Middle-East Journal of Scientific Research 11 (3): 304-310, 2012
ISSN 1990-9233

Dynamic Balance in Inactive Elder Maleschanges after Eight Weeks Functional and Core Stabilization Training

[1]Ali Abbasi, [1]HosseinBerenjeian Tabrizi,
[1]HajarJahadian Sarvestani and [2]Jamal Rahmanpourmoghaddam

[1]Department of Physical Education and Sport Sciences, Faculty of Humanities,
Kazerun Branch, Islamic Azad University, Kazerun, Iran
[2]Bachelor in Physical Education and Sport Sciences, Iran

Abstract: The purpose of the present research was to study the effect of eight weeks functional and core stabilization training on dynamic balance in inactive elder males. Forty five inactive elder males voluntarily participated in this research and randomly divided into three groups of functional training (FT), core stabilization training (CST) and control (N=15 per groups). The Y-Balance Test was used to assess dynamic balance before and after training. The training procedures were elaborated for the subjects and were performed for eight weeks, 3 sessions per week and one hour per session. One-way ANOVA was applied to determine the differences between three groups at the $\alpha \leq 0.05$. Results revealed that there were no significant differences among three groups in pretest and between FT and CST in posttest) as well. However, there were significant differences amongFT and CST with control group ($P \leq 0.05$) in posttest. In conclusion, using both types of training are recommended for increasing dynamic balance in inactive elder males.

Key words: Dynamic Balance · Functional Training · Core Stabilization Training · Elderly

INTRODUCTION

Balance deficit is one of the main risk factors that affect falling among adults [1-4]. Balance is one of the main elements of most physical activities and it is an important factor in the performance of sports skills [5, 6].

Balance is a complex motor skill that describes the dynamics of body posture in preventing falling [7].Punakallio*et al.* [8] defined balance as static, the ability to maintain center of pressure (COP) within base of support (BOS) and dynamic, active movement of COP while standing, walking, or performing any other skill. Olmsted *et al.* [9] and Guskiewicz*et al.* [10] categorized balance from the functional aspect into static (maintaining a position with minimum movement), semi-dynamic (maintaining a position while BOS moves) and dynamic (maintaining balance while a prescribed movement is performed) [9, 10]. From biomechanical and functional perspectives, dynamic balance can be defined as the active movement of COP within BOS and maintaining the stability of BOS while performing a prescribed task [7, 11, 12]. Most daily activities perform dynamically; thus, dynamic balance is of utmost importance in performing physical activities and sports skills.

Considering the increasing population of senior citizens around the world and the increased life expectancy in this group, diagnosis and prevention of injuries and ailments are of particular importance in improving their quality of life and independence [4]. The scientific community, especially scientists in sports and rehabilitation are more sensitive to and careful of preventing and treating these ailments. Basically, falling due to lack of balance is a threat to the elderly which changes their quality of life and leads to increased costs of sustaining them [13]. Moreover, it might lead to physical, social and economic complications or even death [13]. Disturbance in balance is one of the driving factors in increasing the risk of falling whose improvement can prevent the incidence of falling and the complications associated with it [14]. There are various common methods for training balance and preventing falls. The effect of different training types has been the subject

Corresponding Author: Ali Abbasi, Department of physical Education and Sport Sciences,
Faculty of Humanities, Kazerun Branch, Islamic Azad University, Kazerun, Iran.
Mob: +989127305114.

of many studies that have reported contradictory results [4, 15-19]. Some of these studies have reported the positive effect of strength training on improving balance and decreasing risk of falling in the elderly [18, 19]. Some others on the other hand found strength training ineffective for improving balance and decreasing the risk of falling [19]. Regarding the effect of functional training on the balance of the elderly, Rosendahl*et al.* [20] states that high-intensity functional training improves balance and gait ability in elderly people. However, Manini *et al*. [19] found strength and functional training ineffective for the balance of the elderly. Despite the application of various training programs for improving balance and decreasing falling in the elderly (e.g. strength, balance, sprint training, rehabilitation training, aquatic balance training and recently whole body vibration training, functional training and core stability training) the question remains which of these methods is more effective and more important. Considering the general view that physical activities and training has a positive effect on dynamic balance, the purpose of the present research was to study the effect of eight weeks functional and core stabilization training on dynamic balance in inactive elder males.

MATERIALS AND METHODS

The current study was a Quasi-experimental one with pretest - posttest design on two experimental groups and one control group. Forty-five inactive elder males voluntarily participated in this research and randomly divided into three groups of functional training (FT), core stabilization training (CST) and control (N=15 per groups). The university institutional review board approved this study. All participants signed an informed consent document approved by the Institution human subjects review board. The subjects fully reported any record of joint dislocation and possible falling in a specific form. Subjects who had experienced falling over the past 12 months or had any joint dislocation, chronic arthritis, or dizziness were excluded from further study. Y-Balance Test was used to assess the dynamic balance of the subjects before and after training [21]. After performing the pre-test, the training procedures were elaborated for the subjects and were performed under the trainer's supervision for eight weeks, 3 sessions per week and one hour per session. At the end of the training period, post-test was performed. Descriptive statistics was used to describe the personal characteristics of the subjects, One-way ANOVA was applied to determine the differences between three groups at the $\alpha \leq 0.05$. All the statistical operations were done using SPSS 16 software.

Functional Training: The procedures for performing select functional exercises included health-related physical fitness training such as endurance, strength, flexibility and balance which are presented in Table 1 [22].

Core Stability Exercises: The procedures for select core stability exercises included five types of exercise (i.e. semi sit-ups, sit-ups with rotation, lateral bridge, prone bridge and four levels of lower body strength exercises) which are presented in Table 2.

Table 1: The procedures for performing select functional exercises

Movement	Goal	Procedures
Jogging	Endurance	152.4 m
Lifting Heavy Objects	Strength	Lifting sandbags (1.1-3.33 kg) up to the waist, shoulder and above the head
Push-Ups	Strength-Endurance	Body against the wall with 45-60° angle, 15 repetitions per set with both open and closed arms
Sitting and Rising from a Chair	Strength- Endurance	15 repetitions, fast performance
Reaching for the Ground in the Standing Position	Flexibility	Performed on both legs for 1 minute
Unilateral Dorsiflexion in the Standing Position	Strength	15 repetitions
Swaying the Body Backwards and Forwards in Standing Position	Balance	Two minutes, 10-second pause between the forward and backward movements
Single-Leg Standing	Balance	Standing on each leg two times for one minute
Kneeling from the Standing Position and Rising	Balance, Strength and Flexibility	Two rounds with 15 repetitions
Static Extension of Hamstring Muscles	Flexibility	Sitting with open legs, trunk leaning forward, isometric knee extension and ankle dorsiflexion
Raising the Arm and Leg while crouching on all fours	Balance-Strength	Two rounds with 15 repetitions
Parallel	Strength	Two rounds with 15 repetitions, in the seated position on an armchair
360° Rotation in the Standing Position	Balance	10 repetitions for each direction

Table 2: The profile of select core stability exercises

First Week	Repetition	Fifth Week	Repetition
Lower Abdominal Series – Level One	2 sets with 10 repetitions	Lower Abdominal Series – Level Four	2 sets with 10 repetitions
Semi sit-ups	2 sets with 10 repetitions	Semi sit-ups	2 sets with 20 repetitions
Lateral Bridge	2 series with 10 repetitions	Lateral Bridge	2 series with 20 repetitions
Sit-Ups with Rotation	2 sets with 10 repetitions	Sit-Ups with Rotation	2 sets with 20 repetitions
		Prone Bridge	3 sets with 20 repetitions
Second Week	Repetition	Sixth Week	Repetition
Lower Abdominal Series – Level One	3 sets with 10 repetitions	Lower Abdominal Series – Level Four	3 sets with 10 repetitions
Semi Sit-Ups	3 sets with 10 repetitions	Semi sit-ups	3 sets with 20 repetitions
Lateral Bridge	3 sets with 10 repetitions	Lateral Bridge	3 sets with 20 repetitions
Sit-Ups with Rotation	3 sets with 10 repetitions	Sit-Ups with Rotation	3 sets with 20 repetitions
		Prone Bridge	2 15-second series
Third Week	Repetition	Seventh Week	Repetition
Lower Abdominal Series – Level Two	2 sets with 10 repetitions	Lower Abdominal Series – Level Five	2 sets with 10 repetitions
Semi Sit-Ups	2 sets with 15 repetitions	Semi sit-ups	2 sets with 25 repetitions
Lateral Bridge	2 sets with 15 repetitions	Lateral Bridge	2 sets with 25 repetitions
Sit-Ups with Rotation	2 sets with 15 repetitions	Sit-Ups with Rotation	2 sets with 25 repetitions
		Prone Bridge	3 15-second sets
Fourth Week	Repetition	Eights Week	Repetition
Lower Abdominal Series – Level Two	3 sets with 10 repetitions	Lower Abdominal Series – Level Five	3 sets with 10 repetitions
Semi Sit-Ups	3 series with 15 repetitions	Semi sit-ups	3 series with 25 repetitions
Lateral Bridge	3 series with 15 repetitions	Lateral Bridge	3 series with 25 repetitions
Sit-Ups with Rotation	3 series with 15 repetitions	Sit-Ups with Rotation	3 series with 25 repetitions
Prone Bridge	2 10-second series	Prone Bridge	4 15-second series

Fig. 1: Y-Balance Test procedures

Y-Balance Test Procedures: In this test, three directions (anterior, posteromedial and posterolateral) are set in a central plateau. The angles between these three directions are specified with graded bars which are fixed on the sides of the plateau in three directions and an indicator is installed on each of the bars [22]. Before starting the test, the preferred leg of the subjects is determined. If the right leg is the preferred limb, the test is performed counterclockwise and it will be performed clockwise if otherwise [22]. The subject stands with their preferred leg (single-leg) on the plateau where the three directions meet and performs reaching by moving the indicators with the other leg in a direction that the examiner randomly chooses, as long as there is no error (without moving the stance leg from the plateau, or using the reach foot as support, or falling down). Then, the subject returns to the beginning position on both legs and the extent to which they have moved the indicator is recorded as their reaching distance. Each subject performs three trials for each of the directions and finally their average was calculated, divided by leg length (in centimeters). The dynamic balance calculated as follow [22] (Figure1):

$$Y = \frac{Anterior + Posteromedial + Postrolateral}{3} \times 100$$

RESULTS

Table 3 presents the descriptive characteristics of the subjects and Table 4 presents the data related to reaching distance of the subjects in the balance test (both pretest and posttest).

Results of one-way ANOVA revealed that there are not any significant differences in reaching distance between three groups in pretest ($P \leq 0.05$). However, there are significant differences in reaching distance between three groups in posttest. The results of Tukey post-hoc

Table 3: Descriptive characteristic of the subjects

Group	Height (Cm)	Mass (Kg)	Age (Years)
CST	168.46±8.15	73.24±10.23	57.74±3.35
FT	172.20±6.43	70.35±8.74	55.34±4.21
Control	170.56±4.65	71.52±9.28	56.59±4.19

Table 4: Data related to the reaching distance of the subjects in Y-Balance Test

Time	Group	Y-Balance	F	P-value
Pretest	CST	70.96±6.32	10.64	0.951
	FT	71.74±6.74		
	Control	72.54±5.47		
Posttest	CST	83.54±6.78	224.45	0.009
	FT	81.37±5.34		
	Control	71.67±5.64		

test revealed that there are significant differences in reaching distance between CST ($P = 0.002$) and FT ($P = 0.003$) with control group in posttest, while there was not any significant differences between CST and FT in posttest ($P \leq 0.05$).

DISCUSSION AND CONCLUSION

The purpose was to study the effect of eight weeks functional and core stabilization training on dynamic balance in inactive elder males. The results, in accord with the findings of previous research such as Rosendahl*et al.* [23] and De Bruin *et al*. [18], suggested the increased balance control after performing CST and FT in inactive elder males [18, 23]. In addition, the effect of both training types on balance control was equal and no significant difference was observed between them. In order to identifying the causes and mechanisms underlying the improvement in balance after performing exercises, one needs to point to different elements of the sensorimotor system which are responsible for maintaining balance. This system includes sensory, motor and the central processing components. The function of this system relies on the feedbacks obtained from different senses that are related to various motor behaviors, flexibility and adaptability. Thus, balance occurs based on functional motor skills that are flexible and these skills can improve through training and experience [4, 15, 16, 24, 25].

Central nervous system evaluates the feedbacks from sensory receptors around the body in order to be informed of the position and movement of the body in space. Normally, this information is transferred to the central nervous system via visual, vestibular and somatosensory senses so that CNS evaluates the position and movement of body in space with respect to gravity and the surrounding environment. In central processing regions, these feedbacks are combined and evaluated so that the importance and relationship between them is determined and proper motor responses including equilibrium responses are selected and performed with proper speed and intensity [26]. The information collected by visual, vestibular and somatosensory systems are processed in three separate levels of motor control which are the spinal cord, brain stem and higher regions such as cerebellum, basal ganglia and cortex [26]. The effectiveness of training for balance requires a response in three motor levels. At the spinal cord level, its main role is to adjust muscle reflex. The sensory data from mechanoreceptors of the joint following balance reflexes lead to a compensatory contraction around the joint and prevent extra pressure to the passive factors that inhibit the movement of the joint [27]. At the brain stem level, balance reflexes helps balance control and at higher nervous centers (cortex and cerebellum), with conscious focus and attention, the individual tries to consciously control the joint positions and body balance [27]. Control at each of these levels requires the sensory data collected from visual, vestibular and somatosensory systems. As a result, with additional training, the proper load will be applied on these senses and proprioceptors [28].

Due to physiological and sensorimotor adjustments in skill learning, functional exercises can decrease the variability in recruitment of motor units, increase the plasticity of the motor cortex, or help the elderly learn (or relearn) how to employ their muscles for optimal performance of the motor task [29]. It is interesting that recent research has shown that practicing a motor skill is closely related to increased corticospinal excitability and this is not achieved through strength training.

It seems that neural adaptations achieved through these types of training remain for a long period signifying the importance of training-specificity. An important issue in designing functional training programs is to pay specific attention to the principle of training-specificity

[18] that can be one of the reasons for the effectiveness of these types of training in improving the balance of the elderly. The training program used in the present research highly emphasized balance training which included functional activities of everyday life like walking, moving up and down the stairs and siting and rising from a chair that basically require maintaining balance. Generally, due to the connection between the bones and limbs and the fact that the body structure is not a hard material, performing each voluntary movement will disturb balance [30]. To compensate for this internal weakness, voluntary movements perform along with feedforward postural adjustment. These automatic, involuntary movements are a source for ensuring precise, coordinated movements [30]. In fact, activation of the muscles that control this postural adjustment takes place before the activation of the voluntary muscle activity. Considering the manifest principle of specificity in functional exercises, this type of training may have had an effect on the activation of the muscles responsible for feedforward postural adjustment and voluntary movements for controlling balance. On the other hand, improvement in balance can be due to better distribution of attention between the motor tasks of interest. Actually, task-specific training can lead to more concentration on that motor task [31].

One of the factors that can affect the improvement of balance maintenance and strength gain through FT is the initial level of physical activity in the elderly individual. The subjects of the present research had no pathological diseases and were functionally independent and they could walk without the need for any additional instrument (e.g. canes or walkers). None of the subjects engaged in any regular sport activity before participating in the exercises. Thus, the improvement in balance can possibly be attributed to their low level of physical fitness as well as the effect of functional training on the improvement of muscle strength, joint range of motion, neural control of movements and mental factors of the subjects [32].

The applied training program in the present research emphasized strength and stretching exercises. These exercises can improve strength in lower limb muscles and prevent the displacement of COP and as well increase muscle flexibility and decrease pains in the lower body when trying to maintain balance and finally, increase balance. The functional exercises were designed similar to everyday activities and considering the relationship between physical fitness and mental health. It can be argued that performing this type of training possibly affects the improvement of neural factors involved in balance control and thus will decrease stresses due to fear, anxiety and low self-confidence, as well as depression due to withdrawal or isolation that are in turn the result of decreased activity. Performing these exercises can lead to adjustment and improvement in the sensorimotor system [33].

The possible reasons for such a relationship between the strength of core stabilizing muscles and balance control can attributed to the fact that insufficient endurance in core stabilizing muscles leads to fatigue and decreased function during functional activities. Since these muscles affect the activation of lower extremity muscles -in healthy people, transverse abdominal muscles and multifidus muscles are activated 30 milliseconds before the movement of shoulder and 110 milliseconds before the movement of lower limbs in order to stabilize the spine [5]-, weakness of these muscles leads to delays in activation of the lower extremity muscles and incidence of injuries. Moreover, these muscles are responsible for maintaining the position of the pelvic area; when these muscles are weakened, it will lead to the loss of correct pelvic direction and as a result, the lower limbs attached to this region decrease in function due to disturbance in the length-tension relation and perturb the balance of the individual [5]. On the other hand, considering the importance of abdominal muscles in creating core stability, the correct function of these muscles is very important. The most important functional aspect of these muscles is stabilizing the spinal column, achieving optimal orientation, link between the pelvis and the spinal column and preventing extra pressure and compensatory movements of the pelvis during the movement of limbs [34]. In case of weakness in these muscles, all these issues will be disturbed and the lower extremities will be prone to injuries and it will increase postural sway.

The possible effects of performing FT on balance in elderly people, in particular the effect on neural factors of balance control, can be associated to core stability training as well. The effects specific to CST can briefly attributed to the following issues:

Performing these exercises, especially with the training protocol developed in the present research, will increase strength in the waist region and abdominal muscles and will enable the elderly people to maintain proper body posture and by restoring the COP axis to its original position, it will decrease postural sway and facilitate balance maintenance. Moreover, by the increase in strength and proper function of the core muscles, these muscles will be effectively engaged at the beginning of activity and will play a preventive role in the imbalance of subjects and before the subject's balance exits the base of support and the individual tries to restore it, these muscles will minimize such effort through a preventive action. Strength gain in core muscles is probably accompanied by decrease in disorders but because it is not assessed in the present research, it cannot be argued with certainty. Yet, it is evident that with the decrease in body abnormalities, balance control will face less sway.

CONCLUSION

Considering the results of the present research, it seems that developing and administering physical fitness programs for the inactive elder males is effective for increasing their balance and as a result their quality of life. Considering their special conditions, both training types (FT and CST) can be used. Further, despite the equal effect of both training types on improving balance in the inactive elder males and also considering the greater safety associated with CST and the satisfaction of the subjects performing this training method and its effect on improving lower limb malformations (one of the factors affecting balance) is more appropriate and this type of training can be recommended to the geriatric society.

REFERENCES

1. Carter, N.D., P. Kannus and K.M. Khan, 2001. Exercise in the prevention of falls in older people: a systematic literature review examining the rationale and the evidence. Sports Medicine, 31(6): 427-438.
2. Hobeika, C.P., 1999. Equilibrium and balance in the elderly. Ear, nose & throat journal, 78(8): 558-566.
3. Shumway-Cook, A., W. Gruber, M. Baldwin and S. Liao, 1997. The effect of multidimensional exercises on balance, mobility and fall risk in community-dwelling older adults. Physical Therapy, 77(1): 46-57.
4. Abbasi, A., H. Sadeghi, H. Berenjeian, K. Bagheri, A. Ghasemizad and A. KarimiAsl, 2011. Effect of Whole Body Vibration, Aquatic Balance and Combined Training on Neuromuscular Performance, Balance and Walking Ability in Male Elderly Able-Bodied Individual. World Applied Sciences J., 15(1): 84-91.
5. Akuthota, V. and S.F. Nadler, 2004. Core strengthening.Archives of physical medicine and rehabilitation, 85: 86-92.
6. Fattahi, A., H. Sadeghi and M.S. Ameli, 2011. Relationship Between Injury Types and Prevalence with Some Anthropometric Properties of Male Elite Volleyball Players of Iran. World Applied Sciences J., 15(5): 667-672.
7. Gribble, P.A. and T. Kaminski, 2003. The star excursion balance test as a measurement tool. Athletic Therapy Today, 8(2): 46-47.
8. Punakallio, A., 2004. Balance Abilities of Workers in Physically Demanding Jobs. University of Kuopio.
9. Olmsted, L.C. and J. Hertel, 2004. Influence of foot type and orthotics on static and dynamic postural control. J. Sport Rehabilitation, 13(1): 54-66.
10. Guskiewicz, K.M. and D.H. Perrin, 1996. Research and clinical applications of assessing balance. J. Sport Rehabilitation, 5: 45-63.
11. Blackburn, J.T., W.E. Prentice, K.M. Guskiewicz and M.A. Busby, 2000. Balance and joint stability: the relative contributions of proprioception and muscular strength. J. Sport Rehabilitation, 9(4): 315-328.
12. Sebahattin, D. and G. Ismail, 2011. The effect of an Eight-Week Swimming Training on Capillary Oxygen Saturation and Respiratory Parameters. World Applied Sciences J., 15(11): 1598-1603.
13. Resende, S. and C. Rassi, 2008. Effects of hydrotherapy in balance and prevention of falls among elderly women.RevistaBrasileira de Fisioterapia, 12(1): 57-63.
14. Lopes, K., D. Costa, L. Santos, D. Castro and A. Bastone, 2009. Prevalence of fear of falling among a population of older adults and its correlation with mobility, dynamic balance, risk and history of falls.RevistaBrasileira de Fisioterapia, 13(3): 223-229.
15. Hosseini, S.S., B. Mirzaei, M. Panahi and H. Rostamkhany, 2011. Effect of Aquatic Balance Training and Detraining on Neuromuscular Performance, Balance and Walking Ability in Healthy Older Men. Middle-East J. Scientific Research, 9(5): 661-666.
16. Hosseini, S., 2011. The Effect of Aquatic and Mental Trainings on Balance in Elderly Males. Middle-East J. Scientific Research, 7(3): 296-302.
17. Cromwell, R.L., P.M. Meyers, P.E. Meyers and R.A. Newton, 2007. Tae Kwon Do: an effective exercise for improving balance and walking ability in older adults. The J. Gerontology Series A: Biological Sciences and Medical Sciences, 62(6): 641-646.
18. De Bruin, E.D. and K. Murer, 2007. Effect of additional functional exercises on balance in elderly people.Clinical rehabilitation, 21(2): 112-121.

19. Manini, T., M. Marko, T. VanArnam, S. Cook, B. Fernhall and J. Burke, 2007. Efficacy of resistance and task-specific exercise in older adults who modify tasks of everyday life. The J. Gerontology Series A: Biological Sciences and Medical Sciences, 62(6): 616-623.
20. Rosendahl, E., 2006. Fall prediction and a high-intensity functional exercise programme to improve physical functions and to prevent falls among older people living in residential care facilities. Sammanfattningmedicinofrehabilitering Community Medicine and Rehabilitation.
21. Hertel, J., R.A. Braham, S.A. Hale and L.C. Olmsted-Kramer, 2006. Simplifying the star excursion balance test: analyses of subjects with and without chronic ankle instability. The J. orthopaedic and sports physical Therapy, 36(3): 131-137.
22. King, M.B., J.O. Judge, R. Whipple and L. Wolfson, 2000. Reliability and responsiveness of two physical performance measures examined in the context of a functional training intervention. Physical Therapy, 80(1): 8-16.
23. Rosendahl, E., Y. Gustafson, E. Nordin, L. Lundin-Olsson and L. Nyberg, 2008. A randomized controlled trial of fall prevention by a high-intensity functional exercise program for older people living in residential care facilities.Aging clinical and experimental Research, 20(1): 67-76.
24. Shumway-Cook, A. and F.B. Horak, 1986. Assessing the influence of sensory interaction on balance. Physical Therapy, 66(10): 1548-1550.
25. Nashner, L.M., 1982. Adaptation of human movement to altered environments. Trends in Neurosciences, 5: 358-361.
26. Kornatz, K.W., E.A. Christou and R.M. Enoka, 2005. Practice reduces motor unit discharge variability in a hand muscle and improves manual dexterity in old adults. J. Applied Physiology, 98(6): 2072-2080.
27. Ungerleider, L.G., 1995. Functional MRI evidence for adult motor cortex plasticity during motor skill learning. Nature, 377: 155-158.
28. Carroll, T.J., B. Benjamin, R. Stephan and R.G. Carson, 2001. Resistance training enhances the stability of sensorimotor coordination. Proceedings of the Royal Society of London. Series B: Biological Sciences, 268(1464): 221-227.
29. Jensen, J.L., P.C.D. Marstrand and J.B. Nielsen, 2005. Motor skill training and strength training are associated with different plastic changes in the central nervous system. J. Applied Physiol., 99(4): 1558-1568.
30. Oddsson, L.I., 1990. Control of voluntary trunk movements in man. Mechanisms for postural equilibrium during standing. Actaphysiologicascandinavica. Supplementum, 595: 1-60.
31. Oddsson, L.I.E., P. Boissy and I. Melzer, 2007. How to improve gait and balance function in elderly individualsâ_"compliance with principles of training. European Review of Aging and Physical Activity, 4(1): 15-23.
32. Lord, S.R. and S. Castell, 1994. Physical activity program for older persons: effect on balance, strength, neuromuscular control and reaction time.Archives of physical medicine and rehabilitation, 75(6): 648-652.
33. Whooley, M.A., K.E. Kip, J.A. Cauley, K.E. Ensrud, M.C. Nevitt and W.S. Browner, 1999. Depression, falls and risk of fracture in older women. Archives of Internal Medicine, 159(5): 484-490.
34. Sahrmann, S., 2005. Diagnosis and treatment of movement impairment syndromes. Mosby.