



Effect of square stepping exercise versus Swiss ball exercise on balance in institutionalized elderly population

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Abstract

Aim: To compare the effect of Square Stepping Exercise and Swiss Ball Exercise on Balance in Institutionalized elderly population.

Material and Method: Experimental Study design. A total of 30 subjects was randomly assigned in to 2 groups. Each group had 15 subjects named as Group A and Group B. **Group A:** Square Stepping Exercises. **Group B:** Swiss Ball Exercises. Simple Random Sampling was done. Source of Sample tau devi lal Old Age Home Sec-4 (Gurugram)

Variables: i) Dependent Variables: Balance. ii) Independent Variables: Square stepping exercises, Swiss ball exercises. Outcomes measure- Berg Balance Scale (BBS)

Result: Data was analyzed using SPSS Version 21.00. The Balance Score were examined under Square Stepping Exercises and Swiss ball Exercises Training by using Paired t- test within in the group and Independent sample t- test between the groups. The P-value was set at a significant level of P< 00.5.

Conclusion: The study shows significant improvement in balance of elderly population following Swiss Ball Training. But improvement is more marked under Square Stepping Exercises training.

Keywords: square stepping mat, swiss ball, berg balance scale

Introduction

Elderly or old age consists of ages nearing or surpassing the average life span of human being, the boundary of old age cannot be defined exactly because it does not have the same meaning in all societies. Numerous studies demonstrates that impaired balance and decrease lower extremity strength are important risk factor for the loss of physical function, occurrence of fall in older adults ^[1,2]. Amongst elderly people bone fractures in relation to falls are a frequent phenomenon. These accidents are often associated with physical decline, negative impact on quality of life and reduced survival. Fall risk has been related to a number of factors such as history of falls, muscle weakness, gait deficit, balance deficit, use of assistive device, visual impairment, mobility impairment, fear of falling, cognitive impairment, depression, sedentary behavior, age, number of medications, psychotropic/cardiovascular medications, nutritional deficits, urinary incontinence, arthritis, home hazards and footwear ^[3].

Fall defined as an event which results in person coming to rest inadvertently on the ground or other lower level ^[4, 5, 6]. Resulting from fall in older people can lead to severe depression, malnutrition, and increased chance of infection which can have more deleterious effects on physiological structures and functions in older people than in younger people ^[7]. Falls are a leading cause of injury and death among older adults and a significant public health issue ^[8]. Although falls are common among the elderly population, recent research conducted in kerala state, in India, has found a greater increases in fall in elderly women residing in long

term care homes compared with women living in the community ^[9]. Balance is a complex process involving the reception and integration of sensory input and the planning and execution of movement to achieve a goal requiring upright posture ^[10]. Every activity we carry out requires us to react to gravity and our body to adjust accordingly in order to maintain balance ^[11]. There is a positive relationship between balance control or motor and sensory system function in order to understand the cause of falling and create a effective strategies to prevent fall in the elderly population ^[12, 13].

The number of elderly people is growing very fast in both developed and developing countries. The rapid change in the social and cultural values had made a tremendous impact on mental well being of elder. In the modern world elder are the mean of a burden on the family in all societies and culture and mistreatment with elderly is common everywhere¹⁴. Many families who lives in the urban localities tend to send the elder in the institutions. Institutionalization provokes the feeling of loneliness and neglect in elder. Such living arrangements may have negative effect on mental health of its resident, because placement is often accompanied by feeling of lack control over own life and inability to make decisions regarding daily issue ^[15]. Sensory system deteriorates with age increase attention in allocated to heighten the signal coming from this system in order to gain necessary information for postural control ^[16, 17]. Balance become more impaired in elderly population who are residing in residential care facilities because of sedentary life style, mental frailty, physical weakness, physical damage that cause falling, experience of

suffering fall has an effect on status cause anxiety and self imposed mobility restriction [17]. This inhibition of mobility as a result of fear decreases the physical fitness and activity level in the institutionalized elderly population and further increase the risk of fall [18]. The square stepping exercise or SSE is a low cost indoor program to improve fitness of the lower extremity developed through universities. It is an exercise method based on solid scientific Evidence and its application include the improvement of mobility in children and the prevention of life-style disease [19]. There is a positive relationship between balance control or motor and sensory system function in order to understand the cause of falling and create a effective strategies to prevent fall in the elderly population [12, 13]. Another recent advance in core stabilization training is use of the Swiss ball. These exercises are used to strengthen the core abdominal muscles [20]. Abdominal muscular endurance and strength are important for trunk stability, appropriate posture and body movements. The core is important because it provides proximal stability for distal mobility [21]. The central nervous system and body proprioceptors work together to refine pattern of movement. Performing exercises on Swiss ball may increase proprioceptive demands and stress the core muscles that are important. Therefore the purpose of this study was to Compare the effect of square- stepping exercises and Swiss ball exercise on balance in institutionalized elderly population.

Method

Study Design- Experimental Study Design

Sample Size- A total of 30 subjects was randomly assigned in to 2 groups. Each group had 15 subjects named as Group A and Group B.

Group A – Square Stepping Exercises.

Group B – Swiss Ball Exercises.

Sampling- Simple Random Sampling

Source of Sample- Tau devilal old Age Home Sec-4 (Gurugram)

Inclusion Criteria

1. Institutionalized Elderly Population.
2. Age above 50 years
3. Both male and female.
4. Able to understand and follow verbal instruction.
5. Ambulate independently at least 10 meter.(10 meters walk test)
6. Mini Mental Scale- above 24
7. Faller and non faller.
8. Geriatric Depression Score above 14
9. Berg Balance Score- above 30

Exclusion Criteria

1. Any Neurological condition (stroke, Parkinson’s disease etc.)
2. Limited mobility.
3. Any orthopedic disorder (rheumatoid arthritis, fracture etc.)

4. Complaint of dizziness or blurred vision leading to difficulty in walking.
5. Acute low back ache.
6. Lower extremity joint deformity.
7. Uncontrolled diabetes.
8. Any cardiovascular disorders.

Variables

Dependent Variables- Balance

Independent Variables- Square stepping exercises, Swiss ball exercises

Instruments and Tools Used- Square Stepping Mat, Swiss Ball, Arm rest chair Stopwatch.

Procedure

30 subjects who fulfilled the inclusion criteria was divided into two groups. Subjects in Groups A and B followed protocol 2 times in a week for 12 weeks. Written informed consent was taken from subjects prior to study.

Group A: Square Stepping Exercises (Experimental Group)

The Square stepping exercises (SSE) group was participating in the supervised group session 2 times a week for 12 weeks. Each session comprised of warm up exercises, square stepping exercises and cool down exercises. SSE is performed on thin felt mat (100x250cm) that is partitioned into 40 squares (25cm each).

Instruction to the Subject

The subject was instructed to walk from one end of the mat to the other according to step pattern provided. When the persons reached the end of the mat, they were instructed to return to their start position by walking normally off the mat and then stand in line for the next stepping. The SSE includes forward, backward, lateral, and oblique step patterns. After the person become familiar with each pattern, they were instructed to walk with heels lifted, that is, on their toes, without treading on the frames of square. Each step pattern is repeated 4-10 times to ensure that person could complete the pattern, and followed by introduction of more complex step pattern.

Elementary 1	Elementary 2	Intermediate 1	Advanced 3



Fig 1

Group B: Swiss Ball Exercises (Experimental Group)

Swiss ball exercises program consisted of 12 types of exercises for balance twice a week for 12 weeks: warm up, Swiss ball exercise and cool down exercise. The ball used in this program was 55 cm in diameter and it was selected with the consideration of the height of the subject. For warm up and cool down, stretching exercises were performed to increased Flexibility of the joint and break time for 3 min was inserted between each set in consideration of physical strength of the subject. Each exercise was performed in 3 steps from easy to difficult level: ball exercise in lying down position (Bridging on the Ball, Knee Flexion, Hip Adduction), ball exercise sitting in the ball (Trunk Flexion, Anterior, Posterior and Lateral tilting), and ball using the wall(Ball pushing Facing the Wall). The program lasted for 12 week and the number of repetition and sets were gradually increased by session.

Table 1

Exercises	1-3 week	4-6 week	7-9 week	10-12 week
1. Bridging on Ball	10×3	10×4	5×4	5×4
2. Hip Adduction	3×5	5×5	3×5	3×5
3. Leg Raised Holding the Ball Between the Feet	3×5	5×5	3×5	3×5
4. Knee Flexion	3×5	5×5	3×5	3×5
5. Sit up on the Ball: Trunk flexion	3×5	5×5	3×5	4×5
6. Back Extension on Ball: Trunk Extension		3×5	3×4	4×4
7. Bounce on Ball		3×3	3×4	4×4
8. Pelvic Rotation on Ball		3×3	3×4	4×4
9. Knee Extension on Ball		3×3	3×4	4×4
10. Pelvic ant. Post. And lateral tilting on Ball			2×3	3×3
11. Side Bridging: Trunk lateral bending			2×3	3×3
12. Ball push facing the wall			2×3	3×3



Fig 2

Result

Data was analyzed using SPSS Version 21.00. The Balance Score were examined under Square Stepping Exercises and Swiss ball Exercises Training by using Paired t- test within in the group and Independent sample t- test between the groups. The P- value was set at a significant level of P< 00.5.

40 Subject were assessed from Tau-Devi Lal old age home sec-4 (Gurugram). Five Subjects were excluded because they did not follow the inclusion criteria. Five Subjects excluded because of Complaint of musculoskeletal pain.

Total 30 Subject was selected who met all the inclusion Criteria. Total 30 patient which included 16 female and 14 male. First we compared demographic and functional data of the age matched subgroup. Analysis comparison was done between both group first at base line, after 4 weeks, 8 weeks, and then again comparison was done after 12 weeks intervention and result was noted.

Group a (Square Stepping Exercises)

Balance Score showed significant balance improvement with the mean BBS after 12 weeks was increased to 53.2 ±1.699 from a value of 34.87±3.314. Balance Score showed improvement with the mean score of BBS from base line (34.87±3.314) to after 4 weeks exercises (43.13 ±3.701). Then there was significant improvement occurs after 4 weeks training to 8 weeks training with the mean score of BBS increased to 48.07 ±3.127 from value of 43.13 ±3.701. There was also significant improvement occurs after 8 weeks training to 12 weeks training with the mean score of BBS increased to 53.2 ±1.699 from value of 48.07 ±3.127.

Table 2

Group- A Square Stepping Exercises		Base line to 4 th week	4 th week to 8 th week	8 th week to 12 th week
	N	15	15	15
	Mean	43.13	48.07	53.20
	S.D	3.701	3.127	1.699
	t-value	11.585	10.665	8.663
	p-value	0.001	0.000	0.000

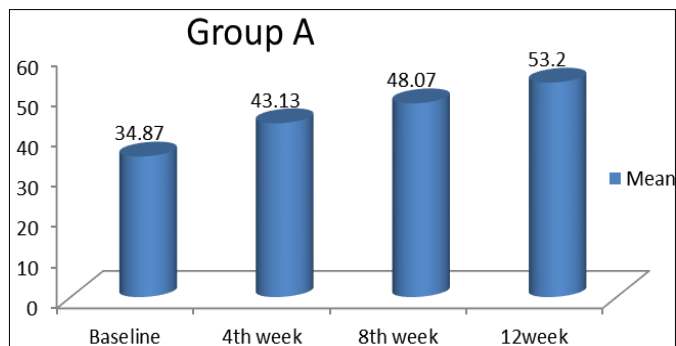


Fig 3

Group B (Swiss Ball Exercises)

Balance Score showed significant improvement with the mean score of BBS after 12 weeks was increased to 51.47 ±1.995 from the mean score of BBS at base line was 33.87 ±2.615. There was mild improvement occurs in mean score of BBS from baseline exercise to after 4 weeks as the mean score of BBS at baseline was 33.87 ±2.615 and this score was increased after 4 weeks to the value of 41.33 ±2.743. Then there was improvement occurs in mean score of BBS from 4 weeks to 8 weeks and the score was increased to the value of 47.13 ±2.356 from the value of 41.33 ±2.743 But there was significant improvement take place with the mean score of BBS after 8 weeks exercise to 12 weeks exercise and that score was increased to the value of 51.47 ±1.995 from the value of 47.13 ±2.356 after 8 week to 12 week.

Table 3

Group- B Swiss Ball Exercises		Base line to 4 th week	4 th week to 8 th week	8 th week to 12 th week
	N	15	15	15
	Mean	41.33	47.13	51.47
	S.D	2.743	2.356	1.995
	t-value	8.305	13.564	8.940
	p-value	0.003	0.002	0.000

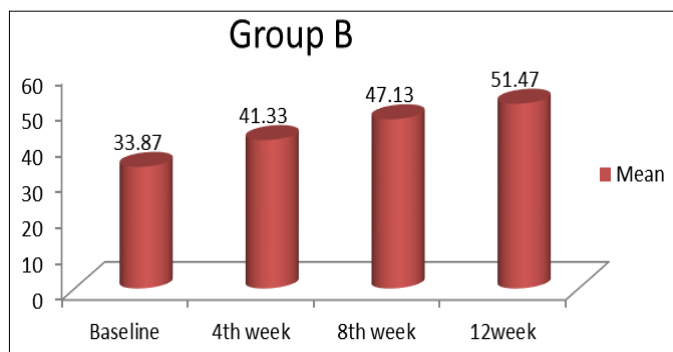


Fig 4

Table 4: Mean Comparison of Berg Balance Score (BBS) in Study Population at Base line, After 4 week, 8 week and 12 week.

BBS		Baseline	4 th week	8 th week	12 th week
Group- A	Mean ± S.D	34.87±3.314	43.13 ±3.701	48.07 ±3.127	53.2 ±1.699
	p-value 0.001				
Group- B	Mean± S.D	33.87 ±2.615	41.33 ±2.743	47.13 ±2.356	51.47 ±1.995
	p-value 0.005				

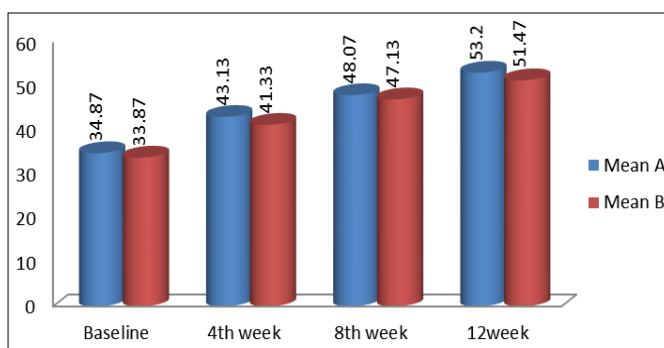


Fig 5

Table 5: BBS Changes Baseline to After Twelve Week

		t- test for Equality of Means		
		t-value	Df	P-value
Balance at baseline	Equal variance assumed	.971	28	.367
Balance after 4 week	Equal variance assumed	1.513	28	.141
Balance after 8 week	Equal variance assumed	.923	28	.364
Balance after 12 week	Equal variance assumed	2.562	28	.016

This result showed that at Base line treatment both Groups having not significant difference in Berg Balance Score. (t- Value is. 971 and P- Value is. 367). After 12 weeks of exercises Berg Balance Score was increased in Group – A as the (t- Value is 2.562 and P- Value is. 016). So Result showed that Group A was more significant as compared to Group B. Discussion- The result of the study support our hypothesis that there was significant improvement in balance of institutionalized elderly Population in both group who received square stepping exercises and Swiss Ball Exercises. But Group A who received Square Stepping Exercises showed more significant improvement as compared to Group B who received Swiss Ball Exercises (p<0.016). There was improvement in BBS score after 12 weeks training program in both groups. Square Stepping Exercises (SSE) is a simple, low-cost and feasible method that can be easily performed indoors. The SSE program involves multidirectional movements including forward, backward, lateral and oblique

step patterns on a thin mat. Falls are the public health epidemic of this decade. One out of three adults aged 65 and over falls each year⁴⁾ [22]. Falls are the leading cause of traumatic brain injury, fractures, loss of independence, associated illness and early death in older adults. The results of this study imply that SSE could be used as means of rehabilitation and public health promotion because it has number of advantages: First, it is possible for fewer staff members (including physicians, public health nurses, and exercise instructors) to simultaneously supervise several older adults with high risk of falling as SSE can be performed within a small indoor space. Second, outdoor walker can substitute walking with SSE when it rains. Third, SSE requires minimum investment because it involves the use of low tech equipment. Fourth, because of the significantly small reaction time, which is a cognitive function, SSE may improve information processing speed and psychomotor processes [3]. Fifth there is visual feedback while performing Square Stepping Exercise on the Special mat, also while performing the exercise [22].

According to Shigematsu *et al.*, SSE is found to be effective in balance improvement from the meta-analysis done with three studies with $P=0.0015$. The studies were found to be heterogeneous which could be due to the exercises used for comparing with SSE were different (trunk extension, trunk flexion, bri etc.), for instance one study used balance and strengthening exercises but the other two studies used walking as a treatment for the controlled groups.

A study by Pijnappels and colleagues (2005) revealed that during a trip, when the balance of one leg is lost, the other leg is immediately lifted off the floor, in a manner similar to hopping, in order to prevent a fall. This mechanism can explain the reason for the lower number of falls observed in the SSE group as the former appears to have adequate functional ability to prevent falls [23].

Shigematsu and Okura *et al.* (2006) found improved locomotion speed (walking around 2 cones) using the same SSE program of intervention, better neuromuscular function and coordination as a protective response to falls. Another research in this field indicated that SSE was as effective as a specific training to strength and balance to prevent falls in older people (Shigematsu *et al.*, 2008) [23].

Subjects who received Swiss ball training also showed improvement in balance. Anderson and Behm (2005) suggest, the proprioceptive system relies on information from the joints and muscles to coordinate unconscious reflexes to maintain balance [24]. According to Lehman *et al.* (2005) local muscles have a greater proprioceptive function, and if the Swiss-ball stresses these muscles to a greater extent, this may form the basis for an improved balance effect after training show improvement in dynamic balance [25].

Many previous studies have reported that strengthening exercises, such as trunk stabilization exercise, are effective at increasing muscle activity and improvement in balance.

Stephen *et al.* (1999) a reported that greater motor unit recruitment and a higher rate of motor unit firing, which may be elicited by strengthening exercise, can raise the level of muscle activation and help in improvement in balance. Exercise balls have been introduced into the fitness industry as a mode of training for various purposes. One of these purposes

is increasing "core stability" and balance. One should assume that "core stability" refers to the synergistic contraction of the muscles of the abdomen and lower back. In addition, exercise balls can be used to strengthen other muscles, including those of the legs and help in improvement in balance [25].

According to these explanations and results, the trunk stabilization exercise with a Swiss ball increased the muscle activities of the elderly. Generally, the elderly are not powerful enough to perform common resistance exercises and provide evidence of the validity of trunk stabilization exercise but also suggest an alternative approach to improve the core stability of the elderly and improvement in balance. So that Swiss Ball exercises help in improvement in balance but SSE is more helpful to improve balance and strength.

On the basis of above discussion and result of statically analysis showed that Square Stepping Exercises after completion of intervention improve Balance 5.25% faster as compared to Swiss ball exercises.

Conclusion

The study shows significant improvement in balance of elderly population following Swiss Ball Training. But improvement is more marked under Square Stepping Exercises training.

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