



THE TEST-RETEST RELIABILITY OF ‘Y-BALANCE TEST’ AS DYNAMIC BALANCE MEASURE ON MALAYSIAN PRIMARY SCHOOL CHILDREN

Ai Choo Lee and Kuan Boon Ong

Sultan Idris Education University, Malaysia

The objective of this study was to determine the test-retest reliability of the ‘Y-Balance Test’, a new high level test involving balancing on three directions consist of anterior, posteromedial and posterolateral directions. The ‘Y-Balance Test’ consists of a series of lower extremity reaching tasks in above mentioned three directions that challenge subjects’ postural control, strength, range of motion, and proprioceptive. A total of 13 primary schools (5 from Malay streams, 4 Chinese streams and 4 Indian streams) were randomly selected from 971 primary schools in Perak State, Malaysia. There were 351 healthy Malaysian primary school boys and girls age ranging from 7 to 12 years old being recruited using simple randomization. A pilot study was conducted on 24 subjects to find out the test-retest reliability of the ‘Y-Balance Test’ before the actual study being administrated (anterior ICC=0.96; posteromedial ICC=0.96, and posterolateral ICC=0.98). The test-retest reliability was assessed with two trials for each testing session. In this study, the test-retest Intraclass Correlation Coefficients (ICCs) were 0.98, 0.98, and 0.99 on anterior, posteromedial, and posterolateral directions respectively. The results indicated excellent test-retest reliability for all three directions. In conclusion, the ‘Y-Balance Test’ is reliable in measuring dynamic balance on Malaysian primary school children. Therefore, the ‘Y-Balance Test’ revealed excellent reliability as a dynamic balance measurement tool to assess the dynamic balance ability among primary school children. Children with high dynamic balance ability are believed could outperform in sports, games and other related physical activities.

Keywords: Anterior, Dynamic Balance, Posteromedial, Posterolateral, Y-Balance Test.

Introduction

Dynamic balance control is regard as an essential indicator of musculoskeletal health. Balance control refers to the inborn capacity of a person to sustain, attain or restore a specific state of postural stability. The ability to maintain postural and balance control under dynamic conditions is an important fundamental component of physical activity and sports performance. All sports require excellent dynamic balance control to achieve high performance. However, in Malaysia, there is a paucity of static and dynamic balance measurements data.

Till today, no population-based reference material of dynamic balance control measures existing in the literature especially for children age raging from 7 to 12 years old. According to Rival et al. (2005), developmental changes of postural control in children with respect to standing balance, a transition phase should occur around 7 to 8 years of age. But, during 9 to 10

years old, balance appeared to be adult-like (Rival et al., 2005), however, not fully matured (Riach C, Starkes J., 1994). The 'Y-Balance Test' is one of the measurement tool used to evaluate postural and dynamic balance control. It is essential to evaluate the test-retest reliability before using it as postural and dynamic balance control measures for children. Therefore, the present study was designed to evaluate test-retest reliability of the 'Y-Balance Test' for postural and balance control focus on dynamic balance.

Literature Review

Balance is a complex process involving the coordinated activities of the reception and integration of multiple sensory inputs, motor components for the planning and execution of movement, and biomechanical components. The position of the body in relation to gravity and its surroundings is sensed by combining visual, vestibular, and somatosensory inputs to achieve a goal requiring upright posture so that a fall would not happen. Optimal controls of balance in upright posture as well as postural stability are essential requirements for sports activities, daily activities, or for the prevention from musculoskeletal injury.

Nashner (1994) stated that the ability to maintain postural and balance control depends on information provided by visual cues, vestibular function, and somatosensory feedback from structures in the lower extremities. The integrity and interaction of postural control mechanisms allow a wide range of movement and functions to be achieved without loss of balance. During sensory conflict situations, the CNS must quickly select the sensory inputs providing accurate orientation information and must ignore the other misleading ones. Failure to ignore conflicting sensory inputs can lead to instability or surface and surround motion illusions. Sensory organization is a process by which all three senses receive input and a determination is made whether any of the input is misleading. Despite the availability of multiple sensory inputs, the CNS generally relies on only one sense at a time for orientation information.

The Star Excursion Balance Tests (SEBTs) are a series of eight unilateral balance tests that incorporate a single-leg stance of one leg with maximum targeted reach of the free leg. Due to constrain of protocol variations and time consuming for test administration, Plisky and colleagues simplified the SEBTs to the 'Y-Balance Test' remaining only three unilateral balance tests, conducting in three selective directions consist of anterior, posteromedial and posterolateral that formed a 'Y' shape (Plisky, et al., 2006). Plisky et al. were conducted a research to identify the reliability of 'Y-Balance Test' as dynamic balance control measure. The finding indicated that the 'Y-Balance Test' obtained Intraclass Coefficients of Correlation (ICCs) between 0.88 to 0.99, indicated that the 'Y-Balance Test' is reliable to be utilized as dynamic balance control measure (Plisky, et al., 2006). However, there is lack of information about the 'Y-Balance Test' being utilized as dynamic balance control measure in primary school children. Therefore, this research is intended to distinguish the reliability of the 'Y-Balance Test' before using the 'Y-Balance Test' confidently to measure dynamic balance control for primary school children.

Methods

Subjects

A total of 13 primary schools were randomly selected from 971 primary schools in Perak state, Malaysia. Averagely, there were 30 students from each school volunteered to participate in the

reliability assessment for dynamic balance using the 'Y-Balance Test'. There were 351 primary school children from difference ethnic groups were recruited from year 1 till year 6, age ranging between 7-12 years by simple randomization. The subjects were consisted of 141 Malay children, 104 Chinese children and 106 Indian children. They were divided into four categories such as, a) lower boys (87 subjects age 7 to 9 years), b) lower girls (88 subjects age 7 to 9 years), c) upper boys (90 subjects age 10 to 12 years), and d) upper girls (86 subjects age 10 to 12 years). Refer Figure 1 for statistic descriptive of subjects' demographic.

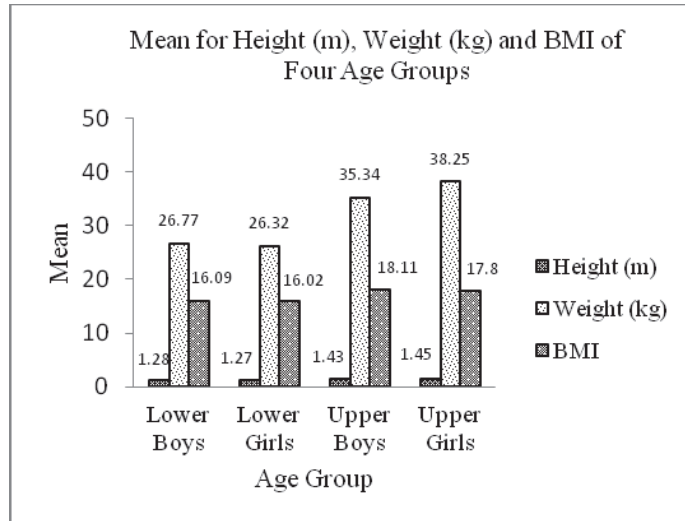


Figure 1. Statistic descriptive of subjects' demographic.

All subjects read and signed an informed consent form approved by the university review board prior to the participation. The parents of all 351 school children were notified by a letter and asked permission for their child's participation in the reliability assessment for dynamic balance control using the 'Y-Balance Test'.

All subjects were self reported to be free of any lower extremity injuries, having normal vestibular function, normal visual function, and normal musculoskeletal function in all joints within six months of participation. Subjects with lower extremity injuries within six months of participation, past history of surgery on lower extremity, history of neurological conditions that affect balance were excluded in this study. The study was approved by the Ethical Committee of the Sultan Idris Education University.

Procedure

A pilot study was conducted on 24 subjects to find out the test-retest reliability of the 'Y-Balance Test' before the actual study was being administrated. A total of 24 primary school children were randomly selected as volunteer. They were boys and girls age ranging from 7 to 12 years old. The test-retest reliability of this pilot study established the ICCs for anterior, posteromedial, and posterolateral were 0.96, 0.96, and 0.98 respectively.

The present reliability study for dynamic balance control using the 'Y-Balance Test' in 7 to 12 years old included test and retest measurements with a minimum of one hour interval. Both the test and retest measurements were performed with two trials by the same researcher,

according to the standardized test-setting mentioned as followed. Children were barefooted for all measurements.

Before performing the 'Y-Balance Test', the children's age and information of involvement in sports were registered. Weight was assessed to the nearest 0.1 kg (weighing scale). Height to the nearest 1 mm was measured using a wall-mounted stadiometer. The 'Y-Balance Test' took place in a discrete room free from external distractions.

The 'Y-Balance Test' was performed with the subject standing barefoot at the center of a grid laid on the floor with three lines extending at 120° increments from the center of the grid. A "Cross Hairs" was drawn at the center of the grid. The length and width of the stance foot were measured and the foot was meticulously placed so that the geometric center of the foot aligned with the intersection of the "Cross Hairs".

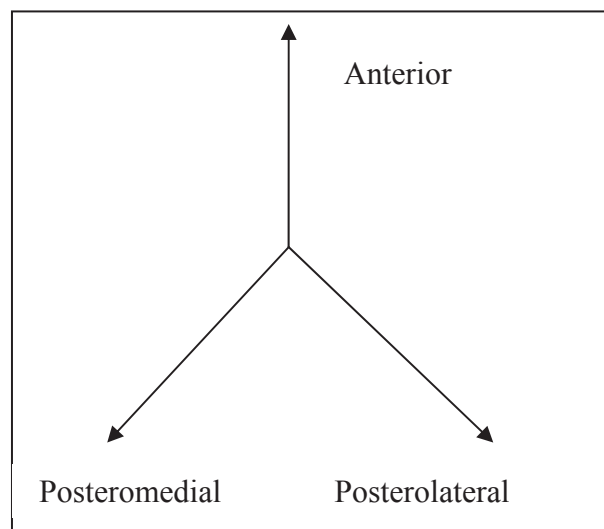


Figure 2. The three directions of 'Y-Balance Test' for left and right leg stances.

Each subject performed a practice trial in each of the three directions on each leg before recording began. All subjects began by performing two trials in the three directions. Trials were separated by an hour interval. The order of testing was Anterior (AT), Posteromedial (PM), Posterolateral (PL) consequently. After performing all excursions on the initial stance leg, the same protocol was repeated with the contralateral leg serving as the stance leg.

The subject maintained a single leg stance while reaching with the contralateral leg to touch as far as possible along the chosen line. The subject touched the farthest point possible on the line with the most distal part of their reach foot and holds for 10 seconds each direction for three consecutive directions (AT, PM, and PL).

The reach foot touched the farthest point on the line as lightly as possible so that the reach leg did not provide considerable support in maintaining upright posture. The subject then returned to a bilateral stance while maintaining equilibrium.

The examiner marked the point touched along the line and then manually measured the distance (cm) from the center of the grid to the touch point with a tape measure. Trials were discarded and repeated if the examiner felt that the reach foot was used to provide considerable support when touching the ground, or if the subject lifted the stance foot from the center of the grid, or if the subject lost his or her balance at any point in the trial.



Figure 3. Subject performing the three directions excursion test.

Statistical Analysis

Statistical analyses were conducted using Statistic SPSS 19.0 for Windows. The level of statistic significance was set at $p < 0.05$. For each of the three directions of excursion, test-retest reliability was evaluated using the average scores from the first and second trials through the Intraclass Correlation Coefficients (ICCs), with 95% confidence interval. The ICC values were interpreted according to the general guidelines of Fleiss (1986), that is, ICCs $> .75$ was labelled as 'excellent', $> .40$ as 'fair to good', and $\leq .40$ as 'poor'.

Results

The study findings were reported using ICCs, representing test-retest reliability for the use of 'Y-Balance Test' in measuring dynamic balance on 351 primary school children in Malaysia. The results for all three tests variations are shown in Table 1. For this study, the Intraclass Correlation Coefficients (ICCs) indicated 0.98, 0.98, and 0.99 on directions of anterior, posteromedial and posterolateral respectively. For all three tests variations, ICCs showed excellent test-retest reliability.

Table 1. Test-retest Reliability for Y-Balance Test.

Test Variation	ICC	95% Confidence Interval
Anterior	0.983	0.978-0.986
Posteromedial	0.981	0.977-0.985
Posterolateral	0.993	0.991-0.994

Discussion and Conclusion

The aim of the present study was to determine the test-retest reliability of the 'Y-Balance Test' as dynamic balance control testing in Malaysian primary school children age ranging from 7 to 12 years old. The study finding reported ICCs for test-retest reliability ranged from 0.981 to 0.993 for all three directions. These results indicate that the estimates of test-retest reliability of the 'Y-Balance Test' were excellent for all three directions.

The present study found that the 'Y-Balance Test' has excellent test-retest reliability in measuring dynamic balance control in Malaysian primary school children, age ranging from 7-12 years old. The finding of present study supported study of Plisky et al., (2006), reporting that the 'Y-Balance Test' obtained excellent reliability to be utilized for measuring dynamic balance control for primary school children. In this study, 351 primary school children were recruited from 13 primary schools which were randomly selected among 971 primary schools in Perak State, Malaysia. They did not have any specific background in balance testing or training.

In conclusion, the present study indicated excellent test-retest reliability of the 'Y-Balance Test' to be used as dynamic balance control measure. Therefore, the researchers are confident to use the 'Y-Balance Test' to measure dynamic balance ability of primary or elementary school children aged 7 to 12 years old. In general, children with high dynamic balance ability are believed could outperform in sports, games and other related physical activities. Thus, it is suggested that the 'Y-Balance Test' can be used for sport talent identification for primary school children age ranging from 7 to 12 years old.

References

1. Balogun, J.A., Ajayi, L.O., Alawale F. (1997) Determinants of single limb stance balance performance. *Afr J Med Med Sci*, 26: 153-7.
2. Bressel, E., Yonker, J. C., Kras, J., & Heath, E. M. (2007). Comparison of static and dynamic balance in female collegiate soccer, basketball, and gymnastics athletes. *Journal of Athletic Training*, 42(1), 42-46.
3. Brouwer B, Culham EG, Liston RA, Grant T (1998) Normal variability of postural measures: implications for the reliability of relative balance performance outcomes. *Scand J Rehabil Med* 30:131-137.
4. Cimbiz, A., & Bayazit, V. (2004). Evaluation of balance and muscle strength in physical education students with recovered lower limb injuries. *Journal of Back & Musculoskeletal Rehabilitation*, 17(3/4), 111-116.
5. Davlin-Pater, C. (2010). The Effects of Visual Information and Perceptual Style on Static and Dynamic Balance. *Motor Control*, 14(3), 362-370.
6. Fleiss JL. (1986) Analysis of data from multiclinic trials. *Control Clin Trials* 7:267-275.
7. Fujinaga, H. (2008). Static standing balance as a component of motor fitness among the 5-year-old children. *International Journal of Fitness*, 4(2), 67-74.
8. Gribble, P. A., Robinson, R. H., Hertel, J., & Denegar, C. R. (2009). The Effects of Gender and Fatigue on Dynamic Postural Control. *Journal of Sport Rehabilitation*, 18(2), 240-257.
9. Gribble, P. P. (2003). The Star Excursion Balance Test as a measurement tool. *Athletic Therapy Today*, 8(2), 46-47.
10. Gribble, P. A., Tucker, W., & White, P.A. (2007). Time-of-Day influences on static and dynamic postural control. *Journal of Athletic Training*, 42(1), 35-41.
11. Hertel, J., Miller, S., & Denegar, C. (2000). Intratester and intertester reliability during the Star Excursion Balance Test. *Journal of Sport Rehabilitation*, 9(2), 104-116.

12. Hertel, J., Gay, M., & Denegar, C. (2002). Differences in postural control during single leg stance among healthy individuals with different foot types. *Journal of Athletic Training, 37*(2), 129–132.
13. Hertel J, Braham RA, Hale SA, Olmsted-Kramer LC (2006) Simplifying the star excursion balance test: analyses of subjects with and without chronic ankle instability. *J Orthop Sports Phys Ther 36*:131–137.
14. Kahle, N. L., & Gribble, P. A. (2009). Core stability training in dynamic balance testing among young, healthy adults. *Athletic Training & Sports Health Care: The Journal for The Practicing Clinician, 1*(2), 65-73.
15. Karen, J.M., Bridget, J.M., Julie R.S. (2009), Gender and age affect balance performance in primary school-aged children, *Journal of Science and Medicine in Sport 14*: 243-248.
16. Kinzey, S., & Armstrong, C. (1998). The reliability of the Star-Excursion test in assessing dynamic balance. *Journal of Orthopedic and Sport Physical Therapy, 27*, 356–360.
17. Kochanowicz K., Kucharska E. (2006) Accuracy of body balance assessment factors in children aged 11 to 13. *Rocznik Naukowy, AWFiS Gdansk, 16*: 89-94.
18. Kochanowicz, K., & Kucharska, E. (2010). Body balance in children aged 11-13 years and the process of Physical Education. *Polish Journal of Sport & Tourism, 17*(2), 87-91.
19. Maciaszek, J., Osiński, W., & Szeklicki, R. (2006). Age, BMI, psychomotor and functional fitness as determinants of static and dynamic balance in elderly men with osteopenia or osteoporosis. *Studies in Physical Culture & Tourism, 13*(1), 25-32.
20. Nashner, L. (1994). Evaluation of postural stability, movement, and control. In: Hasson S, Ed. *Clinical Exercise Physiology*. Philadelphia: CV Mosby.
21. Norris, B., & Trudelle-Jackson, E. (2011). Hip and thigh muscle activation during the Star Excursion Balance Test. *Journal of Sport Rehabilitation, 20*(4), 428-441.
22. Olmsted, L. C., Carcia, C. R., Hertel, J., & Shultz, S. J. (2002). Efficacy of the Star Excursion Balance Test in detecting reach deficits in subjects with chronic ankle instability. *Journal of Athletic Training, 37*(4), 501–506.
23. Olmsted, L. C., & Hertel, J. (2004). Influence of foot type and orthotics on static and dynamic postural control. *Journal of Sport Rehabilitation, 13*(1), 54-66.
24. Onigbinde, A., Awotidebe, T., & Awosika, H. (2009). Effect of 6 weeks wobble board exercises on static and dynamic balance of stroke survivors. *Technology & Health Care, 17*(5/6), 387-392. doi:10.3233/THC-2009-0559.
25. Plisky P.J., Rauh MJ, Kaminski T.W., Underwood F.B. (2006) Star excursion balance test as a predictor of lower extremity injury in high. school basketball players. *J Orthop Sports Phys Ther 36*:911–919.
26. Riach C, Starkes J. (1994) Velocity of centre of pressure excursions as an indicator of postural control systems in children. *Gait Posture 2*: 167-172.
27. Rival C, Ceyte H, Oliver I. (2005) Development changes of static standing balance in children. *Neurosci Lett 376*: 133-136.