

## THE EFFECTS OF WHOLE-BODY VIBRATION TRAINING ON DECUPLE JUMP PERFORMANCE IN HANDBALL ATHLETES

Alex J.Y. Lee<sup>1</sup>, Hsiu-Kuang Chang<sup>2</sup>, Lung-Ching Liang<sup>1</sup>, Wei-Hsiu Lin<sup>3</sup>

<sup>1</sup>National HsinChu University of Education, HsinChu, Taiwan

<sup>2</sup>Chinese Culture University, Taipei, Taiwan

<sup>3</sup>National ChiaYi University, ChiaYi, Taiwan

To evaluate the effects of whole-body vibration training (WBVT) on decuple jump performance in handball athletes. Sixteen collegiate Level I handball athletes volunteered and divided equally as control group and experimental group (EG). All athletes underwent the same handball specific training, but the EG received additional WBVT (amplitude: 2 mm, frequency: 20 - 40 Hz) three times per week for eight weeks. The decuple jump (DJ) performance was evaluated by the total distance covered in ten single leg long jumps. Single factor ANCOVA was used to examine the differences in each parameter between the groups after training with the pretest values as a covariate. The statistical significance was set at  $p < .05$ . Results showed that after 8 weeks WBVT, the EG had significantly improved the total distance of DJ ( $25.03 \pm 1.83$  m vs.  $26.26 \pm 1.65$  m,  $F = 5.45$ ,  $p < .05$ ). It is concluded that 8 weeks of additional WBVT could improve the decuple jump performance in handball athletes.

**KEY WORDS:** muscle strength, explosive power.

**INTRODUCTION:** Team handball is a dynamic sport characterized by highly developed motor skills such as speed and agility, reaction speed, explosive power, strength, as well as its coordination (Hatzimanouil & Oxizoglou, 2004). A handball match involves a large number of repeated accelerations, sprints, jumps, blocking, pushing and rapid changes in moving directions, i.e. side cutting (Gorostiaga et al., 2006). Recently, the rules of team handball were revised to allow fast attacks immediately following scoring, which most likely have increased the physical intensity during match play (Ronglan et al., 2006)

Whole body vibration training (WBVT) is a neuromuscular training method that exposes the entire body to mechanical vibrations as the individual stands on a vibrating platform which has been recently developed and introduced as a training tool in athletic settings (Delecluse, Roelants, & Verschueren, 2003; Cardinale, & Bosco, 2003). The transmission of mechanical oscillations (20–50 Hz) to the body has a strong sensory stimulatory effect on the muscle that can stimulate many biological systems which in turn may lead to physiological changes at numerous levels including stimulation of muscle spindles, joint mechanoreceptors, changes in cerebral activity and changes in neurotransmitter (Schuhfried et al., 2005).

It has been suggested that strength and power are two important factors in elite handball players (Gorostiaga et al., 2006). Strength is important in actions like tackles and in fights competing for position between defense players and circle players, whereas power most likely is of even greater functional importance for fast movements such as sprinting, jumping, throwing and side cutting that involve contraction times less than 250 ms (Aagaard et al., 2002). The ability to exert high maximal muscle force and vertical jump height are both of vital importance in modern elite handball match play, however, there is little information in the scientific literature whether WBV may exert an ergogenic effect on jump performance in handball athletes. Therefore, the aim of this study was to determine the effects of a WBVT program with regular handball practice on decuple jump performance in handball athletes.

**METHODS:** Sixteen healthy male elite handball athletes from the Taiwan Level 1 Collegiate league were recruited and volunteered as participants. The study was designed as a controlled, randomized intervention study which all participants were divided equally as control group (CG, mean height:  $175.6 \pm 5.2$  cm, mean mass:  $69.9 \pm 5.6$  kg, mean age:  $19.4 \pm$

0.9 yrs, handball experience:  $7.6 \pm 3.4$  yrs) and WBVT group (WBVTG, mean height:  $173.3 \pm 4.0$  cm, mean mass:  $73.3 \pm 8.2$  kg, mean age:  $23.0 \pm 4.5$  yrs, handball experience:  $10.3 \pm 3.7$  yrs). All participants gave their informed consent and the conditions of the study were approved by the local ethics committee. Athletes who were already participating in another strength program were excluded from the study as well.

During the period of the study, all participants underwent the same handball specific training five sessions (4 training and 1 game) per week, but the EG received additional WBVT (amplitude: 2 mm, frequency: 20 - 40 Hz) three times per week for eight consecutive weeks. Each handball training sessions last about 2 h per week, including the warm-up, shooting practice (single and multi-people), position running, group strategy & attack tactic, attack & defense formation, and cool-down. Both groups trained for 8 weeks at a frequency of 3 times a week, with at least 1 day of rest between sessions. Participants were familiarized with testing procedures 2 days before the testing session.

Each player performed the unilateral horizontal decuple jumps (DJ, 10-jump test), which involved the participant attempting to cover the greatest horizontal distance possible by performing a series of ten forward jumps with alternate left and right foot contacts. Participants were allowed three trials, with the longest distance covered recorded for analysis. The total distance covered was measured as for the horizontal jumps. It has been proposed that the 10-jump test has been shown to be reliable with intraclass correlations between 0.80 and 0.95 (Maulder & Cronin, 2005), and is an appropriate alternative to traditional jumping exercises for estimating lower limb explosive power in various types of athletes (Bouhlel, Bouhlel, Chelly, & Tabka, 2006; Chamari et al., 2008; Chtara et al., 2008).

WBVT was carried out on the DKN Extreme PRO in standing position. The program consisted of squatting, deep squatting, wide-stance squatting, 1-legged squatting, calf raises, inversion/eversion movements, jumps onto the plate, and light jumping. After each exercise, the participants were allowed to rest for 2 minutes before starting the following exercise. Training intensity was increased over the 8 weeks by fixed amplitude (2 mm) but increasing the frequency from 20 to 40 Hz of the vibration, the duration of the exercise, and the number of repetitions. Also, the number of repetitions of 1 exercise and the number of different exercises increased systematically over the 8-week training period.

All statistical procedures were performed by using SPSS version for Windows 12 (Chicago, IL, USA). Single factor ANCOVA was used to examine the differences in each parameter between the groups after training with the pretest values as a covariate. Intra-class correlation coefficients (ICC) assessed the test-retest reliability of comparing the mean of the dependent variables between testing sessions. For all analyses, the level of statistical significance was set at  $P < .05$ .

**RESULTS:** The ICC test-retest reliability analyses revealed that jump height of DJ (0.94) was consistent between sessions. Figure 1 details the DJ performance before and after training for each group. The results of the ANCOVA for the total distance of decuple jump also indicated a significant differences between the groups with post-training performance being significantly better than pre-training in the WBVT group (pre:  $25.03 \pm 1.83$  m vs. post:  $26.26 \pm 1.65$  m,  $F = 5.45$ ,  $p < .05$ ).

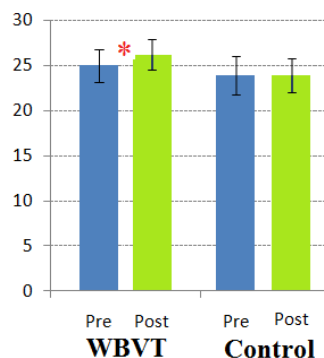


Figure 1: The DJ performance between groups before and after training. (\*  $p < .05$ )

**DISCUSSION:** Our results show that the horizontal (DJ) jump performance was enhanced from 25.0 m before training to 26.3 m after 8 weeks of extra WBVT training in a group of handball athletes.

This study utilized the decuple jump test with the reason that unilateral horizontal jumping distance is more specific to the running/sprinting movement than vertical bilateral jumping height. The unilateral jumps correlated strongly ( $r = 70.65$  to  $70.80$ ) with sprint times for all 5-meter, 10-meter, and 30-meter sprint distances (Chaouachi et al., 2009) which could be due to the commonalities that exist between sprinting and unilateral horizontal jumping: (1) both movements occur in the horizontal direction; (2) both movements require rapid stretch-shortening cycles performed unilaterally; and (3) both movements have similar proximal-to-distal segment sequencing patterns, which involve similar inter- and intra-muscular coordination. Therefore, this study demonstrated significant improvements in DJ after 8-weeks regular WBVT, might because of the movements involved in the decuple jump test require rapid stretching and high-velocity muscular contractions. In the present study, WBVT exposure elicits both concentric and eccentric contractions, it could be speculated that the additional effect of WBV might be due to the eccentric stimuli it provides. This study demonstrated that regular handball practice with extra WBVT for 8 weeks can significantly improve the unilateral horizontal decuple jump performance about 5%. These improvements have been attributed to reflex muscle contractions as a result of a tonic vibration reflex. This reflex contraction is caused by an excitation of muscle spindles, leading to enhanced activity of the Ia loop (Roll, Vedel, & Ribot, 1989; Cardinale & Lim, 2003). In addition, the enhanced muscle power observed following acute vibration is suggested to occur via potentiation of the neuromuscular system whereby stimulation of muscles spindles (Ia afferents) results in reflex activation of motor neurones with increased spatial recruitment (Komi, 2000). Furthermore, Torvinen et al (2002) randomized 56 young adults to either a vibration group or a control (no training) group. Jumping power was enhanced 8.5% after a 4-month WBV intervention.

**CONCLUSION:** In conclusion, for the male collegiate handball athletes studied here, implementing a 8-week extra WBVT had positive effects on unilateral horizontal decuple jumps performance. Enhanced motor unit synchronization and firing rates, facilitated muscular contraction stretch-shortening cycle, and improved lower extremity neuromuscular coordination could account for these enhancements.

#### REFERENCES:

- Hatzimanouil D. & Oxizoglou N (2004). Evaluation of the morphological characteristics and motor skills in the national junior handball teams of Greece and Yugoslavia. *Journal of Human Movement Studies*, 46, 125-140.
- Gorostiaga EM, Granados C, Ibanez J, Gonzalez-Badillo JJ, Izquierdo M. (2006). Effects of an entire season on physical fitness changes in elite male handball players. *Medicine and Science in Sports and Exercise*, 38, 357-366.
- Ronglan LT, Raastad T, Borgesen A. (2006). Neuromuscular fatigue and recovery in elite female handball players. *Scandinavian Journal of Medicine & Science in Sports*, 16, 267-273.
- Delecluse C, Roelants M, Verschueren S. (2003). Strength increase after whole-body vibration compared with resistance training. *Medicine and Science in Sports and Exercise*, 35, 1033-1041.
- Cardinale M, Bosco C. (2003). The use of vibration as an exercise intervention. *Exercise and Sport Science Review*, 31, 3-7.
- Schuhfried O. & Mittermaier C, Jovanovic T, et al. (2005). Effects of whole body vibration training in patient with multiple sclerosis. *Clinical Rehabilitation*, 19, 834-42.
- Maulder, P. & Cronin, J. (2005). Horizontal and vertical jump assessment: Reliability, symmetry, discriminative and predictive ability. *Physical Therapy in Sport*, 6, 74-82.

- Bouhlef, E., Bouhlef, M., Chelly, S., & Tabka, Z. (2006). Relationship between maximal anaerobic power measured by force–velocity test and performance in the counter movement jump and in the 5-jump test in moderately trained boys. *Science and Sports*, 21, 1-7.
- Chamari, K., Chaouachi, A., Hambli, M., Kaouech, F., Wisslof, U., & Castagna, C. (2008). The 5-jumps for distance as a field test to assess lower limbs explosive-power in soccer. *Journal of Strength and Conditioning Research*, 22, 944-950.
- Chtara, M., Chaouachi, A., Levin, G. T., Chaouachi, M., Chamari, K., Feki, Y. et al. (2008). Effect of concurrent endurance and circuit resistance-training sequence on muscular strength and power development. *Journal of Strength and Conditioning Research*, 22, 1037-1045.
- Chaouachi, A., Brughelli, M., Levin, G., Boudhina, N. B. B., Cronin, J. and Chamari, K (2009). Anthropometric, physiological and performance characteristics of elite team-handball players. *Journal of Sports Sciences*, 27, 151-157
- Roll JP, Vedel JP, Ribot E. (1989). Alteration of proprioceptive messages induced by tendon vibration in man: a microneurographic study. *Experimental Brain Research*, 76, 213-222.
- Cardinale M. & Lim J. (2003). The acute effects of two different whole body vibration frequencies on vertical jump performance. *Medicine and Sport*, 56, 287-292.
- Komi PV. (2000). Stretch-shortening cycle: a powerful model to study normal and fatigued muscle. *Journal of Biomechanics*, 33, 1197-1206.
- Torvinen S, Kannus P, Sievanen H, et al. (2002). Effect of four-month vertical whole body vibration on performance and balance. *Medicine and Science in Sports and Exercise*, 34, 1523-1528.