen-fu Huang
Department of Physical Education, National Taiwan Normal University, Taipei, Taiwan

The purpose of this study was to investigate the effect of eight weeks training with extra weight in the hands on standing long jump performance. Fifteen junior high school male students participated in the study. Vicon motion system (10 cameras, 200Hz) and two Kistler force plates (1000 Hz) were used to collect the kinematics and kinetic data of pre-training and post-training tests. The results found the jumping distance increased 18 % after extra weight training. The horizontal velocity of center of mass (CM) at takeoff, flight distance, landing distance, the CM difference at takeoff, the horizontal positive impulse and the peak horizontal ground reaction force were all significantly enhanced. It was concluded that eight weeks of extra weight in the hands jump training increased the high school male standing long jump performance.

KEY WORDS: high school student, extra weight, standing long jump, biomechanics.

INTRODUCTION: The standing long jump has often been used as one of the standardized tests in the physical fitness test. In the fifth century B.C., a Greek athlete named Phayllos is said to have set a record long jump with weights during the pentathlon of the Delphic games (Harris, 1972; Kyle, 1990; Lee, 1995). Phayllos jumped 16.28 m and threw 28.12 m with the discus. It is proposed that the ancient Greek long jump was a continuous succession of five standing long jumps. At that time, the athletes jumped with extra weights in the hands, which were called halteres (between 1 and 4.5 kg). These extra weights were swung forward as the athlete jumped in order to increase momentum. The jumpers held the halteres throughout the duration of the jump. Swinging them down and back at the end of the jump would change the athlete's center of mass and allow the athlete to stretch his legs and bend his knees, increasing the standing long jump distance.

Many studies have proved that extra weights were held in each hand of the athletes during the long jump competition and some indicated that when jumping with an optimal load, the jumping performance was improved (Minetti and Ardigo 2002; Lenoir, Clercq and Laporte, 2005). However, the effect of the training with extra weights on standing long jump performance especially on teenagers was not studied. The purpose of this study is to find the optimal load for teenagers and to investigate the effect of eight weeks of training with extra weight in the hands on the high school male standing long jump performance.

METHODS: Fifteen junior high school male students (height 173.1±6.63cm, body mass 59.3±7.95kg) served as subjects for this study. All subjects were informed of the experimental procedures and gave their consent before participating. Before performing any jumps, the subjects were instructed to warm up for five minutes by doing some light running, jumping, and stretching. The subjects were instructed to initially stand on a force platform and jump as far as possible once given a verbal signal for each trial. Each subject performed his maximum standing long jump and swung his upper limbs forward and upwards while loaded with one pair of dumbbells randomly denoted out of 6 (0,1,2,3,4,5) that ranged from zero (unloaded) to 5 kg of total extra mass. We found that jumping with 4 kg extra weight allowed for the best jumping distance. The subjects underwent eight weeks of training including unloaded and maximum 4 kg loaded arms swings, vertical jumps, and standing jumps, and made steady progress incrementally from the first week to the eighth week.The eight weeks training course contains a number of jumps, including the vertical jump and the standing jump. The course was designed to allow the subjects to adapt to the incrementally added weights as the movement went from easy to difficult. In the first week, the movement training included unloaded vertical jumps and loaded arm swings with 0.5 kg in each hand. In the second week, the movement training included unloaded standing jumps and loaded arm swings with 1.0 kg in each hand. The third week, the movement training included loaded vertical jumps with 0.5 kg in each hand, and loaded arm swings with 1.5 kg in each hand. The fourth week, the movement training included loaded standing jumps with 1.0 kg in each hand. The fifth week, the movement training included loaded standing jumps with 1.0 kg in each hand and loaded arm swings with 2.0 kg in each hand. The sixth week, the movement training included loaded standing jumps with 1.5 kg in each hand and loaded arm swings with 2.5 kg in each hand. The seventh week, the movement training included loaded standing jumps with 2.0 kg in each hand and loaded arm swings with 2.0 kg in each hand. The eighth week, the movement training included loaded standing jumps with 2.0 kg in each hand, and unloaded standing jumps to prepare subjects for the final assessment. Vicon motion analysis system (10 cameras, 200Hz) and two Kistler force plates (1000 Hz) were used to collect the kinematical and kinetic data of jumping performance. Visual3D was used to analyze the kinematic and kinetic data. Dempster's study (1955) was used to calculate body segment parameters. The paired t-test was used to test the significant difference at $\alpha = 0.5$.

RESULTS:
The subjects were teenagers and the effect of growth and development may be an important factor. Therefore, we used paired t-test to test the subjects' height and weights of pre-training and post-training (Table 1). There were significant increases after the post-training ($t = 4.365$, $P < .05$).

Table 1
The high school male' height and weights

	Age	Height	Weight	BMI
pre-training	14.71(0.87)	173.1(6.63)	59.3(7.95)	19.8(2.03)
post-training	14.97(0.87)	174.5(6.24)	62.2(8.61)	20.4(2.29)

***p < .01**

The mean standing long jump distance for unloaded trials before training were 2.06 m. After eight weeks of training the performance was 2.43 m for unloaded trials. The jumping distance increased 37 cm (18%). The horizontal velocity of CM at takeoff ($F = 19.57$, $P < .01$), flight distance ($F = 33.18$, $P < .01$), landing distance ($F = 40.901$, $P < .01$), the CM difference at takeoff ($F = 252.72$, $P < .01$) were all significantly increased. The horizontal positive impulse ($F = 24.497$, $P < .01$) and the peak horizontal ground reaction force ($F = 8.460$, $P < .01$) at the takeoff phase were all significantly enhanced after the training (Table 2).

Table 2
Kinematic and kinetic variables of jumping performances

Kinematic	pre-training trails	post-training trails
Distance (m) *	2.06(0.20)	2.43(0.19)
Horizontal Velocity CG take-off (m/s) *	3.05(0.29)	3.41(0.23)
Vertical Velocity CG take-off (m/s)	1.84(0.21)	1.76(0.08)
Take-off distance (m)	0.56(0.07)	0.60(0.071)
Flight distance (m) *	1.25(0.12)	1.49(0.111)
Landing distance(m) *	0.24(0.05)	0.33(0.037)
The CM difference at takeoff (m) *	0.32(0.020)	0.39(0.020)
Ankle joint angular velocity (rad/s) *	10.27(1.52)	13.01(1.17)

Knee joint angular velocity (rad/s)	11.94(1.16)	12.22(1.44)
Hip joint angular velocity (rad/s) *	6.54(0.78)	8.34(0.66)
Kinetic	pre-training trails	post-training trails
Take-off propelling ground force (s)	0.43(0.05)	0.42(0.02)
Horizontal positive impulse (Ns/kg) *	2.13(0.28)	2.58(0.29)
Vertical positive impulse (Ns/kg)	4.09(0.56)	4.45 (0.46)
Horizontal GRF (N/kg) *	10.13(0.91)	11.83(1.49)
Vertical GRF (N/kg)	20.13(1.44)	21.10(1.86)

$^*p < .01$

The peak angular velocities of hip (F=81.824, P<.01) and ankle (F=66.139, P<.01) at takeoff phase for all subjects were significantly greater after the training (Fig 1 & 2).

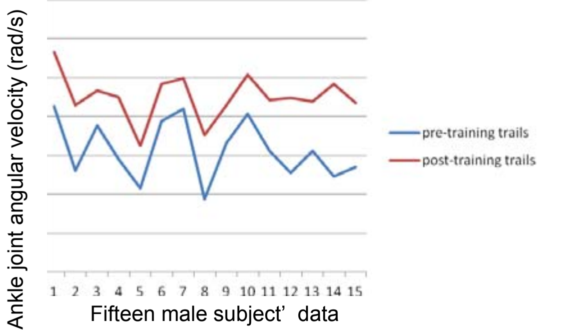

Figure 1: The peak of ankle joint velocity.

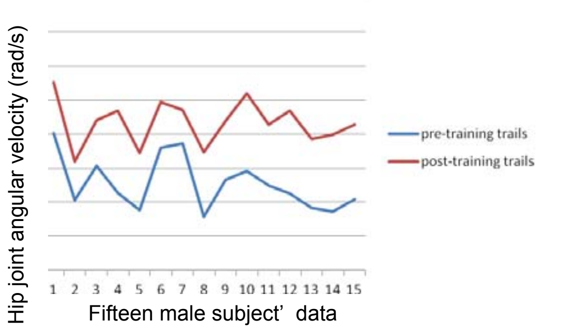

Figure 2: The peak of hip joint velocity.

DISCUSSION: The results indicated that eight weeks of standing long jump training with optimal extra weights increased the peak horizontal ground reaction force and positive horizontal impulse during the takeoff phase and enhanced the standing long jump performance. The previous studies indicated the optimal added weight for adults is an extra six to eight kg (8%) in order to increase the jumping distance. The greater peak hip and ankle velocities at the takeoff phase after eight weeks of training may indicate the subjects had adapted to the 4kg (6.7%) and may indicate an increase in the lower extremities strength after eight weeks of training which enhanced the post training standing long jump performance. For teenagers, the results of the development of nutrition and sleep in eight weeks of this study indicated that maturity also played an important factor for enhancing the standing long jump performance. The study indicated extra weights in the hands and eight weeks of training increased the standing long jump jumping performance. However, the effect of throwing the extra weights into the air mid-jump in the standing long jump is unclear. Future research on this topic is needed to understand the effect of extra weights in the hands on standing long jump performance.

CONCLUSION: The study demonstrated that the use of extra weights, 6.7% of body weight on hands during eight weeks training can improve high school male 18% of standing long jump performance.

REFERENCES:

Dempster, W. T. (1955). Space requirement of the seated operator. WADC Technical Report (TR-55-159). Dayton, OH: Wright - Patterson Air Force Base.

Harris, H. A. (1972). The method of deciding victory in the pentathlon. Greece and Rome, Second Series, 19, 60-64.

Kyle, D. G.(1990). Winning and watching the Greek pentathlon. *Journal of Sport History*, 17,291-305.

Lenoir, M; Clercq, D. D.; Laporte, W. (2005). The “how” and “why” of the ancient Greek long jump with weights: A five-fold symmetric jump in a row? J. Sports Sci 2005; 23(10):1033-1043.

Minetti, A. E., Ardigo, L. P. (2002). Halteres used in ancient Olympic long jump. *Nature*, November 2002;420 (14) :141-142.