COMPARISON OF STATIC BALANCE MEASURES WITH HEIGHT AND WEIGHT ADJUSTMENTS BETWEEN TAEKWONDO AND HANDBALL PLAYERS

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This study aimed to compare the static balance of taekwondo athletes and handball players. Considering the body size might affect the sway during static balance testing as the inverted pendulum model demonstrated. The static balance of the subjects was evaluated by the Biodex Balance System. The results showed that the APSI, MLSI and OSI of taekwondo athletes were significantly lower than those of the handball players. Moreover, the three stability indices of the two groups of athletes were significantly correlated with height and weight, but not age. The data showed that body size were positively related to the sway in the static balance testing. The taekwondo athletes were lighter than the handball players in average, nevertheless, lower height-and-weight adjusted stability indices of the taekwondo athletes were found.

KEY WORDS: postural stability, inverted pendulum, body mass, stature, sport

INTRODUCTION: Improving balance control or postural stability is recommended for athletes. It is documented that a better balance control may not only reduce the injury risk of the lower extremities (Hrysomallis, 2007), but also improve athlete performance (Hrysomallis, 2011). Assessment of the static balance hence is a common procedure in the athletic training. Most of the tests require the subject to stand quietly on a wobble platform or a force plate and measure the sway of the body. Typically, less sway represents a better balance control. To explain the biomechanical basis of static balance, the inverted pendulum model is often adopted (Loram and Lakie, 2002). With the ankle act as the pivot, the center of body mass and height plus the acceleration of gravity will create a torque to sway the body. In this regard, subjects with more weight and height will inevitably sway more than shorter and lighter counterparts. Actually, this was featured in the study of Hue, et al. (2007), which indicated the body weight alone explained 52% variance of static balance of normal adults.

Among various athletes, it was observed that gymnasts and soccer players balance better than team sports athletes (Hrysomallis, 2011). Athletes of martial arts, such as taekwondo (Leong, Fu, Ng, & Tsang, 2010) and karate (Del Percio et al., 2007), were experts in balance, too. Beside the training effects, it should be noted that gymnasts and martial art athletes are generally lighter than team sports athletes. However, the factor of body size was mostly ignored in the comparison of the balance control of different sports. Base on the inverted pendulum model, we reasoned that body size should be concerned when comparing balance control of athletes. Therefore, the aim of this study was to compare the static balance of taekwondo athletes and handball players by using covariance method (ANCOVA) with height and weight as covariates, in order to discriminate the effect of body size on static balance measures.

METHODS: 40 male taekwondo athletes (18.0±1.2 years, 175.4±7.3 cm, 68.7±11.8 kg) and 40 handball players (18.4±1.3 years, 177.0±6.9 cm, 74.3±6.9 kg) participated in this study. All of them were trained for years and had no leg complain during the assessment.

The static balance of each subject was evaluated by the Biodex Balance System SD (Biodex Medical Systems Inc., Shirley, NY, USA). This device requires the subject to stand bipedal on a wobble platform and maintain balance. The medial-lateral axis and anterior-posterior axis of foot displacements are measured and computed as the medial-lateral stability index (MLSI) and anterior-posterior stability index (APSI) respectively. The overall stability index (OSI) is computed from the summation of body sway across the ML and AP axes (Arnold & Schmitz, 1998). A larger index represents more sway on the platform and hence inferior static balance control. Each subject was encouraged to practice several times at first time. After familiar with the device, three measures, each lasted for 20 seconds and intermitted with 20 seconds rest, were recorded. Data were analyzed with standard T-test, Pearson product-moment correlation coefficient, and ANCOVA by using SPSS18.0 with a significance level set at 0.05.

RESULTS: The taekwondo athletes and the handball players did not differ in age and height. However, the taekwondo athletes were lighter and perform better static balance than the handball players, as the OSI, APSI and MLSI were significantly smaller (table 1).
The three indices of static balance, namely, OSI, APSI and MLSI were significantly correlated with height and weight both in the two groups of athletes (table 2 and table 3).
ANCOVA results showed that the height-and-weight adjusted MLSI and OSI remained significantly lower of the taekwondo athletes than of the handball players (table 4).

Table 1
Standard T test results

Variables	Taekwondo (n=40)			Handball (n=40)		
Age (year)	18.0	±	1.2	18.4	±	1.3
Height (cm)	175.4	±	7.3	177.0	±	6.9
Weight (kg)	68.7	±	11.8*	74.3	±	9.0
BMI(kg/m2)	22.3	±	3.1*	23.7	±	2.1
Static balance						
OSI	2.113	±	1.157**	2.995	±	1.374
APSI	1.445	±	0.785**	1.918	±	0.793
MLSI	1.235	±	0.709**	1.965	±	1.212

*Significant difference between the two groups ($p<0.05$),
**High level of significant difference between the two groups ($p< 0.01$).

Table 2
Pearson correlation results of the taekwondo athletes

	Age	Height	Weight
OSI	.023	.520**	.644**
APSI	.011	.503**	.607**
MLSI	.032	.501**	.650**

*P<0.05，**P<0.001

Table 3
Pearson correlation results of the handball players

	Age	Height	Weight
OSI	.308	.736**	.770**
APSI	.337	.749**	.769**
MLSI	.092	.577**	.583**

*P<0.05，**P<0.001

Table 4
ANCOVA results

	Taekwondo (n=40)	Handball (n=40)
Adjusted OSI	2.326 ± 0.142*	2.782 ± 0.142
Adjusted APSI	1.574 ± 0.090	1.789 ± 0.090
Adjusted MLSI	1.372 ± 0.129*	1.828 ± 0.129

All means are adjusted for height and weight by ANCOVA

DISCUSSION: Static balance measures of the taekwondo athletes were lower than the handball players in average. At first glance, this could be due to the lighter weight of the taekwondo athletes, since the stability indices were positively correlated with height and weight. However, adjusting the stability indices with height and weight by ANCOVA showed the adjusted OSI and MLSI of the taekwondo athletes remained lower than handball players. This implied that body size may contribute to the body sway during static balance test as the inverted pendulum model demonstrated. However, other factors, such as a more precise neuromuscular control after a long-term training, may improve the balance control of the taekwondo athletes.

To counteract the sway of the body resulted from the torque created by displacement of center of body and the acceleration of gravity is demanded in maintaining static balance during upright stand. It depends on the integration of the sensory inputs and the neural muscular control. On the ascending sensory inputs, Leong, Fu, Ng, and Tsang (2011) showed the adolescent taekwondo practitioners were more skilled in balance and pointed out they relied more proprioceptive sensory inputs. On the descending neural muscular control form cortex, spinal cord to the motor unit, Taube (2012) indicated that balance training can lead to supraspinal adaptations within the central nervous system and is mainly responsible for improving balance skills.

Adaptation of the balance control is multifactorial. Our study showed the height and weight were related to the body sway during balance testing. It is suggested body size and other anthropometrical factors should be considered in the assessment and comparison of the balance control of athletes of various sports.

CONCLUSION: In the assessment of static balance of athletes, the measures should be weight-and-height adjusted in order to gain a more precise comparison of balance control.

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