

BIOMECHANICAL EFFECT OF GROUP EXERCISE PROGRAM USING STABILITY BALL ON THE COUNTER MOVEMENT JUMP

Yu-Lan Wu¹, Yi-Wen Chang¹, Tien-Ju Kuo², Hong-Wen Wu²

¹Department of Exercise and Health Science, National Taiwan University of Physical Education and Sport, Taichung, Taiwan

²Department of Physical Education & Graduate Institute of Physical Education, National Taiwan University of Physical Education and Sport, Taichung, Taiwan

The purpose of this study was to evaluate the training effect of three-month group exercise program using stability ball. Ten female subjects were recruited to join this group exercise class for three months. The biomechanical parameters of counter-movement jump were collected before and after class. The average of maximal jumping height and the take-off velocity have significantly increased after three months. The group exercise program according American College of Sport Medicine training guideline which was designed in this study was helpful to increase the jump height of counter movement jump and to improve the biomechanical parameters of the landing.

KEY WORDS: Stability Ball, Counter Movement Jump, Group Exercise Program

INTRODUCTION: There are three main types of core strength training: traditional strength training, progressive strength training and strength training using a stability ball. Strength training using a stability ball (Swiss ball) to improve core muscles has been a common method. However, the previous studies about training using Swiss ball only focused on specific action (Lehman et al., 2006; Marshall et al., 2006). Few of studies have discussed the effect of training program. According to the American College of Sport Medicine (ACSM) training guidelines, a training program should contain a set of trainings including cardiorespiratory endurance, muscle strength/muscle endurance and flexibility (ACSM, 2006; ACSM, 2007). Previous researches have indicated that core muscle strength training for trunk stability could improve the parameter of biomechanics during landing (Butcher et al., 2001; Myer et al., 2006). Also, the published researches about for muscle strength training only studied the effect traditional and progressive training. Few studies had discussed the training effect of group exercise program using a stability ball. Hence, the purpose of this study was to evaluate the training effect of three-month group exercise program using stability ball.

METHODS: A training program using stability ball according ACSM's training guidelines, including cardiorespiratory endurance, muscle strength/muscle endurance and flexibility was designed in this study. In the warm-up and cardiorespiratory endurance training section, the modified the basic movements of aerobic dance (marches, grapevine, step-touches, jacks ...) by sitting on the ball or holding the ball were executed. Ten major muscles strength training and flexibility exercises were also designed using stability ball. Ten female subjects from the National Taiwan University of Physical Education and Sport were recruited to join this group exercise class (one hour program; twice a week) for three months. The biomechanical parameters of counter-movement jump were analyzed before and after class. Each subject was asked to perform counter movement jump at the motion analysis laboratory. The VICON motion analysis system was used to collect the kinematical data at 250 Hz. Two KISTLER force platforms were used to collect ground reaction forces and moments at 1000 Hz. Pair-*t* test was used to compare the differences on the biomechanical parameters of counter movement jump before and after training.

RESULTS: After three months group exercise training, the results showed that the joint angles of trunk extension, hip flexion and knee flexion instant of jump landing were increased (Figure 1). However, there was still no significant difference between the results before and

after training. The maximal jump height and take-off velocity during counter movement jump (Figure 2), and knee flexor moment after landing were significantly increased (Figure 3) ($p < .05$).

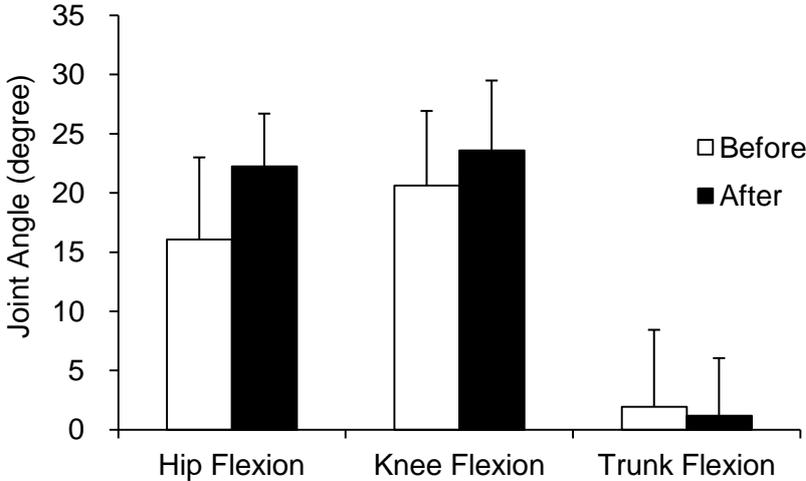


Figure 1: The joint angles of the hip, knee and trunk at the instant of landing. *Pair-t test, $p < 0.05$.

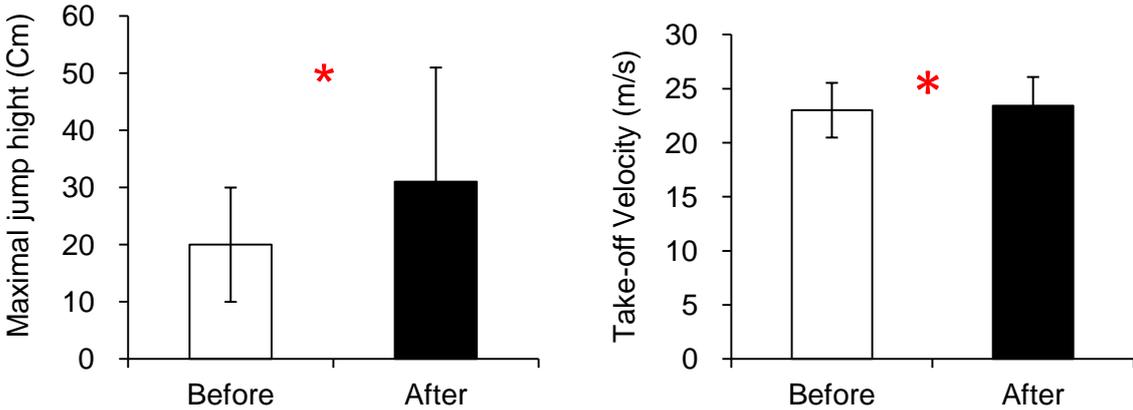


Figure 2: Maximal jump height and take-off velocity during counter movement jump. *Pair-t test, $p < 0.05$.

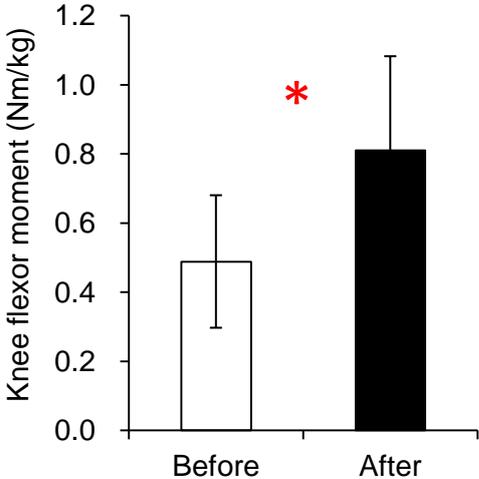


Figure 3: Peak knee flexor moment after landing. *Pair-t test, $p < 0.05$.

DISCUSSION: A group exercise training program using stability ball according ACSM's training guidelines, including cardiorespiratory endurance, muscle strength/muscle endurance and flexibility were designed in this study. After three month training, the results in our study showed that there was positive tendency to improve the pattern of landing. Although there was no significant difference on the joint angle at the instant of the landing, it might result from the number of subjects and the intensity of training program. However, we believed that the group exercise using the stability ball was still helpful to improve the parameter of biomechanics during landing. The maximal jump height and the take-off velocity during counter movement jump were increased after three months group exercise training. It might result from the increase of core muscle strength. Previous studies about plyometric and traditional muscle strength training reported that the increase of core strength could increase maximal jump height and the take-off velocity during jump (Myer et al., 2006 ; Butcher et al., 2001). In our study, the strength training was executed during group exercise class using the stability ball. The group exercise programs using the stability ball have more fun than traditional muscle strength training program. In addition, the increase of the hip & knee flexion, and the decrease of trunk flexion angle during jump landing would decrease anterior cruciate ligament injury during landing (Beynon et al., 1998; Kanamori et al., 2000 ; Blackburn et al., 2008 ; Leetun et al., 2004, Blackburn et al., 2009).

CONCLUSION: There were significant training effects on the biomechanical parameters during counter movement jump. A group exercise training program using stability ball according ACSM's training guidelines, including cardiorespiratory endurance, muscle strength/muscle endurance and flexibility was not only increase the fun of exercise program but also increase the ability of counter movement jump.

REFERENCES:

- American college of sports medicine (2006). ACSM's resource manual for guidelines for exercise testing and prescription. Baltimore : Lippincott Williams & Wilkins.
- American college of sports medicine (2007). ACSM's health-related physical fitness assessment manual. Baltimore : Lippincott Williams & Wilkins.
- Beynon, B.D. & Fleming, B.C. (1998) . Anterior cruciate ligament strain in-vivo: a review of previous work. *Journal of Biomechanics*, 31, 519 – 525.
- Blackburn, J.T. & Padua, D.A. (2008) . Influence of trunk flexion on hip and knee joint kinematics during a controlled drop landing. *Clinical Biomechanics*, 23 (3) , 313 – 319.
- Blackburn, J.T. & Padua, D.A. (2009) . Sagittal-plane trunk position, landing forces, and quadriceps electromyographic activity. *Journal of Athletic Training*, 44 (2) , 174-179.
- Butcher, S.J., Craven, B.R., Sprigings, E.J.C., Chilibeck, P.D., & Spink, K.S. (2001) . Influence of trunk stability and leg strength training on vertical take-off velocity in athletes. *Medicine and Science in Sports and Exercise*, 33 (5) , Supplement abstract 891.
- Kanamori, A., Woo, S.L., & Ma, C.B. (2000) . The forces in the anterior cruciate ligament and knee kinematics during a simulated pivot shift test: a human cadaveric study using robotic technology. *Arthroscopy*, 16, 633 – 639.
- Leetun, D.T., Ireland, M.L., Willson, J.D., Ballantyne, B.T., & Davis, I.M. (2004) . Core stability measures as risk factors for lower extremity injury in athletes. *Medicine and Science in Sports and Exercise*, 36 (6) , 926-934.
- Lehman, G. J., MacMillan, B., MacIntyre, I., Chivers, M., & Fluter, M. (2006). Shoulder muscle EMG activity during push up variations on and off a Swiss ball. *Dynamic Medicine*, 5, 7.
- Marshall P. W. M., & Murphy B. (2006). Increased deltoid and abdominal muscle activity during swissball bench press. *Journal of Strength & Conditioning Research*, 20 (4), 745-750.
- Myer, G.D., Ford, K.R., Brent, J.L., & Hewett, T.E. (2006) . The effects of plyometric vs. Dynamic stabilization and balance training on power, balance, and landing force in female athletes. *Journal of Strength and Conditioning Research*, 20 (2) , 345-353.