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The effects of standing long jump with hand-held extra weight after eight-week training program

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SUMMARY

Standing long jump with hand-held extra weight could promote the performance was argued thousand years ago. Many previous studies only focus on immediately performance of standing long jump with extra weight. The aim of this study was to investigate the effects of standing long jump with hand-held extra weight after eight-week training program. Fifteen junior high school male students without lower extremity injuries were participated.. Vicon motion analysis system (10 cameras, 200Hz) and two Kistler force plates (1000 Hz) were synchronized to collect the standing long jump data. The 3D kinematics and kinetic data were analyzed by using Visual3D software. Variables were assessed by using mixed one-way ANOVA. The significant level set at α =.05. The results showed that the jump distance, center of mass (CM) horizontal takeoff velocity, CM horizontal takeoff impulse and peak hip, knee and ankle torques were significantly enhanced after this training program. It was concluded that this training program could promote abilities of lower extremities and increase standing long jump performance.

INTRODUCTION

Standing long jump was one of events in ancient Olympic game and in the eighteenth ancient Olympiad in 708 BC. For now, standing long jump test is an index of fitness in a lot of countries. The distance of standing long jump was an easy method to evaluate the lower extremities explosive force. Jumping is a fundamental human movement that requires complex motor coordination of both upper and lower body segments [1]. Arm swing enhances standing long jump performance because of the increased horizontal and vertical positions and velocities of center of mass at take-off [2]. Many recent studies found that hand-held weight could certainly increase the performance during standing long-jump task [3, 4]. It also showed that carried extra weight could enhance CM horizontal velocity, horizontal impulse, and improved the performance of standing long jump. Otherwise, subjects carried extra weight when standing long jump would reduce the CM vertical velocity and maximum angular velocity of lower extremity joints [5].

Minetti and Ardigo determined the optimal extra weights by using computer simulation. The mechanisms of increasing maximal jumping distance were that the optimal extra weights could allow CM to move faster and recruit more upper limb muscles involved in this action [6]. The effects of carrying extra weight would also include activating stretch-shorten cycle and improving the performance [7]. Many previous studies only focused on immediately performance of standing long jump with extra weight. The purpose of this study was to investigate the effects of standing long jump after eight weeks hand-held extra weight training program in junior high school students.

METHODS

Subject

Fifteen junior high school track and field male athletes without lower extremity injuries were participated in this study. The mean age, body mass, Body Mass Index, and height of subjects were respectively showed as 14.71 ± 0.87 years, 59.3 ± 7.95 kg, 19.8 ± 2.03 kg / m^2, and 173.1 ± 6.63 cm. All subjects were informed of the experimental procedures and gave their consent before participating.

Training program

It included counter movement jump, standing long jump and arm swing in the eight weeks training program, and hand-held weight increased gradually (one to four kilograms) (showed as Table 1). The optimal extra hand-held weight was 4 kg which was decided by previous study [8].

Data collection

Ten Vicon high-speed cameras (200Hz) (MX13+ Oxford Metrics Ltd., Oxford, England) and one Kistler force platform (Kistler, 9287B, Switzerland) (1000Hz) were synchronized to collect standing long jump data.

Data analysis

Body segment parameters were calculated by Dempster [9]. A Butterworth digital recursive filter with 6Hz cutoff frequency was used to filter the random noise. The ground reaction forces and impulses of standing long jump were analyzed by using Visual 3D software. Variables including jump distance, CM takeoff velocity, CM takeoff impulse and peak hip, knee and ankle torques were assessed by using one-way ANOVA. The significant level set at α =.05.

RESULTS AND DISCUSSION

The jumping distance was defined as the horizontal displacement from the initial position of toe marker to the heel marker at touch down. The jumping distance of subjects significantly increased after eight-week training program, by approximately 17.96%. The CM horizontal

takeoff velocity, CM horizontal takeoff impulse and peak hip, knee and ankle torques were also found significantly larger than pre-test. There was no significant difference in CM vertical takeoff velocity and CM vertical takeoff impulse.

Previous study demonstrated that extra loaded training could enhance performance by recruiting motor unit faster, increasing the firing rate of motor unit, synchronizing the recruitments of motor units, improving the activation of single muscle and the abilities of the coordination between muscles [10]. These factors improved not only the muscle strength but also the explosive force [11], which might increase the velocity of arm swing and the velocity of CM at takeoff as well. The increased velocity of arm swing could increase the torque, power and work at the hip joint by enhancing the abilities of extensor muscle, which could significantly improve the jumping performance [12]. In our study, the peak hip, knee and ankle torque significantly increased after eight-week training program, indicating that the arm swing might be improved by extra loaded training as well as the muscle strength of lower extremity.

Loaded jump has been established that it could increase the horizontal velocity of body CM at takeoff and horizontal positive impulse, but decrease the vertical velocity of body CM at takeoff [5]. According to the specificity of sport training, the jump performance would remain the same effect with eight-week loaded jump training. The better CM horizontal takeoff velocity and CM horizontal takeoff impulse contribute the longer jump distance.

CONCLUSIONS

This study demonstrated that the hand-held extra weight training program improved standing long jump performance. The increased CM horizontal takeoff velocity and CM horizontal takeoff impulse contributed jump distance after training. It was suggested that this eight-week training program could effectively enhance standing long jump performance.

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Table 1: The eight-week training program

Week	**Program one**	**Program two**
The 1st week	Counter movement jump for 10 trail	Arm swing with 1kg for 10 trail
The 2nd week	Standing long jump for 10 trail	Arm swing with 2kg for 10 trail
The 3rd week	Counter movement jump with 2kg for 10 trail	Arm swing with 3kg for 10 trail
The 4th week	Standing long jump with 2kg for 20 trail	
The 5th week	Standing long jump with 2kg for 10 trail	Arm swing with 4kg for 10 trail
The 6th week	Standing long jump with 3kg for 10 trail	Arm swing with 5kg for 10 trail
The 7th week	Standing long jump with 4kg for 10 trail	Arm swing with 4kg for 10 trail
The 8th week	Standing long jump with 4kg for 10 trail	Standing long jump for 10 trail

Table 2: Standing long jump kinematics and kinetic data.

	Pre-test (mean(SD))	Post-test (mean(SD))
Jump distance(m)	2.06(0.20)	2.43(0.19) *
CM horizontal takeoff velocity(m/s)	3.05(0.29)	3.41(0.23) *
CM vertical takeoff velocity(m/s)	1.84(0.21)	1.76(0.08)
CM horizontal takeoff impulse(Ns/kg)	2.13(0.28)	2.58(0.29) *
CM vertical takeoff impulse(Ns/kg)	4.09(0.56)	4.45(0.46)
Peak hip torque(Nm/kg)	2.34(0.26)	2.84(0.32) *
Peak knee torque(Nm/kg)	3.51(0.60)	3.88(0.68) *
Peak ankle torque(Nm/kg)	2.29(0.24)	2.49(0.30) *

*Significantly different between pre-test and post-test. (p<.05)