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Research article

Effects of Agility Ladder Drills on Dynamic Balance of Children

Heng Choon Meng*, Jeffrey Low Fook Lee, PhD
Faculty of Sports Science and Coaching, Sultan Idris Education University

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Abstract
*Journal of Sports Science and Physical Education 2(*1): 68–75, 2014 - The purpose of the study was to examine the effect of the agility ladder drills in improving the dynamic balance ability of school children. Eighteen primary school male participants were assigned randomly into an experimental and control group respectively. The experimental group practiced the agility ladder drill activities for four weeks (three time a week) after school whereas the control group adhered to their normal daily routine without any intervention. Pre and post tests on dynamic balance were administered using the Star Excursion Balance Test (SEBT). Statistical analyses using 2 group vs 3 tests ANOVA with repeated measures on the second factor showed no main effects between groups and tests. However, there was a significant interaction between group and test. The experimental group improved their dynamic balance score from pre- to post-test compared to the control group although no significant improvements were observed in the retention test. Agility ladder drills provide an additional approach to improve the dynamic balance of young children.

Keywords: Agility ladder, dynamic balance, Star Balance Excursion Test

Introduction

Most of human movements require continual change in posture to accommodate the changes in the body's center of gravity while performing daily activities (Mickle, Munro, & Steele, 2011). These movements are dynamic balance which is described as the ability to maintain a stable position while performing a task that requires movement (Ricotti, 2011). Dynamic balance is more important than static balance in term of injury prevention and it enhances a child's ability to participate in variety of sports that involve movements (Claxton, Troy & Dupree, 2006). The better the ability of dynamic balance of children, the lower the chances of them obtaining injuries and subsequently higher better participation in a variety of physical activities.

Although activities like dancing may enhance balance as the study on female dancers performed more variability direction of movements compared with active non-dancers (e.g., Ambegaonkar, Caswell, Winchester, Shimokochi, Cortes, & Caswell, 2013). However, dancing may not consistently be better than physical activity in improving balance. The scores collected in the Balance Error Scoring System (BESS) of the dancers ware compared with the BESS scores of the previous research of balance in athletes as conducted by Bressel, Yonker, Kras, and Heath, (2007), the scores of dancers were not better than the athletes.

Ambegaonkar and colleagues (2013) argued that the dancers participated in the study were primarily modern dancers who performed more dynamic balance as well as physical activities athletes. As BESS primarily examined the static components of balances which required participants to maintain static positions. Yet the scores of dancers and athletes were mostly similar.

Dynamic balance has been investigated in various adult populations, such as the comparisons among athletes (Bressel, et al., 2007) and adults with pathologies (Basnett, Hanish, Wheeler, Miriovsky, Danielson, Barr, & Grindstaff, 2013). Although numerous researchers have studied ways to improve the dynamic balance of children with deafness (Fotiadou et al, 2002), lower body disabilities (Basnett et al, 2013) and athletes (Bressel et al., 2007), few studies have examined the kind of interventions that might be most effective in improving the balance skills of normal school children.

Agility ladder drills is a ladder-like training equipment which is placed on the floor to improve the athletes' foot and movements ability to change direction of the body rapidly (Robinson & Owens, 2004). It was widely used as tool to improve the speed and agility for intermittent dynamic type of sports like soccer and basketball (Bloomfield, Polman, O'Donoghue & McNaughton, 2007). Agility ladder drills are also used for basketball not only to improve agility, but also to improve the balance and reaction time of the players (MacKay, 2009). Brown (2000) suggested that training to improve the conditioning for speed, agility and quickness, these training apparatus also improved the motor coordination, acceleration, balance and reaction. Reviews by DiStefana, Clark, and Padua (2009) suggested that balance can be improved in a healthy population and should be incorporated in future rehabilitation and injury prevention programme. However, few researches investigated the influence of different sport activities on the static and dynamic balance of children (Ricotti, 2011). Therefore, this study attempts to examine the effects of the agility ladder drills on improving the dynamic balance of young children.

Method

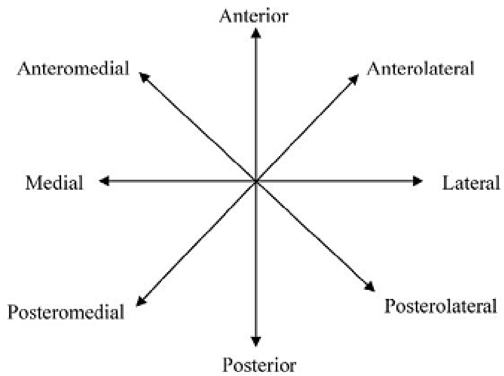
Participants

Eighteen male participants (age 8.8 ± 0.4 years) from a primary school voluntarily participated in the study. Participants were screened for any lower extremity injuries and have no history of hip, knee or ankle injury. Nine participants were assigned randomly into an experimental and control group respectively. All guardians of the participants gave written informed consent for their children to participate in the study.

Protocol

Dynamic balance of participants was tested using the Star Excursion Balance Test (SEBT) with the interclass correlation coefficients ranging from 0.67 to 0.87 (Gribble, Kelly, Refshauge & Hiller, 2013). The SEBT was performed as described by Gribble and colleagues' study (2013). Participants stood in the middle of grid laid on the floor with 8 lines extending 45° angles respectively from the centre of the grid, each of which was labelled according to the direction of excursion in relation to the standing leg as shown in Figure 1.

Figure 1: Illustration of Star Balance Excursion Test (SEBT) Directions. Adapted from Bressel, Yonker, Kras, and Heath, (2007).



Participants undertook the testing barefooted, foot position was controlled by aligning the heel positioned on the intersecting lines at the centre of the grid and great toe with the anteriorly projected line. Simultaneously standing on a single limb and keeping hands on the hips, participants were asked to maintain a single-leg stance on the test leg whilst extending the opposite leg to touch as far as possible along the chosen line with the most distal part of their foot. The foot was only allowed to touch lightly, without shifting weight or coming to rest on the foot of reaching limb. Participants then returned to the bilateral stance. The point at which the participant touched was marked by the examiner and measured manually using a measuring tape (Mitco, Awesome Hardware, China) to the nearest 0.5 cm and recorded from the centre of the grid to the reach mark for each of the directions. The researcher measured all participants, and the marks were erased after each trial.

The participants' dominant leg was determined according to which leg was used in the test of kicking a ball through a goal (Hardy et al, 2008). The test was modified to kicking a ball through a 1-m height and wide goal using a single kick while standing 5 m from the goal. The leg used to kick the ball was determined to be dominant (Hardy et al., 2008). The non-dominant leg was used as the reach leg when collecting the data. The more powerful dominant leg stands at the centre of the grid to establish a stable base of support. In addition, the non-dominant leg length was measured to normalize the reach distances ([reach distances/leg length] ×100%).

The order of the directional reaches of the reach limb followed the sequences of anterior, anteromedial, medial, posteromedial, posterior, posterolateral, lateral and anterolateral (Figure 1). At the commencement of the balance test, the reach limb had to continue for each directional reach without rest, until all eight directions were completed for each attempt. After a successful attempt, participants rested for approximately 15 seconds before the next attempt (Hardy, Huxel, Brucker & Nesser, 2008; Gribble et al., 2013). Each participant completed four practice attempts and three data collection attempts for each directional reach.

Mis-attempts were operationally defined if any of the following behaviours occurred: (1) participants placed more body weight than a light touch on the reach leg to stop the body from falling in that direction, (2) the reach leg came to rest on ground, (3) the stance leg's moved from the center of the grid, (4) the reach leg could not be returned to the centre of the grid under control as subjectively determined by the researcher (Hardy et al., 2008). Maximum of 2 mis- attempts were allowed during data collection. However, all participants tested were able to perform the SEBT, and no participants were excluded from the study due to mis-attempts or absent of training.

Intervention

The experimental group underwent four weeks of agility ladder drills three times a week. Each type of training was repeated twice (refer to Appendix 1). The training sessions were conducted after school hours. The ladder was specifically made with the measurement of 4.5 meter long and 0.5 meter of wide by following the standard ladder drill measurement with 0.3 meters between rung.

Measurement

Only the best of three measurements were recorded for each directional reach. Each participant was measured his leg length, from the anterior superior iliac spine to the center of the medial malleolus of the ipsilateral leg. The measurement in centimeter (Power Tape, HuaXing, China) was taken while the participants lay supine on a flat table. The leg length was used to normalise the reach distances by dividing the distance reached by leg length then multiplied by 100 (Hardy et al, 2008; Munro & Herrington, 2010; Gribble et al, 2013) so that treatment effects could be compared among participants. Then, a composite reach score was obtained by taking the average of all the normalised reach scores ([Sum of Normalized 8 directional scores / 8]).

Statistical Analysis

A 2 group vs 3 tests ANOVA with repeated measures on the second factor was used to determine the effects of pretest-posttest and the differences of control and experimental group after the intervention. SPSS for Windows (version 17.0) was used to calculate the measurements and the significance level was set at $P<0.05$.

Results

Two way Analysis of Variance revealed no significant differences in the between subject effects ($F_{(1,16)} = 0.9$, $P > 0.05$). The within-subject effects was also not significant ($F_{(2,16)} = 2.6$, $P > 0.05$). However, there was a significant interaction between test and participant was significant ($F_{(2,16)} = 3.7$, $P = 0.035$).

Table 1 showed the mean (M) and standard deviation (SD) of pre-, post- and retention-tests scores of the dynamic balance test for experimental group and control group. After four weeks of intervention, the experimental group displayed improvement of dynamic balance in reach distance (% leg length) compare with the control group. After five days, retention test scores were measured and the experimental group remained better dynamic balance compared to the control group. From Table 1, the dynamic balance of experimental group improved but not significantly. Results interaction of the experimental group and control group in the pre, post and retention test as displayed in Figure 2.

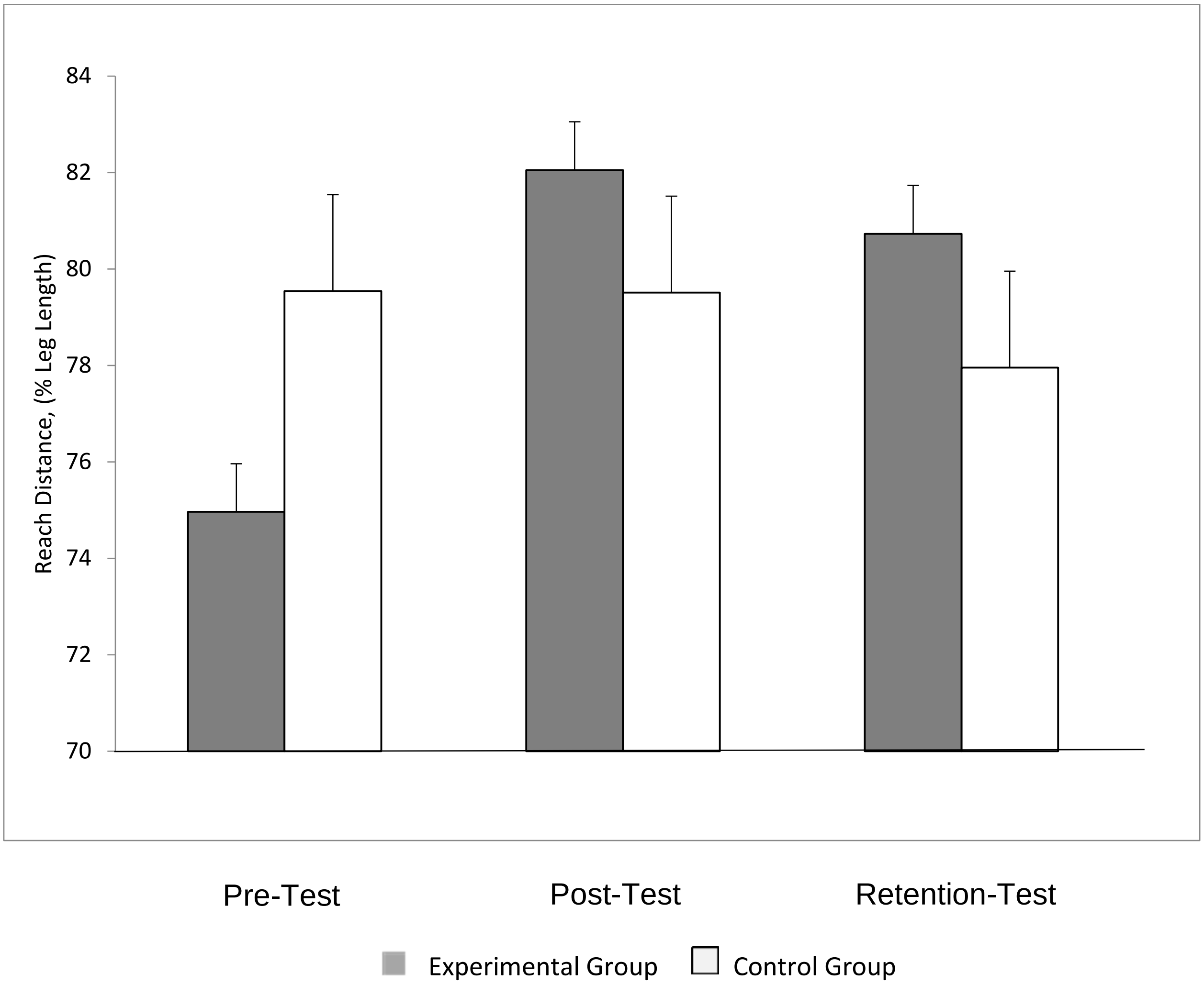
Table 1: The Reach Distances (% Leg Length) Between Pre-test, Post-test and Retention-test of Dynamic Balance for experimental group and control group

	Group	Mean	Std. Deviation
Pre-Test	Control	79.54	6.67
	Experimental	74.96	8.57
Post-Test	Control	79.51	6.63
	Experimental	82.05	7.84
Retention-Test	Control	77.95	10.32
	Experimental	80.73	10.89

<u>Note</u>s

The mean and standard deviation (in normalized reach scores, % leg length) of the pre-test, post-test and retention test of both experimental and control group.

Figure 2: Reach Distances (% Leg Length) Between Pre-test, Post-test and Retention-test of Dynamic Balance.



Discussion

The purpose of this study was to examine the effectiveness of agility ladder drills in improving the dynamic balance of young children. The results showed the performance of the experimental group improved compared to the control group in the study although not significantly. The non-significant difference could be due to the relatively small sample size and the intervention period insufficient to elicit a significant effect. The dynamic ability of the experimental group still remained high even in the retention test. This shows agility ladder drills could be used as a tool to improve dynamic balance of children.

As Brown (2000) suggested that training improved speed, agility and quickness, the training also improved coordination, acceleration, balance and response time. Dynamic balance requires both base of support and human movements requires continual change or adjustment to suit the change (Claxton, Troy, & Dupree, 2006). When performing the agility ladder drills, the participants kept on shifting their foot to different directions quickly (MacKay, 2009) and this helped the participants in controlling their stance dynamically to gain balance. These movements are suggested to improve their balance dynamically apart from their agility.

Ambegaonkar et al., (2013) suggested that dancing might also improve dynamic balance as well as physically activities. Both activities needed lower body strength and flexibility for body balance control as the movements of powerful legs, arms, and torso were needed to reposition the body to prevent falling (Claxton et al, 2006). Agility ladder drills performed the same purposes of preventing fall as it required high ability to change body parts rapidly (Robinson, & Owens, 2004) to keep balance. The agility ladder drills improved the muscles strength of ankles and hip that helped the body maintained postural stability (Ricotti, 2011).

Most of the dynamic balance studies were investigated using adult populations. This study attempted to examine the ability on children. More explanation and extra demonstration of performing the SEBT is needed for the participants as they easily made errors during the trial testing. Besides, the measurements were taken in the after school session. Somehow the pupils were tired and some participants were needed to be persuaded to participate actively. A simpler usage of measurement tools for children such as the balance board so that children easier to understand the testing protocol and performed the test.

Future research could examine more specifically the changes in dynamic balance between gender and across sections of the primary school children. In this study, the improvement of dynamic balance in experimental group was not profound. DiStefana et al., (2009) reviewed and concluded that four weeks of balance training was sufficient for improving both static and dynamic balances. However, the participants in the reviews were adults. As this study focused on children and might need longer period of intervention so that improvements could be observed.

This study showed that the dynamic balance could be trained using agility ladder drills. The findings indicated the agility ladder drills intervention were able to increase the dynamic balance of children. The scores of the SEBT of experimental group in the post test and retention test were higher compared with control group. Although dynamic balance could be improved by specific balance training programme, but the agility ladder drills also could be utilised as an additional approach to improve dynamic balance of children.

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Heng Choon Meng
Faculty of Sports Science and Coaching,
Universiti Pendidikan Sultan Idris (UPSI),
35900 Tanjung Malim, Perak, Malaysia.

Appendix 1

Table 1

Four weeks of agility ladder drills intervention

Types	Repetition
One Two (Left)	2
One Two (Right)	2
In-In-Out-Out	2
Double In Out	2
Ski Jump (Left)	2
Ski Jump (Right)	2
Jump Left Jump Right	2
Jump Right Jump Left	2
One Foot Slalom (Left)	2
One Foot Slalom (Right)	2
Icky Shuffle Both Feet (Left)	2
Icky Shuffle Both Feet (Right)	2

Note. Intervention activities were performed three times a week.