OPTIMAL EXTRA WEIGHT ON HANDS ENHANCE STANDING JUMP PERFORMANCE

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INTRODUCTION

Standing long jump is one of events in ancient Olympic game and in the eighteenth ancient Olympiad in 708BC; extra weights (halteres) were used either to make the challenge more difficult or to enhance the jumping performance. Minetti et al. [1] used computer simulation to determine the optimal extra weights that would be needed to maximally increase a jumping distance. They suggested that the extra mass 2-9 kg would increase a 3-meter jump by at least 17 cm. However, they only asked subjects to perform the vertical jump with halteres instead of standing long jump. Huang et al [2] suggested optional extra weight for extending distance is 6-12% of body mass. However, their subjects dropped the extra weights in the air which may gain more distance during jumping. The purpose of this study was to investigate the effect of different levels of extra weights on standing long jump performance.

METHODS

Twelve male athletes (age 21.8±1.7yr, height 175±5cm, body mass 67.8±12.0kg) served as subjects for this study. Each subject performed maximal standing long jump while loaded with one pair of handbell that ranged from zero (unloaded) to 10 kg of total extra weights. The extra weights were defined as four loading levels: zero, low (2kg or 4kg), middle (6kg or 8 kg), and high weight (10kg). Each subject was randomly assigned one weight on both low and middle levels. Each subject performed two trials for each level. Four best jumps from each subject (one unloaded and three loaded trials) were selected for analysis. A Redlake camera (125Hz) was synchronized with a Kistler force platform (9287B, 1250Hz) to collect standing jump data. Nine body landmarks (ear, shoulder, elbow, wrist, hip, knee, ankle, toe and heel) were digitized by Kwon 3D software. Dempster's study [3] was used to calculate body segment parameters.

RESULTS AND DISCUSSION

Figure 1 shows the effect of different extra weights on jumping distance. Average values of the best jumps for each loads (handbell weight / BW) are shown as a fraction of the value for an unload jump. Curve is best-fit by using second-degree polynomial regression. For the average mass of subjects in this study, the optimal extra weight for enhancing performance is 4.24 kg or 6.25% of body mass. The results of selected variables were listed in Table 1. The vertical velocity of body CG and body CG angle at takeoff were reduced as extra weights increased during the jumps. The results showed a longer time to peak horizontal force (T max) and a greater horizontal impulse (H Impulse) as extra weights increased. In addition, the peak vertical power (Max V_P) decreased as extra weights increased. Minetti suggested that 5-6 kg of extra weight is optimal for extending jumping distance. This study indicated that 4.24 kg or 6.25% BW of extra weight is optimal for extending jumping distance.

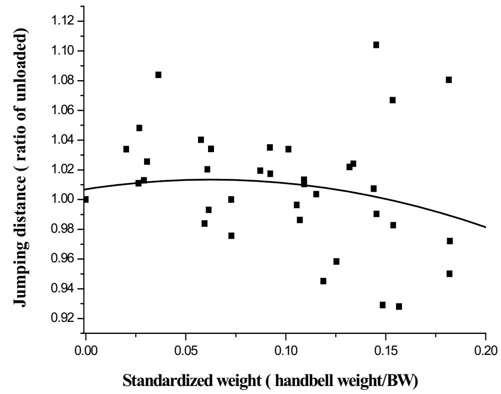

Figure 1: Effect of different weights on jumping performance.

REFERENCES

1. Minetti AE, et al. *Nature*. **420**, Nov 14, 141-142, 2002.
2. Dempster WT. *WADC Technical Report,* 55-159. OH:Wright-Patterson Air Force Base, 1955.
3. Huang C, et al. *Proceedings of ISB XIX*, Dunedin, New Zealand, Abstract 169, 2003.

Table 1：Variables of four levels of extra weight during jumps.

N=12	unloaded	low	middle	high
Distance (m)	2.92±0.16	2.98±0.17	2.95±0.22	2.92±0.23
V velocity (m/s)	2.09±0.2	1.98±0.2	1.72±0.16*	1.62±0.14*
H velocity (m/s)	3.06±0.25	3.16±0.22	3.18±0.25	3.13±0.29
CG angle (deg)	34.4±4.3	32.1±3.3	28.4±3.3*	27.6±3.5*
Tmax (s)	0.76±0.16	0.86±0.2	0.96±0.17*	1.02±0.16*
H Impulse (N*s)	237.6±42.0	253.6±42.5	273.2±41.8*	283±44.5*
Max V_P (Watt)	2479±619	2185±500	1924±405*	1747±406*

* = significance with unloaded jump