Original Article

EFFECTS OF DYNAMIC STABILITY TRAINING ON BALANCE IN HEALTHY OLDER ADULTS

Furqan Ahmed Siddiqui[1], Tahir Masood[2]

Abstract

Background: *Balance is very important in maintaining an optimal amount of functional status. With ageing, balance deteriorates leading to higher fall risk and declined overall functional status. The aim of this study was to determine the impact of dynamic stability exercise in improving anticipated balance in healthy older adults.*

Methodology*: Eighteen healthy volunteers were selected via non probability convenient sampling technique, between 50 to 80 years of age for this randomized controlled trial. Both females and males with no major co-morbid conditions and cognitive impairments were recruited and divided into two equal groups (N=9): Dynamic stability training group (DST Group) and Control group (CT Group). DST group received balance training exercises on Biodex Balance System SD, 3 times a week for 8 weeks with each session lasting for 45-60 minutes. CT group was not provided any specific intervention. Data was gathered on demographics and Functional Reach Test (FRT) using a wall mounted meter scale at baseline and after every 2 weeks until end of 8-week training. Difference between groups was evaluated using independent sample t test whereas within-group analysis was done using repeated measure ANOVA.*

Results: *The mean age in DST group was reported as 62.89 ± 6.81 years with gender distribution of 44.4 % (n=4) males and 55.6% (n=5) females. Mean height, weight and BMI were computed as 159.5 ± 6.75 cm, 71.39 ± 5.39 kg and 28.67 ± 2.67 kg/m^2 respectively. Similarly mean age in CT group was reported as 62.89 ± 9.31 years with gender distribution of 33.3% (n=3) males and 66.7% (n=6) females. Mean height, weight and BMI were computed as 158.8 ± 11.55 kg, 77.57 ± 13.84 cm and 30.80 ± 4.54 kg/m^2 respectively. Significant difference (p<0.05) in FRT scores was observed after 8 weeks of intervention between DST group (17.22 ± 2.17) and CT group (14.30 ± 2.98). Within-group analysis showed improvement in DST group (P<0.01) compared to CT Group (P>0.05)as a result of dynamic stability training for 8 weeks.*

Conclusion: *The use of dynamic stability balance system for balance training can significantly improve balance in the elderly. Such training might play a vital role in ensuring functional independence of older individuals.*

Key words: *Anticipatory Balance, Balance training, Dynamic Stability Training, Functional reach, older adults*

Introduction:

Balance is defined as "the ability to maintain the body's center of mass (COM) over its base of support (BOS)"[(1)]. Complex interaction between sensorimotor control system and integrating motor output to muscles is required to maintain balance[(2)]. Through a properly maintained and functioning balance system an individual is able to clearly determine the direction and speed of movement, position of body with reference to gravity and adjust postures automatically. The capability to sustain the body's COM over the BOS during standing, while moving, and in reaction to imminent postural disequilibrium is one of the major goals of balance control[(3)]. In order to maintain posture and perform normal routine activities, it is essential to maintain proper balance control. Balance and posture is very important in geriatric population because there is an overall deterioration in balance control system resulting in increased fall risk. The poor control of posture is significantly related to reduction in mobility, physical performance and elevated fear of falling[(4)].

Mancini et al. stated in their study that 30-65% elderly of age 65 years and above have a few balance problems(1). Similarly Sibley et al. reported that in individuals with 75 years and above, at least 75% have postural stability problems[(5)]. By definition older adults are people of age 65 and above but this cannot be implied to developing 3rd world countries where life expectancy is between 60 to 70 years. So United Nation agreed to give relaxation of this age to a lower limits of 50 or 60 years [(6,7)]. According to an estimate, in Pakistan population of people with age 60 years and above will increase up to 7.3% in 2025 and 12.4% in 2050[(8)].In year 2014 there were 11.17 Million individuals in Pakistan with age of 60 years and above. This number is predicted to increase to 17.53 Million by 2025[(9)].

To restore and maintain balance when perturbed, anticipatory and compensatory postural strategies are used by the central nervous system. Anticipatory control of postural reflect a feed forward mechanism of control wherein a change is seen in muscular background activity before the upcoming perturbation[(10)]. In order to maintain an upright

1. Associate Professor, Foundation University Institute of Rehabilitation sciences (FUIRS)
2. Associate Professor, Isra Institute of rehabilitation Sciences, Isra University Islamabad.

Correspondence:
Furqan Ahmed Siddiqui Associate Dean, Foundation University Institute of Rehabilitation sciences (FUIRS). Foundation University Islamabad.
Email: furqan@fui.edu.pk

posture, there is a need of timely selection of appropriate motor strategy when a threat to balance is sensed which depends on environment and the task to be performed[11,12]. There can be an increase in sway ahead of any movement during dynamic equilibrium. The anticipated postural stability strategies are very important because they bring out the capacity related to anticipatory balance of CNS for perturbations related to upcoming movement[13]. With aging there is delay in these prior adjustments of center of pressure, making it difficult for elderly people to anticipate for the upcoming perturbations during dynamic activities and to counter for its effect, making them behave more in a reactive manner[14]. Proper rehabilitation can result in adjustment and improvement of this anticipatory performance by improving internal predictive model of equilibrium of body for frail geriatric population [15] and in case of normal aging. [16]

Functional reach test (FRT) is one the common tests used for assessment of balance. Because of its simplicity and reliability it is used in measuring an individual's dynamic balance. It is basically assessing the stability limits without external perturbations, analyzing maximum displacement, intentionally, that an individual can reach forward without interference in postural stability.[17]. FRT is an effective method in assessing balance in geriatric population[18]. It is suggested through research that to reduce falls in geriatric population, prophylactic intervention on multiple risks factors of fall is required. These include outpatient balance training and fall risk assessment[19]. In order to increase level of motivation there is need to couple balance exercises with interactive games and visual feedback[20]. Biodex balance system SD is one of the systems which are currently being used for training balance and postural re-education, increase proprioception, somatosensory and neuromuscular control. It uses an integrated system which involves patient in activities of re-education with relation to visual feedback to accommodate body accordingly[21]. Different protocols are being utilized for assessment of balance and training of balance. To date, no study in Pakistan has yet reported the effects of training using such systems on balance. Therefore, the aim of this novel study was to determine the impact of dynamic balance training with visual feedback using more advanced dynamic stability training system like Biodex balance System SD in improving anticipated balance control in healthy elderly population.

Material and Methods:

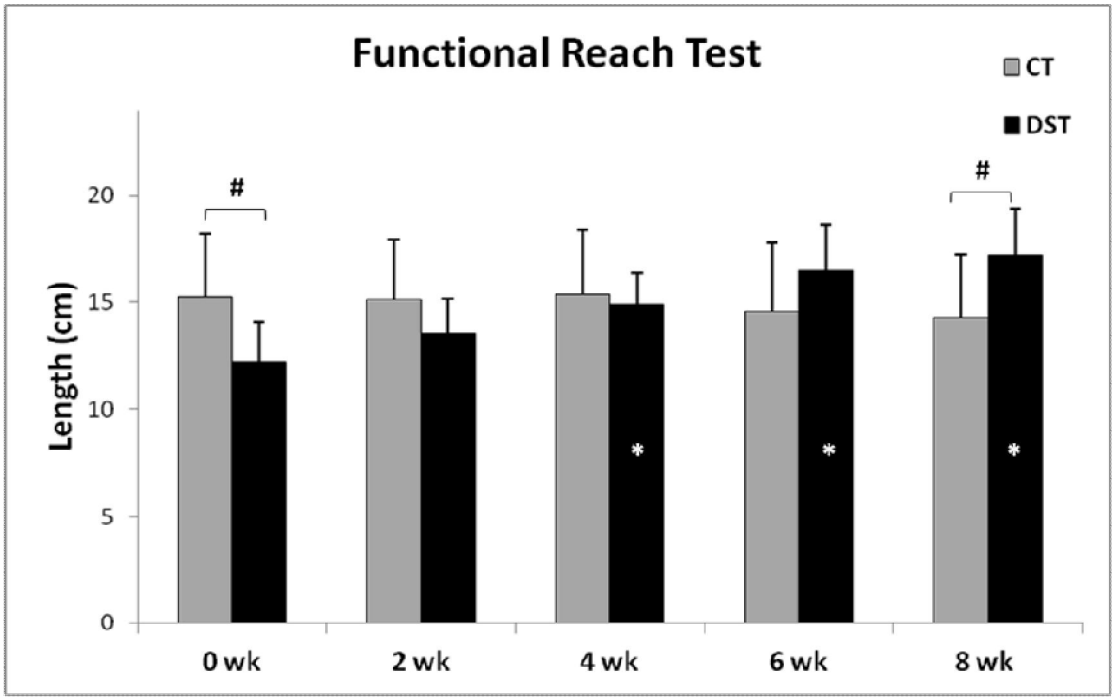
A randomized controlled trial was done from July 2016 to October 2016. Data was collected from 18 volunteers selected via non probability convenience sampling technique, having age between 50 – 80 years, of either gender with no major co-morbid conditions and cognitive impairments. Ethics review committee of Foundation University Islamabad campus approved study protocol and informed written consent was taken from all individuals before participation in study. Subjects were divided into two group i.e. Dynamic stability training Group (DST Group) and Control group (CT Group) using simple randomization via coin toss method. Base line demographic data and FRT were recorded on first visit. DST group received balance training exercises i.e. percentage weight bearing training, weight shift training and limits of stability training on Biodex Balance System SD (Model 950-440, Biodex, Inc., Shirley, NY, USA), thrice a week for 8 consecutive weeks from same researcher. Each session lasted for 30-45 minutes. CT group was not provided any specific intervention during the study period. Data was gathered on demographics and FRT using a wall-mounted meter scale at baseline and then after every two weeks till end of study protocol at 8 weeks by same researcher. Data was analyzed using SPSS version 20.0. Demographics were reported in percentages and frequencies. Between-group analysis was done using independent samples T test whereas within-group analysis was done using repeated measure ANOVA. Level of significance was set at a p value of less than 0.05.

Results:

The mean age in DST group was reported as 62.89 ± 6.81 years with gender distribution of 44.4 % (n=4) males and 55.6% (n=5) females. Mean height, weight and BMI were computed as 159.5 ± 6.75 cm, 71.39 ± 5.39 kg and 28.67 ± 2.67 kg/m^2 respectively. Similarly mean age in CT group was reported as 62.89 ± 9.31 years with gender distribution of 33.3% (n=3) males and 66.7% (n=6) females. Mean height,

weight and BMI were computed as 158.8 ± 11.55 kg, 77.57 ± 13.84 cm and 30.80 ± 4.54 kg/m^2 respectively. Significant difference was observed between DST group (17.22 ± 2.17) and CT group (14.30 ± 2.98) with P value of 0.03 after 8 weeks of training (Fig. 1).

Figure 1: Comparison between FRT Scores of CT Group and DST Group Before and After Training.



* indicates significant improvement compared to baseline score (P < 0.01).

# indicates significant between-group difference (P < 0.05).

Significant improvement was observed in DST group (Wilks' Lambda, F=5.862; P =0.04) compared to CT group which showed no significant change over 8 weeks period (Wilks' Lambda, F = 5.126; P = 0.051). In terms of percentage, DST group exhibited ~41% improvement as a result of dynamic stability training. Pair wise comparison between baseline assessments to 8 week assessment showed mean difference of 5 cm with P value of 0.004 in DST group compared to mean difference of 0.97 cm with p value of 0.206 in CT group. Detailed pair wise comparison of assessments among groups is given in Table 1.

Table 1: Pair wise comparison of assessments in DST group and CT group

Assessment Point	CT Group		DST Group	
	Mean Diff (cm)	P value	Mean Diff (cm)	P value
Baseline Assessment – 02 weeks Assessment	0.141	1	1.33	0.072
02 Week Assessment- 04 Week Assessment	0.260	1	1.33	0.072
04 Week Assessment – 06 Week Assessment	0.801	0.584	1.667	0.054
06 Week Assessment 08 Week Assessment	0.288	1	0.667	0.222
Baseline Assessment – 08 Week Assessment	0.970	0.206	5.00	0.004

Discussion

The most common risk factor for falls in older adults is poor balance. Balance requires integration of multiple systems to keep body's centre of mass over bass of support. Over years, due to aging and deterioration of these balance maintaining systems the risk of fall increases due to poor postural control[1]. In such case early preventive intervention is ideal and for such numerous management techniques are being incorporated including, strength training, flexibility training, custom build exercise regimes etc[22]. Not only these with increasing technological development, new balance training modalities such as Biodex balance system SD are being developed for assessment and management of postural dysfunction. Biodex balance system SD is the most modern form of biofeedback balance training. Biodex system provides an integrated treatment method with active participation of subject along with visual feedback[21]. The current study is first of its kind in Pakistan evaluating the effectiveness of dynamic stability training in improving anticipated balance by using Functional Reach Test (FRT) in comparison to traditional balance training. Results of the study showed that dynamic stability training in contrast to traditional balance training has more profound effect in improving anticipatory balance of elderly over 8 weeks of training. Results also showed that dynamic stability training improves balance markedly in initial 4 weeks. DST group was poorer in balance compared to the control group at baseline and improved significantly better than the control group after 8 weeks.

These results of the study are also supported by study of Rogers et al. in which 10 week intervention program on balance in older adults was evaluated on 12 subjects of age 61-77 years. Intervention program included dynamic balance training on non stable base like air filled exercise balls. Composite scores of several postural sway improved ($p \leq 0.05$) including medial–lateral amplitude, instantaneous speed (reduced by ~13%) and FRT also improved. These results suggest that challenging the physiological systems involved in balance control while on the non stable support surface of the exercise balls improves both static and dynamic balance in older adults and may reduce the risk of fall.[23]The results of the current study are very well supported by another study in which computer based biofeedback training has been used for the improvement of functional balance and mobility in the elderly. Two groups having 12 healthy older adults involved in 12 weeks balance training having two sessions of 30 min per week. Both groups shows significant improvement in anticipated balance and mobility as well as decrease reaction times.(24) Another study supported the results of current study, done on Dynamic balance by using balance system versus Tai Chi training in improving balance in at risk older adults. In these two training programs variants of each program has resulted in reduction of falls. But the Dynamic balance training group shows modest improvement in balance and mobility as compared to Tai Chi training group.[25] Study of Gusi et al. on effectiveness of balance training on reduction of falls the exercise group has significantly greater improvement as compared to control in dynamic balance (by 2 degrees, 95% CI 1 to 3)in accordance with the results of the current study.[26] In another study on healthy older adults 15 participants (aged 70–75 yrs) involved in a 9-wk balance training study. Before and after the investigation period, the balance function was assessed by clinical balance tests and dynamic posturography (biodex balance system). The standing balance significantly improved in training group. In the dynamic posturography, the training group improved their equilibrium scores.[27] Results of this study support the results of the current study. RCT conducted by Bina Eftekhar et al. on 34 elderly diabetic individual to access the efficacy of balance training, results showed a marked improvement in all balance and mobility parameters similarly to current study[28]. Gomez et al. evaluated the effectiveness of easy Balance Virtual Rehabilitation on functional reach in comparison to traditional rehabilitation. Results showed that easy Balance Virtual Rehabilitation was effective in improving FR compared to traditional methods of rehabilitation. These results are in line with results of current study[29].

Dynamic stability training shows a promising way in improving functional reach in elderly individuals. This method of balance training can be incorporated in clinical settings to provide elderly with an engaging and effective balance training regime. As

the study included healthy elderly individuals of age between 50-80 years, the exact effect of dynamic stability training on individuals with postural dysfunction due to other neurological, vestibular or somatosensory problems cannot be justified with this study. So research to evaluate effects of such dynamic postural stability training on balance parameters in these conditions is encouraged.

Conclusion:

This pioneer study conducted in Pakistan has shown that new technology like dynamic stability and balance training systems can be used in improving anticipatory balance and thereby reducing fall risk in healthy older adults.

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Author's Contribution:

Furqan Ahmed Siddiqui: Conception and design of the work, acquisition, analysis, or interpretation of data for the work and revising content for final approval. Accountable for all aspects of the work

Tahir Masood: Conception and design of the work, revising content for final approval and Accountable for all aspects of the work.