THE RESPONSE OF WHOLE BODY VIBRATION ON TAI CHI AND WEIGHT-LIFTING ATHLETES

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Whole body vibration (WBV) is a new technique which may improve leg muscle strength. Many researchers have studied the effect of whole body vibration recently. But study of effects of vibration stimulus to different activity type athletes, such as Tai Chi (N=12) and Weight-lifting (N=15) athletes is lacking. In this study we examine that question. The subjects were asked to stand in a half-squat posture without additional load on a vibration platform with 7 vibration frequencies (5, 9, 12, 16, 20, 24, 30 Hz) at 4 mm amplitude and maintained for 30 seconds. The effect of WBV would be different on different sport subjects' perceived exertion. We discovered that the subject's perception may be related with the acceleration of the subject's head. Using whole body vibration training to improve muscle power and strength depends on the particular sport's training emphasis to setup the appropriate training protocol such as amplitude and frequency.

KEY WORDS: whole body vibration, human response, Tai Chi, weight-lifting

INTRODUCTION:

Whole body vibration (WBV) is a new technique that may be able to improve leg muscle strength. Many researchers have studied the effect of whole body vibration recently (Mester et al., 2006; Abercromby, 2006). The frequency of WBV was usually from 5 up to 50 Hz and the peak to peak amplitude was from 2 to 14 mm. But exposure to whole body vibration is one of several hazards that can result in injury manifesting as lower back pain (Mansfield, 2004; Griffin, 1990). We wanted to know what the appropriate intensity in frequency is when subjects experienced whole body vibration. Would it be different for different sports subjects?

METHOD:

Data Collection: Subjects were selected from Tai Chi (TC, n=12, age: 34.92±11.31 years, height: 169.67±7.77 cm, BW: 70.14±10.46 kg, experience: 10.67±8.27 years) and weight-lifting (WL, N=15, age: 22.47±4.36 years, height: 170.07±6.43 cm, BW: 79.34±12.59 kg, experience: 6.64±2.62 years) athletes. They stood in a half-squat position without additional load on a platform (Model VS 5060 LD, by Vibration Source Inc. Taiwan) with 7 frequencies (5, 9, 12, 16, 20, 24, 30 Hz) at 4 mm amplitude maintained for 30 seconds. They were asked to adjust the angle of the lower extremities to avoid the vibration that transfers to the head. The Rating of Perceived Exertion (RPE) scale of Borg's 10 points was used to record the feel of each subject at each frequency. We used Dactron Photo II and 4 accelerometers (PCB Piezotronics) placed on the platform, tibial tuberosity, shoulder and head (sampling rate was 1000 Hz) to collect the data of acceleration. FFT and coherence function was used to check the main frequency of vibration and the relationship between platform and human body. Motion Analysis System (Motion Analysis Corporation, USA) and 10 Eagle digital cameras were used to record the angle of ankle, knee, and hip joint (sampling rate was 100 Hz). T&T Medilogic plantar pressure system was used to collect the COP (center of pressure) during WBV.

Data Analysis: The statistical t-test was used to compare the independent variables between Tai-Chi and Weight-Lifting groups.

RESULTS:

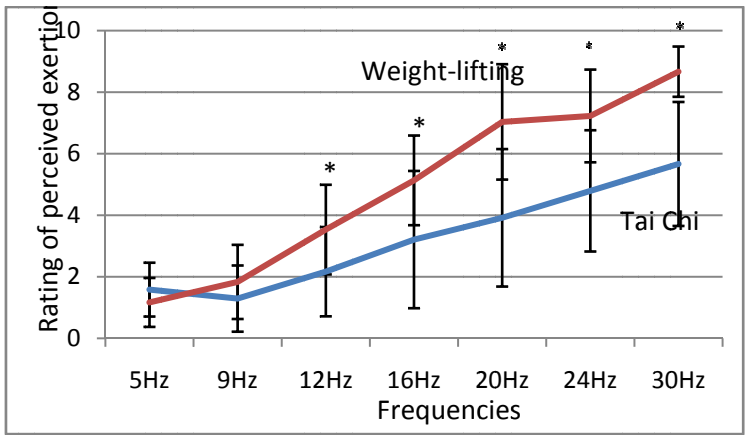

Figure 1: The Rating of Perceived Exertion (RPE) scale of Borg's 10 points was used to record the intensity of the subject's feeling at each frequency between Tai Chi and Weight-lifting groups. (* indicates p<.05)

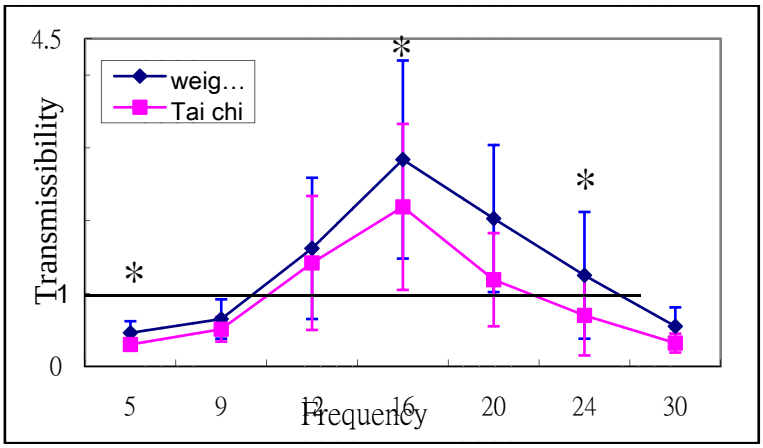

Figure 2: The transmissibility of frequencies at tibial tuberosity between Tai Chi and Weight-lifting groups. (* indicates p<.05)

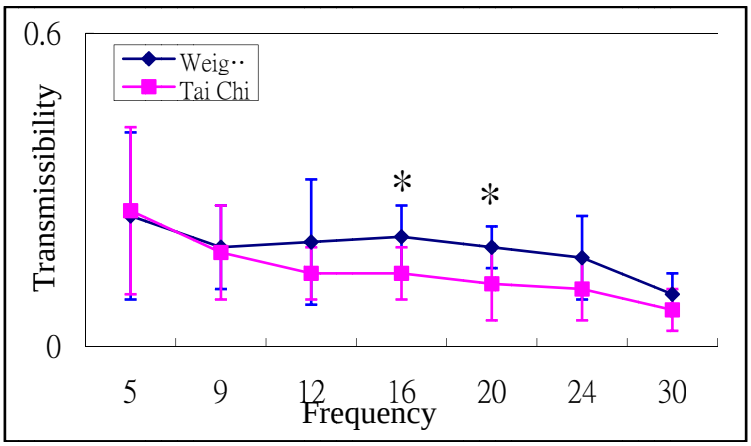

Figure 3: The transmissibility of frequencies at head between Tai Chi and Weight-lifting groups. (* indicates p<.05)

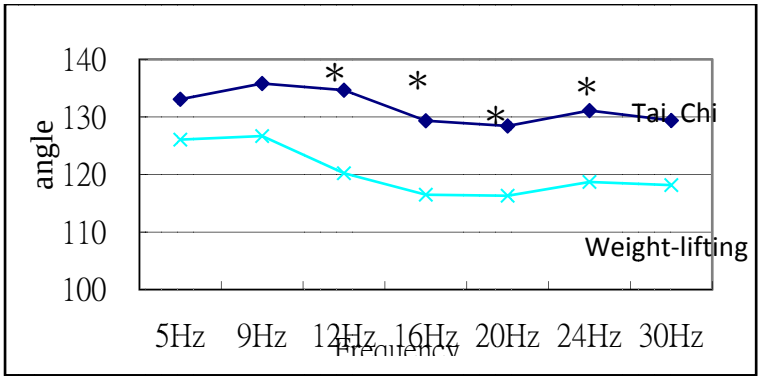

Figure 4: The angle of hip at each frequency between Tai Chi and Weight-lifting groups during WBV. (* indicates p<.05)

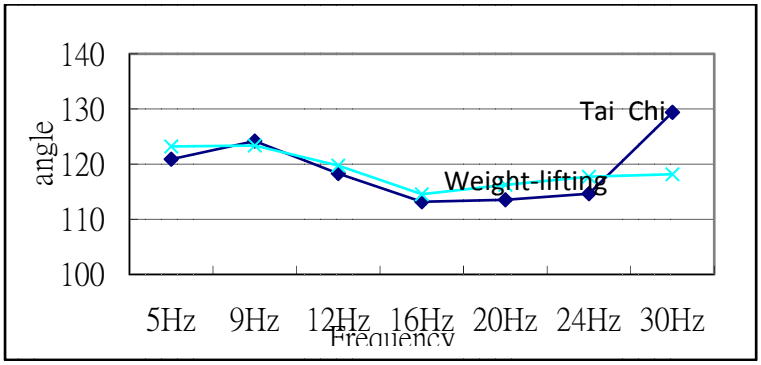

Figure 5: The angle of knee at each frequency between Tai Chi and Weight-lifting groups during WBV. (* indicates p<.05)

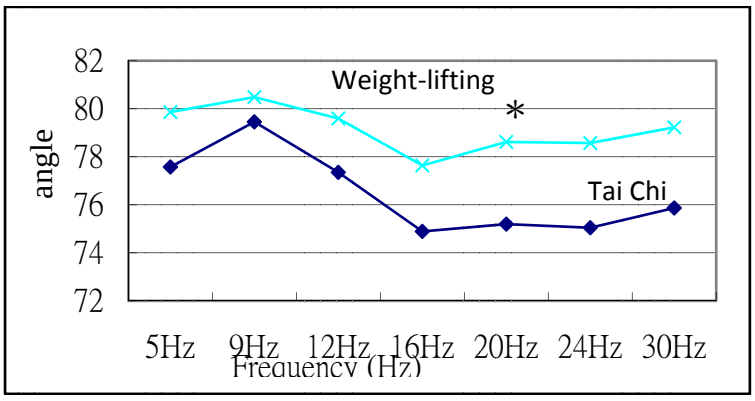

Figure 6: The angle of ankle at each frequency between Tai Chi and Weight-lifting groups during WBV. (* indicates p<.05)

DISCUSSION:

The perceived exertion was different between weight-lifting and Tai-Chi groups at 12, 16, 20, 24, 30 Hz (p<.05). The intensity from vibration source was similar but transfer into the human body was different due to the human body's non-linear system. Also, the vibration spread from platform to head which caused discomfort; were different according to the body weight and sport type. The WL group felt higher intensity than the Tai Chi group at the same vibration simulation. This may be due to muscle stiffness differences. Therefore causing different acceleration transmitted to the head. The vibration platform changed the parameters according to subject's body weight to maintain the stable frequency and amplitude of vibration. The body weight of weight-lifting group is heavier than Tai Chi group. The heavier subject will experience higher power from the platform. The other reason was

acceleration of the head was affected by body posture(esp. hip angle), leg stiffness, and the activity type. Figure 4 shows that the hip angle of the WL group was smaller than the TC group. The upper body and lower body posture angle of the WL group was sharper and fixed at the hip joint which reduced the damping function of the hip. Because the length of leg was not significant between WL and TC groups, but the body weight of the WL group was heavier than the TC group. The WL group has higher leg stiffness than the TC group. According to definition of stiffness $(S = \frac{\Delta F}{\Delta L})$ higher stiffness transfers vibrations easier to the head. Our finding consisted with Crewther et al. (2004) that semi-squat will recruit more muscles to increase the muscular stiffness. The activity types of WL and TC groups were different, WL required lower extremity power and strength to lift barbell and stand up, TC needed to relax and sink his/her body to maintain stability. It was easy to see the difference of body condition and muscle stiffness between WL and TC groups. The effect of WBV was different at the same frequency between WL and TC groups. Mester et al., (2006) suggested that it is necessary to avoid the frequency of human body resonance when using whole body vibration to be a tool of training. They suggested that the frequency should be above 20 Hz. Nevertheless, in this study 20Hz will reach 7 point in RPE scale which means very strong perceived exertion. We suggest that in order to maintain the vibration frequency above 20 Hz, the amplitude of vibration should be reduced in order to protect the subject during WBV.

CONCLUSION:

Using whole body vibration training to improve muscle power and strength depends on the particular sport's training emphasis to setup the appropriate training protocol such as amplitude and frequency. We suggest that in order to maintain the vibration frequency above 20 Hz, the amplitude of vibration should be reduced in order to protect the subject during WBV.

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