COMPARISON OF MOVEMENT CHARACTERISTIC AND MUSCLE ACTIVATION BETWEEN DIFFERENT FITNESS HOOPS

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Purpose: To compare the movement characteristics and muscle activation between Hula Hoop (HL) and Mini Hoop (MH). **Methods:** Sixteen healthy females randomly used HL and MH three minutes, respectively. Motion Analysis System and Noraxon wireless surface electromyography (EMG) were used to measure the movement characteristics and muscle activation. The paired t-test was used to test the difference between MH and HL. **Results:** The HL had larger in range of hip motion and root mean square of EMG in spinal erectors than MH ($p < .05$); the MH had higher in movement frequency (cycles per second) and median frequency of EMG in spinal erectors than HL ($p < .05$). **Conclusion:** Two fitness hoops have different movement characteristics and muscle action due to the different equipment design.

KEY WORDS: fitness equipment, core muscle, trunk, injure

INTRODUCTION: Training of the trunk or core muscles for enhanced health, rehabilitation, and athletic performance has received renewed emphasis (Behm, Drinkwater, Willardson, & Cowley, 2010), and has been promoted as a preventive regimen, rehabilitation, and a performance-enhancing program for various lumbar spine and musculoskeletal injuries (Akuthota & Nadler, 2004). Core strengthening improve lower back pain, body balance, range of motion for trunk rotation, pelvis inclination, low back flexion, (Carpes, Reinehr, & Mota, 2008) and sports performance (Deane, Chow, Tillman, & Fournier, 2005; Memmo, Kim, Solomon, Savarese, & Nadler, 2002).
Common core strengthening exercises are yoga, pilates, tai chi, feldenkrais and somatics that follow core strengthening principles (Akuthota & Nadler, 2004). In addition to these exercise without equipment, stability ball and suspension system are also widely used in the core training (Sukalinggam, Sukalinggam, Kasim, & Yusof, 2012; Byrne et al., 2014). However, these exercises mostly are complex and need guided by the professionals to prevent the occurrence of injuries, and to maintain the correct action.
Hula Hoop (HL) is a simple motion and popular fitness equipment, which was attempts to promotes the trunk or core muscles through hoop circling around the waist by swing hip (Cluff, Robertson, & Balasubramaniam, 2008; Kemp & Pienaar, 2009; McGill, Cambridge, & Andersen, 2014). However, the repeated impact between the waist (or abdominal) and hoop during hula hooping may cause injury in waist and abdominal after long-term hula hooping, such as perirenal hematoma (Park, Kim, Lhee, & Lee, 2007). Therefore, hula hoop may not applicable for the trunk or core muscles exercise due to the risk of injury. The Mini Hoop (MH) is another waist fitness equipment similar to HL. It is tied around the waist and close to the front of abdominal, and made a metal ball inside the hoop rolling along the hoop around by swing hip, whereby to avoid damage caused by the collision, and may contribute to the fitness. However, the kinematics and EMG of the HL and MH on human body are unclear. The purpose of this study was to compare the movement characteristics and muscle activation between the HL and MH.

METHODS: Sixteen female (age, 21.9 ± 1.8 years; height, 163.7 ± 5.1 cm; mass, 55.9 ± 7.3 kg) participted in this study. All subjects with no previous history of low back and were currently healthy. The hoops used were a HL measuring 82.0cm in diameter and a MH measuring 13.0cm in diameter, as shown in Fig. 1.

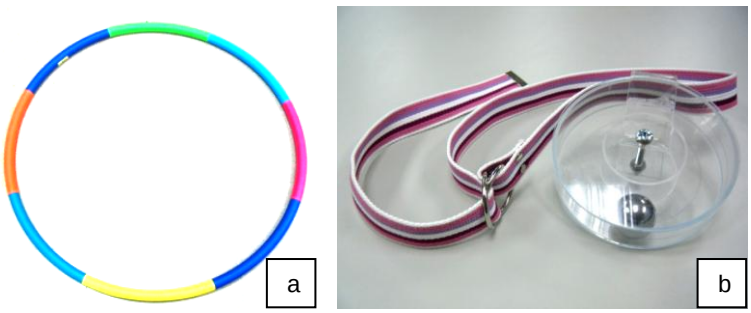

Figure 1: The Hula Hoop (a) and Mini Hoop (b)

Each subject performed a standardized warm-up and practice both hoops to skilled before the test, followed by performed manual muscle testing. Subjects were randomly performed HL and MH 3 minutes. The rest interval between two hoops was 5 minutes. Subjects standing with feet shoulder width apart on the specified area, and cannot move or lift the feet during exercise, and with a most stable action include the movement frequency and range of motion to keep the hoops (HL and MH) running. For the HL, the hands was putted on chest, and kept the HL circling around the waist by swing hip. For the MH, the MH was tied around the waist and close to the front of abdominal, putting the hands on chest, and kept the metal ball inside hoop rolling by swing hip as circle but not rotation. The continuous ten cycles of regular movement were analyzed.

An 8-camera motion analysis system (Motion Analysis Corp, Santa Rosa, CA) captured the marker positions at 300 Hz. Ten reflective markers were placed on each subject's skin to the following anatomical landmarks: acromion, thoracic 8, sacrum, anterior superior iliac spines, greater trochanter, lateral femoral condyles. The movement frequency (cycles/second), range of hip motion in flexion / extension and abduction / adduction were analyzed. A complete cycle was determined by the sacrum to calculate the movement frequency. The average of 10 cycles was calculated to statistical analyses.

The EMG data of spinal erectors was collected at 3,000 Hz using wireless recording system (TeleMyo 2400t, Noraxon, USA). The EMG data was bandpass filtered (20–500 Hz) and the root mean square of EMG (EMGrms) and median frequency of EMG (EMG MDF) was calculated, and the EMGrms was normalized to the highest activity recorded in the manual muscle testing.

A paired t-test was used to test the difference between HL and MH in movement characteristics and muscle activation. Statistical significance was set as $p < .05$. All the statistics were analyzed using SPSS 17 software for Windows (SPSS Inc., USA).

RESULTS: In the movement characteristics, HL had significantly lower movement frequency and larger range of hip motion both flexion/extension and abduction/adduction than MH ($p < .05$); in the muscle activation, HL had significantly larger EMGrms and lower EMG MDF in spinal erectors than MH ($p < .05$). All results as show in Table 1.

Table 1
Movement characteristic and muscle activation between two hoops

	Movement frequency (cycles/second)	Range of hip motion		EMG in spinal erectors	
		Flexion/ extension (°)	Abduction/ adduction (°)	EMGrms (% MVC)	EMG MDF (Hz)
Hula Hoop	1.83 ± 0.18*	12.07 ± 5.05*	8.10 ± 4.68*	47.60 ± 16.63*	47.52 ± 22.79*
Mini Hoop	2.07 ± 0.39	3.21 ± 1.81	1.87 ± 1.57	27.85 ± 20.83	75.10 ± 18.00

EMGrms root mean square of electromyography *EMG MDF* median frequency of electromyography *MVC* maximum voluntary contraction. ***** $p < .05$ compared with Mini Hoop.

DISCUSSION: The different movement characteristics and muscle action was found when used HL and MH, respectively. The HL had larger range of hip motion with lower movement frequency and larger EMGrms in spinal erectors, while MH had higher movement frequency with smaller range of hip motion and higher EMG MDF in spinal erectors. These difference may cause by the different equipment design, such as different target object (HL: hoop; MH: ball) and that revolves around different centers (HL: trunk; MH: front of abdominal).
The results indicated a higher movement frequency with smaller range of hip motion was required to maintain the MH running compare with HL. And this movement characteristics also leads to a higher EMG MDF in spinal erectors; conversely, the larger EMGrms with range of hip motion in HL.
The EMG MDF is depend on the speed of muscle contraction (Masuda et al., 2001); while the EMGrms is decided by the number and firing rate of the active motor unit (Basmajian & De Luca, 1985). The MH had higher in movement frequency (cycles per second) and median frequency of EMG in spinal erectors than HL may due to faster muscle contraction. The HL had larger in range of hip motion and root mean square of EMG in spinal erectors than MH may due to more motor unit was recruitment during muscle contraction in spinal erectors. However, the effect of long-term exercise on muscle requires further study.

CONCLUSION: The study shows two fitness hoops have different movement characteristics and muscle action with different equipment design. The Hula Hoop had larger range of hip motion and EMGrms in spinal erectors, while MH has higher movement frequency with smaller range of hip motion and higher EMG MDF in spinal erectors.

REFERENCES:

Akuthota, V., & Nadler, S. F. (2004). Core strengthening. *Archives of Physical Medicine and Rehabilitation*, 85, 86-92.

Basmajian, J. V., & De Luca, C. J. (1985). *Muscles alive: their functions revealed by electromyography*, 5th edn, Baltimore: Williams & Willkins.

Behm, D. G., Drinkwater, E. J., Willardson, J. M., & Cowley, P. M. (2010). The use of instability to train the core musculature. *Applied Physiology, Nutrition, and Metabolism*, 35(1), 91-108.

Byrne, J. M., Bishop, N. S., Caines, A. M., Crane, K. A., Feaver, A. M., & Pearcey, G. E. (2014). The effect of using a suspension training system on muscle activation during the performance of a front plank exercise. *Journal of Strength and Conditioning Research*, 28(11), 3049-3055.

Carpes, F. P., Reinehr, F. B., & Mota, C. B. (2008). Effects of a program for trunk strength and stability on pain, low back and pelvis kinematics, and body balance: a pilot study. *Journal of Bodywork and Movement Therapies*, 12(1), 22-30.

Cluff, T., Robertson, D. G. E., & Balasubramaniam, R. (2008). Kinetics of hula hooping: An inverse dynamics analysis. *Human Movement Science*, 27(4), 622-635.

Deane, R. S., Chow, J. W., Tillman, M. D., & Fournier, K. A. (2005). Effects of hip flexor training on sprint, shuttle run, and vertical jump performance. *Journal of Strength and Conditioning Research*, 19(3), 615-621.

Kemp, C., & Pienaar, A. E. (2009). Effect of an aerobic-based physical activity programme on physical fitness of 10-15 year-old girls. *African Journal for Physical Health Education, Recreation and Dance*, 15(4), 527-542.

Masuda, T., Kizuka, T., Zhe, J. Y., Yamada, H., Saitou, K., Sadoyama, T., & Okada, M. (2001). Influence of contraction force and speed on muscle fiber conduction velocity during dynamic voluntary exercise. *Journal of Electromyography and Kinesiology*, 11(2), 85-94.

McGill, S., Cambridge, E. D., & Andersen, J. (2014). A 6 week trial of hula hooping using a weighted hoop: Effects on skinfold, girths, weight and torso muscle endurance. *Journal of Strength and Conditioning Research.* doi: 10.1519/JSC.0000000000000653.

Memmo, P., Kim, K., Solomon, J., Savarese, R., & Nadler, S. F. (2002). Core Strengthening: Influence on performance of timed shuttle run. *Archives of Physical Medicine and Rehabilitation*, 83, 1661.

Park, S. K., Kim, H., Lhee, H. Y., & Lee, K. B. (2007). Development of a perirenal hematoma after hula-hooping. *Yonsei Medical Journal*, 48(5), 868-870.

Sukalinggam, C., Sukalinggam, G., Kasim, F., & Yusof, A. (2012). Stability Ball Training on Lower Back Strength has Greater Effect in Untrained Female Compared to Male. *Journal of Human Kinetics*, 33, 133-141.