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Comparison of the effect of balance training methods of core stability, plyometrics and their combination on static and dynamic balance in female futsal players

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ABSTRACT

This study aimed to compare the effect of balance training methods including core stability, plyometrics and their combination on static and dynamic balance in female futsal players. To this end, a number of 60 female futsal players from Shahrekord city were selected as the participants using purposive sampling method. Then the subjects were randomly assigned into four groups each with 15 members including three experimental groups (core stability training (N=15), plyometric training (N=15) and combination training (N=15)) and a control group (N=15). Height, weight and leg length were measured in the subjects. In the pretest, the subjects performed Stork Test and Star Excursion Balance Test (SEBT) to examine their static and dynamic balance performance, respectively. Based on the training protocol, the experimental groups did 8 weeks of their assigned exercise training. The training sessions were held three times a week and 45 minutes per session. The control subjects performed their routine trainings. After eight weeks, all variables were measured in the four groups again. Paired t test was run for within-group comparison, and one-way ANOVA was used for between-group comparison. The results showed that combination training group achieved the best performance in both static and dynamic balance comparing with other groups. Based on the present findings, it can be concluded that a combination of core stability and plyometric exercises may improve static and dynamic balance in female futsal players. Thus, it is recommended that these exercises be included in training programs for futsal players.

Introduction

Among sports, association football is one of the most popular contact sports due to its particular attractiveness. It is one of the popular sports among Iranian men and women. Still, Iranian women tend to play futsal mostly due to scarcity of athletic fields for women (Barani et al., 2009). Two types of risk factors are involved in sport-related injuries including internal and external risk factors. Physical characteristics including balance are one of the internal risk factors. Sudden motions in sports events would dislocate the center of gravity of the human body to outside the base of support. In order to avoid fall and loss of balance, the center of gravity of the body should be restored to inside the base of support through postural adjustment. Balance, that can be either dynamic or static, is the body's ability to maintain its stability in response to the forces that disturb its structural balance. Most sports activities require balance so that a lack of balance can impair optimal sports performance (Farhadi, 2012). Observations have shown that 26% of youths receive injuries mostly in their lower extremity during sports events, which require medical care. Such injuries can cause lifelong complications since ankle and knee injuries may increase the risk of osteoarthritis in old age. Besides, many athletes have to abandon their career due to injuries, which can affect the prevalence of diseases and fatality rate in the long run (Farhadi, 2012). Balance is used as part of injury prevention programs. In the event of injuries, good balance helps the individual have a faster recovery so that balance training is considered as one of the treatment components (Delahunt et al., 2007).

Plyometric exercises are one of the effective methods used to increase athletes' speed, balance and strength. Plyometrics is not a new idea, thought or concept; rather it has long been used to advance athletic and task performance. However, special attention has been given to plyometrics recently. Plyometrics were introduced by USSR scientists and were applied since 1960. Plyometric exercises are developed to resemble the activities done in a certain sport or task so as to advance the way that sport or activity is done. Like other exercises, technique is the key to performance in plyometric exercises. Landing is the most important part of the tasks in these exercises (Khosh Nezhad, 2008). Core stability or core muscle strengthening is one of the new topics in sports medicine. Popular health programs such as Pilates, Tai Chi and Yoga follow the principles of core strengthening. Core stability has enormous advantages that include improved athletic performance, prevention of injuries and reduced backache.

Core is considered as a muscular box that has abdominals in the front, paraspinals and gluteals in the back, diaphragm on the top and pelvic floor and hip girdle muscles on the bottom. There are 29 pairs of muscles in this box that facilitate the stability of spine, pelvis and functional movement chain. Without these muscles, spine would become mechanically unstable and crush under as small loads as 90 Newton that is smaller than the weight of upper extremity. When this system functions properly, it helps distribute and maximize force

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production with minimal compressive, transmission and shear forces in the movement chain joints. Core stability is important in sports in that it provides for stability in upper extremity in order to perform movements in lower extremity (Letafat Kar & Abdul Vahabi, 2010). The term 'core' generally refers to trunk and specifically denotes lumbar-pelvic region. The stability of lumbar-pelvic region is necessary to provide a base for upper and lower extremity movements, absorption of internal and external loads and support of spinal cord and nerve roots. Considering the above discussion and the fact that balance is a key factor in causing sport-induced injuries, the researcher aims to compare the effect of core stability exercises, plyometric exercises and their combination on improvement of static and dynamic balance in female futsal players.

Methodology

A number of 70 female futsal players aged 18-24 years from Sharekord city volunteered to participate in the study. They practiced 4 sessions per week, 90 minutes per session. The volunteers who had a history of injuries in the head, lower extremity, the inner ear and eyes for the last six months were excluded from the study. Finally, 60 subjects (Age=20.885 yrs, Height=163.9825 cm, Weight=62.849 kg) were selected as the participants and assigned into four groups including three experimental groups (core stability training (N=15), plyometric training (N=15) and combination training (N=15)) and a control group (N=15). Before the study was started, the subjects were informed of the research objectives, design, training protocols and instruments. Then they signed an informed consent form. The subjects were asked to participate in training sessions based on the designed schedule and to perform the tests as required. In the first session, height, weight and leg length were measured in the subjects. Leg length was measured from the anterior superior iliac spine to the medial malleolus in order to normalize dynamic balance data. In the pretest, the subjects performed Stork Test and SEBT to measure static and dynamic balance, respectively. The three training groups (core stability, plyometric and combination training) did 8 weeks of exercise training. The training sessions were held three times a week and 45 minutes per session. The control subjects performed their routine trainings, though. After eight weeks of exercise training, measurements of static and dynamic balance were made of all groups in the posttest.

Instruments

Star Excursion Balance Test (SEBT) is a simple method to assess dynamic postural control in people. Introduced by Gary(2000), SEBT is a network comprising of eight lines in different directions that are separated by an angle of 45^0. The test taker should stand on the center of the network with one support leg and use the other leg to reach as far as possible in eight different directions. SEBT is a simple, reliable and inexpensive alternative for expensive instruments. The eight directions are named based on the status of the respective line to the support leg, which include anterior (A), anteromedial (AM), medial (M), posteromedial (PM), posterior (P), posterolateral (PL), lateral (L) and anterolateral (AL). The lines are drawn using athletic tape on a non-glassy surface. The test taker should stretch his leg six times in each direction while the larger amount is recorded for every direction. In every leg stray during every attempt, the test taker should maintain his leg stretched in the respective direction in order for the measurement to be recorded. Every stretch attempt is measured from the center of star, and the mean score of three attempts divided by the test taker's height is normalized with the actual leg length. Another method to normalize the measurements is to sum up the mean scores of measurements in every direction and multiply them by the test taker's height. This method, however, does not allow the tester to identify a loss of dynamic postural control. Nevertheless, it provides a simple method to compare dynamic postural control among different individuals. The larger the stray is, the greater the need for dynamic postural control of the reaching leg is. After every attempt, the test taker should return to the static standing stance on the support leg for 10 to 15 seconds before making the next attempt. Plisky et al. (2006) reported the inter-rater reliability of SEBT to be between 0.78 and 0.96.

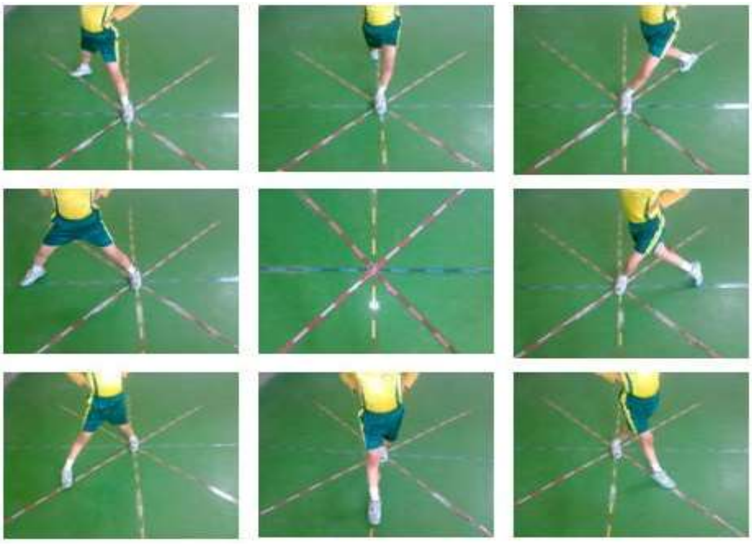

Figure 1. Star test in eight directions

Stork Test is used to assess static balance. The test has shown good reliability with both open and closed eyes, good inter-rater reliability (r=0.87- 0.99) and test-retest reliability ranging from poor to good (r=0.59 - 1). Moreover, good test-retest reliability is reported for the static balance time for both children and adults in Stork Test. In this test, learning effect is assumed to occur if the repetition is made more than three times. In order to assess static balance, the test taker should touch his hip with both hands on either side while the leg on the tested side is raised and flexed at 90^0 so that the sole touches the interior of the contralateral leg. The test taker should maintain this standing position on the support leg while the foot is raised off the ground.

Figure 2. Stork Test

The attempt is over when the heel of the support foot touches the ground or hands are separated from the hip or the sole of the lifted foot separate from the support knee. During the test, the test taker should look at a sign before his face at a four-meter distance. Every test taker should make three attempts while the best time is recorded as his test score. The test can also be taken with the eyes closed. Before the measurement is taken, the testee is taught how to perform the test. Afterwards, the testee practices the test three times with 15 seconds interval between each attempt in order to alleviate the learning effect. During the test, timing begins right after the support heel is raised from the ground. Timing is made using a chronometer and is stopped when the test status is disturbed. After three attempts, the best time is reordered as the test score.

Paired t test was run to do within-group comparison and one-way ANOVA was used for between-group comparison. Tukey's test was used to compare the groups. The level of significance was considered to be $\alpha=0.05$. Statistical analysis was conducted using SPSS16.

Results

One-way ANOVA was used to analyze the static balance data. The results confirmed the significance of the main effect of group ($F=95.501$, $P\leq0.05$). Post hoc Tukey's test was run to determine what training protocol had a greater effect on static balance and to find the locus of difference. The results showed that the difference in mean scores was significant in all experimental groups pairwise. Based on the mean difference table, the largest difference in mean score was in the combination training, core stability, plyometric and control groups, respectively. Core stability and plyometric groups had respectively the largest mean difference with the control group. Core stability group had the second largest mean difference with plyometric group (Table 1).

Table 1. Results of post hoc Tukey's test

	Groups	Mean difference	P
Control group	Core stability	*2.65333	0.000
	Plyometric	*1.64000	0.000
	Combination	*5.17333	0.000
Core stability group	Plyometric	1.01333	0.011
	Combination	*2.52000	0.000
Plyometric group	Combination	*3.53333	0.000

Effect of training on SEBT

One-way ANOVA was run to analyze the dynamic balance data in the eight directions. The results revealed a significant difference among core stability, plyometric, combination and control groups in anterior ($F=94.974$, $P\leq0.05$), anteromedial ($F=32.753$, $P\leq0.05$), medial ($F=6.6$, $P\leq0.05$), posteromedial ($F=19.745$, $P\leq0.05$), posterior ($F=9.811$, $P\leq0.05$), posterolateral ($F=5.338$, $P\leq0.05$), lateral ($F=23.998$, $P\leq0.05$) and anterolateral ($F=7.706$, $P\leq0.05$) directions. The results of Tukey's test showed a significant statistical difference between core stability and plyometric groups ($P\leq0.05$), core stability and combination training groups ($P\leq0.05$), core stability and control groups ($P\leq0.05$), plyometric and combination training groups ($P\leq0.05$) and combination training and control groups ($P\leq0.05$). Comparison of the mean scores revealed the reaching distance of dynamic balance in different groups. In this regard, the combination training group had the best performance in all directions followed by plyometric, core stability and control groups.

Discussion and Conclusion

The present study aimed to compare the effect of eight weeks of plyometric, core stability and combination training on dynamic balance performance in female futsal players. In an assessment of the effect of plyometric, core stability and combination training on static balance in female futsal players, the results revealed that each training program could exert a positive effect on static balance in the subjects per se. Though all training protocols could exert a positive effect on static balance in the subjects, combination training was found to have the most significant effect on static balance in the present participants. This is consistent with the findings of Dalvandi Dokhaharani et al. (2013) and Eric and Johnson (2007) on the positive effect of plyometric exercises on static balance. This is also consistent with the findings of Farzaneh Hesari et al. (2011), Mahdavi et al. (2010), Hosseini and Sadeghi (2011), Crapes et al. (2008) and Petrofsky et al. (2005) on the effect of core stability training on static balance. For example, Dalvandi Dokhaharani et al. (2013) reported that eight weeks of plyometric exercises exerted a considerable effect on static and dynamic balance in non-professional female basketball players. The inconsistency between the present and cited findings may refer to differences in the training sessions, participants' gender and type of sport. Considering the mechanism through which plyometric exercises affect balance performance, one should note that plyometrics increase lower extremity strength. Thus, it seems that improved balance performance following plyometric training results from the impact of muscle strength on proprioceptive system as one the systems controlling balance performance (as cited in Chelly, 2010).

With regard to the effect of core stability training on the duration of single leg stance, Barone et al. (2011) noted that it is important in core stability training to train motions rather than muscles so that different muscles work out together. This would improve the function of neuromuscular system for postural control. Furthermore, in anatomical terms, core is a region that accommodates the center of gravity from which the movements originate. Therefore, it seems that core muscle strengthening following core stability training improves the neuromuscular system and decreases the dislocation of the center of gravity from the base of support and its fluctuations. This could increase the duration of standing stance on a given surface.

Clark et al. (2000) asserted that core stability training may strengthen muscles and thus contribute to balance performance and postural control. In addition, in anatomical terms, core is a region that accommodates the center of gravity from which the movements originate. Therefore, it seems that core muscle strengthening following core stability training improves the neuromuscular system and decreases the dislocation of the center of gravity from the base of support and its fluctuations. Besides, core stability training facilitates neuromuscular calling and improves postural control in the people with weaker postural control.

The results showed that core stability, plyometric and combination training programs each exerted a positive effect on dynamic balance in female futsal players. However, combination training had the most significant effect on dynamic balance performance in all directions of SEBT. This is consistent with the findings of Dalvandi Dokhaharani et al. (2013), Sadeghi et al. (2009) and Petushek et al. (2010) who reported the positive effect of plyometrics on dynamic balance. It is also consistent with the findings of Salari et al. (2013), Mohammad Ali Nasab , Hosseini and Sadeghi (2011), Farzaneh Hesari et al. (2011) on the positive effect of core stability exercises on dynamic balance.

Dynamic balance is one of the prerequisites of plyometric exercises where the individual has to maintain his balance during landing. As the exercises become more difficult, maintaining balance requires more struggle. Thus, in performing plyometric exercises, the neuromuscular system is forced to maintain balance, which can contribute to dynamic balance (Khodabakhshi et al., 2012).

Plyometric exercises include eccentric contraction followed by concentric contraction. Therefore, coordination in doing plyometric workout can contribute to balance performance. Considering the activation of sensory receptors following plyometric exercises, these exercises can directly affect brain activity. This further indicates the preparation of motor neurons in a set of muscles and joints to make a motion, adapt it to environmental context, increase the coordination of motor units and co-contraction of muscles and increase the deterrence of antagonist muscle. This would eventually improve neuromuscular responses, which can in turn improve athletic and balance performance (Khodabakhshi et al., 2012).

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