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Effect of Twelve Sessions of Tai Chi Exercise on Static and Dynamic Balance in Young Girls

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ABSTRACT

Background: Tai Chi is Chinese martial art strengthening the performance of individuals. **Objectives**: The purpose of present study is to determine the effect of a Tai Chi exercise period on static and dynamic balance of young girls. **Methods**: For the purpose of this research, 32 young girls were voluntarily selected and randomly divided into two groups: Tai Chi training group (21 subjects; mean ± SD; age 22.05±2.4 weight 53.67±6.3 kg, height 1.60±0.5 m) and control group (11 subjects; mean ± SD; age 23.37±0.9 weight 53.64±7.8 kg, height 1.62±0.4 m) players. Static and dynamic balance were measured using Biodex Balance System SD three days before and after a 12-session training period with similar conditions in terms of time and place (75 minutes each session). **Results**: Mixed repeated measure test showed a significant difference between pre and post-tests in open eye single-foot, closed eye single-foot, open eye two-foot, and closed eye two-foot stances ($p=0.001$). However, no significant difference was revealed in the control group ($p>0.05$). While there was better balance state in all stances of Tai Chi group, no significant difference was observed between the groups in this respect ($p>0.05$). **Conclusions**: The findings of this research indicated the effectiveness of Tai Chi exercises on static and dynamic balance of young girls. Although there was no significant difference in effect of exercise between training and control groups, mean percentage of changes in training group revealed the effectiveness of exercise in training group compared to control. Therefore, Tai Chi exercises can be recommended to treat and prevent injury due to poor balance. We suggested performing Tai Chi more than 12 session in order to enhance it influences.

Key words: Tai Chi, Exercise, Athletic Injuries, Postural Balance

INTRODUCTION

Tai Chi is a type of Chinese martial art involving movements at low rates, gentle rotation of organs, opening and closing joints, and performing movements in weight bearing conditions. Tai Chi exercises put a high emphasis on respiratory techniques, which enhances performance in people (Azimzadeh et al., 2015). Movements of Tai Chi exercise require balance, stability, and movement of joints. Engagement of mind and inhalation is a point highlighting Tai Chi exercises in relation to other sports, so that Chinese philosophers have cited Tai Chi as a type of meditation. These exercises lead to the flow of energy that improves and maintains health. Tai Chi has four specific styles, including Yang, Wu (Hao), Chen, and Sun in descending order of popularity (Caride et al., 2008).

According to studies conducted on the elderly and patients, Tai Chi exercises improve the balance of individuals as well as their reaction time. Balance is a factor needed for all people in the society throughout their life, which is defined as the ability to maintain a condition to perform voluntary activities and to deal with internal and external exposures. In terms of biomechanics, balance is described as the maintenance of center of mass within base of support (Wu, 2002; Yu & Yang, 2012).

It is possible to classify balance into two subsets: static and dynamic. Olmstead et al. (2004) described static balance as maintaining a position with minimal motion and dynamic balance as keeping the stability of body during movement (Olmsted & Hertel, 2004). Disturbances and weaknesses in static and dynamic balance expose the individual to risk of injury. It is required to measure in both static and dynamic balance to exactly identify this modifiable risk factor.

High frequency of injuries among young people during recreational activities, results significant costs for the community health and leading cause of long-term disability for the injured player. Prevention of injury is a complex process, and researchers have to properly identify the risk factors (Daneshjoo et al., 2015). Poor balance is considered as a risk factor for many injuries (Hrysomallis, 2007). The modifiable risk factors, which have the potential to improve through physical training such as balance, are important to investi-

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gate. It is reported that Tai Chi Chun, improved the strength, kinaesthetic sense, and balance between the ages of 20 and 45 years (Jacobson et al., 1997).

A majority of studies on prevention of injury or Tai Chi exercises has been conducted on elderly people, and the young community has not been investigated to date. Hence, to best of our knowledge there is lack of sufficient information on the impact of Tai Chi exercises on balance in open and close eye condition on single and two foot of young girls. Consequently, the goal of this study is to examine the effect of Tai Chi training program on static and dynamic balance of healthy young girls in open and close eye condition.

METHODS

Participants and Design of Study

The design of study was the quasi experimental design and thirty-two healthy girls voluntaries to participated in this study. Participants randomly divided into Tai Chi group (No= 21) (mean ± SD; age 22.05±2.4 weight 53.67±6.3 kg, height 1.60±0.5 m) and control group (No=11) players (mean ± SD; age 23.37±0.9 weight 53.64±7.8 kg, height 1.62±0.4 m). No significant differences were found between groups in age (p=0.122, t=1.638). Participants were informed about the research they would undergo and their written consent was obtained. The study was approved by the ethical committee of the Institute of Research Management and Monitoring, Shahid Bahonar University of Kerman and the Sports Science Research Committee.

The participation inclusion criteria included; had no previous experience using Biodex Balance System, lower limb injury, balance disorder, neurological or vestibular impairment and were free of pain at the time of study. Prior starting the test session, all the players participated in familiarization sessions with balance tests and all procedures were explained to each participant.

Procedure

All participants performed both the single-leg stability test (SLST) and double leg stability test (DLST) with eyes open and closed. All tests were executed in randomized order. Verbal instructions for all tests were provided to each participant. All participants performed the trials barefooted following a 10-min general warm-up which comprised of dynamic exercises before the test began. We asked all participants to maintain similar eating habits and sleeping patterns. All tests were performed in quiet laboratory place.

Tai Chi Exercise Protocol

All the intervention sessions of Tai Chi were monitored by one of the researchers to ensure their compliance with the training. Verbal encouragements were given throughout the training session to help the participants concentrate on the quality of their training.

The participants performed 12 sessions Tai Chi exercises. Before starting intervention, participants perform 15-minute dynamic warm-up such as calf, quadricep, hamstring, hip, shoulder muscles. Each session of Tai Chi takes approximately 45 minutes to complete and participants performed 10-minute cooldown. Yung style of Tai Chi was chosen for this study. Tai Chi exercise was performed during 12 weeks based on overloaded principle in a way that 24 form was performed in 11 session.

Control Group

For comparison, the control group was requested to continue with their routine living. Moreover, prior the commencement of the research, the participants in the control group was promised that they would receive the intervention training after finish this study. Participants in the control group were supervised closely not to perform any exercises that would contaminate our research' results.

Balance Test

A Biodex Balance System (BBS) (New York, USA) was used to assess the single and double leg balance tests. The Biodex balance System has been shown to be a reliable instrument from 0.65 to 0.85 ICC (intraclass correlation coefficient) values for collecting balance data in humans (Arifin et al. 2014). The static balance measures recorded on BBS in level 12 without any sway.

Three measures of postural stability include overall stability index (OSI), anterior-posterior stability index (APSI) and medial-lateral stability index (MLSI). These indices indicate the standard deviation that assesses the sway from origin point of the platform. All the stability indices were recorded in degrees.

For the ASLT in BBS, the participants were asked to stand still on the BBS platform with their arms crossed over their chest. They were asked to maintain their visual focus on the display screen with dominant leg standing (the leg which preferred for ball kicking), while the other leg was held slightly 90° flexed. Foot displacement was adjusted until a posture that ease for cursor controlling. The platform was then locked and the foot placement remained static throughout the test. The participants were instructed to maintain the cursor at the origin point for 20s with 10s rest between them. The participants were prohibited from resting their non-supporting limb during the test. Three trials were performed for each condition and a 2-min of rest period between each condition was allowed. This test was performed in eyes open and close with single and double leg. The data for three trials were averaged as score.

Statistical Analysis

The IBM SPSS software (Version 22) was used for all analyses. To compare the balance between times (pre-test, post-test), groups (Tai Chi, control groups) and balance (static vs dynamic) the 2 ×2 ×2 (time vs group vs balance) repeated measures mixed ANOVA was used separately for the single and double leg as described (Akbari et al., 2018). The Kolmogorov-Smirnov (KS) test and Levene's test were em-

ployed for assessing normality of the distribution of scores and homogeneity of variance among groups (p>0.05). The data met the homogeneity test and were normally distributed (p > 0.05). In case of statistical significance, the Bonferroni post-hoc test was conducted to detect the significant pair between groups for each test. The effect sizes of each variable were tested using partial eta (η) squared (0.01=small effect, 0.06=medium effect, and 0.14=large effect) (Pallant, 2007). A significance level was considered at the 95% confidence level for all statistical parameter.

RESULTS

Single Leg Open Eyes

Mixed repeated measure ANOVA showed significant differences between pre and pos-tests ($F_{30,1}$=22.6, p=0.001) with large effect size (0.43). There was a main effect between static and dynamic balance ($F_{30,1}$=16.27, p=0.001) with large effect size (0.35). From the Bonferroni post-hoc test, the analysis revealed significant differences between Tai Chi group in open eye in static balance test (p=0.01) and dynamic balance test (p=0.004). There is no significant difference in control group in any condition (p>0.05). While Tai Chi group was better than control group, but difference was not significant ($F_{30,1}$=0.28, p=0.603).

Single Leg Close Eye

In single leg close eye condition, significant differences were found between pre-test and post-test ($F_{30,1}$=5.96, p=0.021) with large effect size (0.15). The Bonferroni post-hoc test showed significant differences between Tai Chi group in close eye in static balance test (p=0.01). There is no significant difference in control group in any condition (p>0.05). While Tai Chi group was better than control group, but difference was not significant ($F_{30,1}$= 0.87, p=0.357).

Double Leg Open Eye

Mixed repeated measure ANOVA showed significant differences between pre and pos-tests ($F_{30,1}$=6.11, p=0.019) with large effect size (0.16). There was a main effect between static and dynamic balance ($F_{30,1}$=102.18, p=0.001) with large effect size (0.77). The Bonferroni post-hoc test, showed significant differences between Tai Chi group in open eye in dynamic balance test (p=0.007). There was no significant difference in open eye condition (p=0.15). In control group results did not show significant differences in all condition (p>0.05). While Tai Chi group was better than control group, but difference was not significant ($F_{30,1}$= 0.35, p = 0.557).

Double Leg Close Eye

In this condition, results showed significant differences between pre and pos-tests ($F_{30,1}$= 9.49, p = 0.004) with large effect size (0.24). There was a main effect between static and dynamic balance ($F_{30,1}$=16.27, p=0.001) with large effect size (0.35). The Bonferroni post-hoc test revealed significant differences between Tai Chi group in close eye in static balance test (p=0.02). There is no significant difference in control group in any condition (p>0.05). While Tai Chi group was better than control group, but difference was not significant ($F_{30,1}$= 2.20, p = 0.148).

Table 1. Mean ± standard deviation in pre and post-test in Tai Chi and control group

Legend: SLS= single leg static, SLD=single leg dynamic, DLS=double leg static, DLD=double leg dynamic,

DISCUSSION

The findings of this research indicated the effectiveness of Tai Chi exercises on static and dynamic balance of young girls. Although there was no significant difference in effect of exercise between training and control groups, mean percentage of changes in training group revealed the effectiveness of exercise in Tai Chi group compared to control group.

Tai Chi, short for Tai Chi Chun is a kind of Chinese martial art designed to improve health, increase longevity, and cause mental relaxation. Tai Chi is a soft martial art that makes body muscles flexible and strong with gentle and simple exercises. Therefore, Tai Chi exercises are likely to increase and improve the balance in people because of strengthening muscles, causing flexibility and softening of muscles and tendons, concentration of mental relaxation as well as mental and neural enhancement. This exercise can also eliminate mental stress and decentralization, which is a factor that can interfere with balance (Maciaszek et al., 2007).

The slow and soft nature of Tai Chi exercises lead to elevated mental concentration, which greatly contributes to control of composure of the individual in critical situations and during

Table 1. Mean±standard deviation in pre and post-test in Tai Chi and control group

		Tai Chi		Control	
		Pre-test	**Post-test**	**Pre-test**	**Post-test**
Open eye	SLS	0.845±0.18	0.733±0.16	0.873±0.29	0.660±0.11
	SLD	1.192±0.55	0.819±0.37	1.645±0.11	1.620±0.19
	DLS	0.430±0.20	0.350±0.14	0.391±0.11	0.350±0.10
	DLD	0.930±0.36	0.690±0.28	0.818±0.35	0.691±0.26
Close eye	SLS	3.605±1.29	2.460±1.17	3.510±1.23	3.145±0.99
	DLS	1.210±0.53	0.886±0.45	1.450±0.35	1.055±0.58

Legend: SLS= single leg static, SLD=single leg dynamic, DLS=double leg static, DLD=double leg dynamic

nervous pressures; thus, Tai Chi is highly beneficial and essential for young people who are in precarious and stressful situations because of their age (Wolf et al., 2003).

The aim of this study was to investigate the effect of Tai Chi training on static and dynamic balance of young girls. A majority of studies on the effect of Tai Chi training programs has been conducted on the elderly. No research have found examining Tai Chi exercises on young people; therefore, there were limitations for comparison of the results of this study with other studies.

The findings of this research showed a progress in balance of young girls after twelve sessions of Tai Chi exercises in open and close eye stances in static and dynamic states. Data of mean balance scores indicated a significant difference between pre-test and post-test in all stances. These findings demonstrate the effectiveness of Tai Chi exercises on the balance of young people, which can be attributed to increased performance of neuromuscular system, coordination between visual and vestibular systems with deep sensation (stretching movements, gentle opening and closing of joints change hydraulic pressure that in turn stimulates deep-seated receptors).

The present study was consistent with the results of Azimzade and co-worker (2015) that investigating the effect of Tai Chi training on balance of women with MS, which showed that Tai Chi exercise as a complementary therapeutic method had a significant effect on increasing balance of patients with MS after 8 weeks (Azimzadeh et al., 2015). The improvement was considered to reflect the effect of exercises on increased neuromuscular adaptations, improved function of vestibular system and vision as well as enhanced deep sense. In research that investigated the impact of 24-week Tai Chi training on balance of middle-aged men static open eye balance in both single- and two-foot conditions improved. In this research, improved balance resulting from the specific approach of Tai Chi exercises was reported, which affected the individual's mental and physical practices as well as affecting CNS (Yu & Yang, 2012). Another similar research was conducted by Tsang and Hui-Chan (2004) selected 49 elderly people divided them into two groups of control (27 subjects) and exercise (22 subjects). The results showed after 4-week and 8-week of Tai Chi Chuan, the participants significantly better in vestibular ratio, directional control and in the limits of stability test. Their result revealed that even 4 weeks of Tai Chi training are sufficient to improve balance control in the elderly people (Tsang & Hui-Chan, 2004).

Tai Chi contain movements linked together in a rhythmic patterns and puts emphasis to keep a upright posture with continually changing weight from one leg to the other, with a rotations and push-pull movements of extremities (Wong & Lan, 2008). Various degrees of muscle contractions of lower and upper extremities muscles are performed during this sport (Wong & Lan, 2008). Thus, perform joint control and muscle coordination ensure good balance control of the human body.

Precentral gyrus is brain area that is responsible for coordinating of autonomic movements of body muscles, whereas the postcentral gyrus is the important sensory receptive brain region for somatosensory system in the sense of touch. The coordination of timing and the amplitude of muscle reactions to postural perturbations and the abilities of re-establishing sensory inputs and subsequently modify postural responses are two significant aspects of balance control. Improvement of the sensation of touch can thus provide more concise information to the brain in how to react and how to coordinate the muscles for better balance control (Yu et al., 2018). Previous study demonstrated that Tai Chi Chun increase in the cortical thickness of the right precentral which might strength the coordination and planning of movement brain(-Wei, et al., 2014; Wei et al., 2013).

In this study, the progress in balance of exercise group was not to the extent causing a significant difference with the control group. Considering the recruitment of healthy subjects, a shorter training was selected than previous studies on patients or elderly people, which may account for lack of significance between the training and control groups while the balance state in all stances (open and closed eyes, single- and two-foot) was superior in Tai Chi group. Therefore, the shorter period of training can be reported as a reason for lack of significant effect of exercises relative to control group. Also, most studies conducted to date on Tai Chi exercises have focused on elderly community, which can influence the outcome.

CONCLUSION

The present study was the first one to examine the effects of Tai Chi exercises on young girls, which increased our information in this regard. Overly, the findings of this study indicated that Tai Chi exercise was a good way to improve the static and dynamic balance of young healthy girls. Although the effect of training was not significant between control and exercise groups, the average percentage of changes in training group was remarkable, which could indicate the effectiveness of exercises compared to the control group. Regarding the findings and safety of these exercises, Tai Chi training can be suggested as an exercise protocol for treating and preventing injuries caused by poor balance.

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