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The effect of wobble board exercise versus BOSU ball exercise on balance, fear of fall and its impact on quality of life in geriatric population

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Abstract
Background: Aging is defined as a physiological process which is accompanied by functional, biochemical, morphological and psychological changes. In geriatric population, balance problems are multifactorial condition caused due to core muscle weakness, altered muscle activation pattern, inability to control postural sway and most commonly due to loss of proprioception. The incidence of balance impairment in elderly population was found between age groups of 66-70 years. The prevalence of fall in Indian older adults above 60 years, reported about 14%-53%. Also the reported incidence of fear of fall altered between 3-85% in geriatric population.
Materials and Methodology: Both male and female (n=60) from tertiary care hospital in Miraj Taluka were taken with age group of 60 years and above were included in this study. Participants were screened based on inclusion and exclusion criteria and were randomly divided into Group A (n=30) and Group B (n=30). Group A received Wobble board exercise and Group B received BOSU ball exercise. Each exercise session included 30 min (10 min warm-up period, followed by 15 min Wobble board/BOSU ball exercise program, and finishing with 10 min cool down period), 2 times a week for 4weeks. Pre intervention and post intervention was done using BBS, FES-I and SF-36 questionnaire.
Result: The results were found to be statistically highly significant within the groups ($p<0.001$) for all parameters and statistically significant between group difference were found for BBS ($p=0.002$), FES-I ($p=0.001$), physical limitations due to physical health ($p=0.023$), energy ($p=0.014$), emotional well-being ($p=0.001$) and general health ($p=0.015$) but no statistical significant between-group difference were found for role limitations due to emotional problem ($p=0.19$) and pain ($p=0.11$) suggesting BOSU ball exercise showed more significant improvement than wobble board exercise.
Conclusion: The study concludes that BOSU ball exercise is more effective in improving balance, fear of fall and has a positive effect on the quality of life than wobble board exercise in geriatric population.

Keywords: BOSU ball, wobble board, fear of fall, quality of life, geriatric, balance

Introduction

According to The United Nations (UN), the population of 60+ years is referred to as older population [1].

Aging is defined as a physiological process which is accompanied by functional, biochemical, morphological and psychological changes. In geriatric population, there is loss of balance, postural instability and affected gait due to impaired cognitive function mainly due to deficit in sensory, visual, vestibular, somatosensory inputs and likewise loss of muscle strength in lower limb result in postural instability leading to frequent fall incidence [2]. In order to perform, common activities of daily living, such as walking, bathing, dressing and so forth, postural stability is considered most important in elderly population [3].

General problems seen in elderly are musculoskeletal disorders like osteoarthritis, rheumatoid arthritis; cardio-respiratory disorders – acute MI, hypertension, asthma; neurological disorders- stroke, Parkinson's disease, psychological disorders, cognitive disorders, balance disorders [4, 5]. Out of which balance disorders leading to falls are more common among elderly population [6]**.** The incidence of balance impairment in elderly population was found between age groups of 66-70 years [7].

According to WHO global report on falls prevention, about 28%-35% of geriatric population aged 65 years and above have been reported of falls in each year. The rate and proportion of the fall increases with age and frailty level [8]. The prevalence of fall in Indian older adults above 60 years, reported about 14%-53% [9].

In geriatric population, balance disorders are multifactorial condition caused due to core muscle weakness, altered muscle activation pattern, inability to control postural sway and most commonly due loss of proprioception [10, 11]. Inability to control normal postural sway in older adults leads to injuries through falls, limits independence, reduces Quality of life and can even lead to death [12]. Falls are considered the most common risk factor for fractures in geriatric population [13]. Nowadays not only fractures due to falls are common but also these falls leading to the development of cerebral hemorrhage, soft tissue injuries, dislocations, traumatic pain syndromes, functional limitations increase the mortality rate in elderly [14]. Fear of fall is found to be one of the major health issues among community dwelling elderly i.e, both who have experienced fall but also those who have never fallen. The reported incidence of fear of fall altered between 3-85% [15]. Study

has anticipated that fear of fall and restriction of activity may result in social isolation, indolence, reduction in mobility and physical function affecting quality of life if preventive actions are not taken immediately, the number of injuries precipitated due to falls is estimated to 100% higher in the year 2030 [16]. Loss of self-confidence, social isolation, increased dependence on others caused due to fear of fall are among the major consequences faced by elderly in day to day life [17].

Various physiological factors of aging process, medications, and environmental factors often contribute to risk of falls which includes reduced stance phase, greater postural sway, reduced dynamic balance, reduce walking speed and decreased mobility [18-20]. It has been reported that aging have a negative impact on static and dynamic balance, hindering with activities of daily living such as getting dressed or undressed, bathing, preparing simple meals, ascending or descending stairs [21].

There are different methods to enhance balance and gait in geriatric population [14]. Physiotherapy interventions like static balance exercises [22], dynamic balance exercises [23], motor strategies [24], Swiss ball exercises and proprioceptive training has shown to improve balance [25].

Vision, vestibular sense, proprioception, reaction time, muscle strength all together contribute in maintaining balance [26]. The sensory receptors (mechanoreceptors and proprioceptors) located in the skin, joints and muscles (muscle spindles, tendon organ afferent, cutaneous receptors and joint receptors) primarily are the neurological basis of proprioception. These muscle afferent receptors through neural signaling of a change in muscle, skin or joint stretch allows the identification of limb position and movement [27].

Proprioception provides basic information for balance, the information such as postural instability recognition, location, joint speed, angle and movement of bodily activity is transmitted to the CNS which identifies and allows the production of normal movement, protects the joint from external injury [28, 29].

Several studies have included unstable surface in proprioception. This type of training stimulates proprioceptive system at 3 levels of neural protection producing motor responses and stabilizing the joint [30]. Swiss ball, wobble board, BOSU ball, foam rubber pad are the different tools which have been used to create instability. Recently, various exercise interventions have been shown to improve balance thereby preventing falls in older adults [31]. When wobble board translates or tilts unexpectedly it stimulates proprioception which in turn leads to muscle activation pattern of ankle, hip and stepping strategy [32]. Previous studies have shown that wobble board exercise significantly improves standing balance in an elderly population [33].

In sedentary women, proprioceptive exercises on uneven surfaces such as Swiss ball or BOSU ball have been proven to improve flexibility, balance and lower limb strength[34]. Studies have also shown that 12 week proprioceptive training using Swiss ball and BOSU ball has significant improvement in postural stability, gait and balance in older adults [35].

Also several studies showed that the wobble board training improves proprioception and balance by loading mechanism through stimulation of mechanoreceptors in the muscles, tendons, ligaments and joints [32, 36].

Aim: To compare the effect of wobble board exercise and BOSU ball exercise on balance, fear of fall and its impact on quality of life in geriatric population**.**

Objectives

1. To find out the effect of wobble board exercise on balance, fear of fall and quality of life in geriatric population.
2. To find out the effect of BOSU ball exercises on balance, fear of fall and quality of life in geriatric population.
3. To assess Berg Balance Scale (BBS), Fall Efficacy Scale- International (FES-I) and Short Form – 36 questionnaire (SF-36) pre and post treatment.
4. To compare the effect of wobble board exercise and BOSU ball exercise on balance, fear of fall and its impact on quality of life in geriatric population.

Materials and methods

An ethical approval was taken by the ethical committee of the institution before undertaking the study and a written consent was taken from the subjects explaining the entire procedure of the study before recruiting them in the study.

Study design: Pretest-Posttest Experimental Design

Sample size: A total of 60 participants were recruited in the study, with 30 participants in each group. Sample size was calculated considering an allowable error of 20% with the confidence interval set at 95% by the following formula based on the results:

Inclusion criteria

- Age group 60 years and above
- H/O no trauma due to falls within the last year
- Able to walk independently
- Mini-mental state examination score at least 24
- Both elderly male and female population
- BBS Score: medium fall risk

Exclusion criteria

- Lower limb fracture or surgery.
- The use of a walking aid or foot orthosis
- Neurological conditions which may alter balance like vestibular disorders, cerebellar disorders.
- Medically unstable patient or under psychiatric treatment.
- Peripheral neuropathies.
- Any sensory impairments in the lower extremities.

Randomization

Setting and location of the study: Tertiary care hospitals, Miraj. Allocation: Subjects were allocated in the Group A (wobble board exercise) and Group B (BOSU ball exercise) by using the chit method.

Implementation: The method of randomization and allocation of the samples in the study was done by the researchers themselves.

Procedure

- Pre-test was done using BBS, FES-I and SF-36 questionnaire as the outcome measures, proceeding with the exercise protocol.
- **Group A** received wobble board exercise training session for 30min, 2 days a week for 4 weeks which included

- Warm up (10min)
- Slow walking
- Stretching of all joints and major muscles
- Wobble board exercise with assistance (15 min)
- Anterior-posterior cycles
- -tilt the wobble board back and forward in the sagittal plane in a controlled manner. 3 sets of 10 repetitions and 1 minute rest between sets.
- Medial-lateral cycles
- -tilt the board side to side in the frontal plane. 3 sets of 10 repetitions and 1 minute rest between sets.
- Cool down (5min)
- Stretching of all joints and major muscle groups

- **Group B** received BOSU ball exercise training session for 30min, 2 days a week for 4 weeks which included
- Warm up (10min)
- Slow walking
- Stretching of all joints and major muscles
- BOSU ball exercise (15 min)
- Stepping up and down on the BOSU ball alternating each foot for all repetitions.
  Parallel bars can be used as a support. 3 sets of 10–15 repetitions with 1 minute of rest between sets.
- Standing on BOSU ball. Parallel bars can be used as support. 3 sets of 15 seconds and 1 minute rest between sets.
- Standing on BOSU ball. Just by one hand on parallel bar.3 sets of 15 seconds and 1 minute rest between sets.
- Standing on BOSU ball. Just by one hand on parallel bar with eyes closed.3 sets of 15 seconds and 1 minute rest between sets.
- Cool down (5min)
- Stretching of all joints and major muscle groups
- After the cessation of exercise protocol, post-test was done using the same outcome measures.
- The study was conducted for 4 weeks (2days/week)

Statistical analysis

The statistical analysis was done by using SPSS version 20. Pre and Post treatment outcomes of BBS, FES-I and SF-36 subscales was done using paired t test and between the group analysis was done using an unpaired t test.

Results

- Characteristic of participants

It is clear from Table 1 that there is no significant difference between the groups in terms of age. Also Table 2 shows that no difference was observed as regards to the gender distribution.

Table 1: Mean age comparison in the two intervention groups

Age	N	Mean	Std. Deviation	p value
Group A	30	70.50	6.15	0.642
Group B	30	69.77	6.00	

Table 2: Gender distribution in two intervention groups A and B

Gender	Group A	Group B	Total	Chi square statistic	P value
Female	20	18	38	0.29	0.59
Male	10	12	22		
Total	30	30	60		

- Balance, fear of fall and quality of life

We observed in Table 3 that there was no statistically significant difference between Group A and Group B before the intervention program.

Table 3: Comparison of BBS, FES-I and quality of life of Group A and Group B pre-intervention program

Variables	Group A		Group B		P value
	Mean	SD	Mean	SD	
BBS	36.87	2.33	36.93	4.25	0.94
FES-I	31.70	4.26	32.77	5.06	0.381
SF-36 subscales					
Physical functioning	61.50	18.99	60.33	9.55	0.765
Role limitations due to physical health	18.67	21.81	19.17	20.26	0.927
Role limitation due to emotional problem	4.44	11.52	3.33	10.17	0.694
Energy/fatigue	46.17	14.84	47.00	11.49	0.809
Emotional wellbeing	61.30	11.93	60.63	10.31	0.818
Social functioning	64.73	15.33	63.42	19.47	0.772
Pain	67.42	8.87	68.50	20.34	0.791
General health	65.00	16.61	66.83	9.96	0.606

BBS: Berg balance scale, FES-S: Fall efficacy scale-International, SF-36: Short Form-36

Table 4 noted that Group A geriatric population after wobble board exercise showed significant difference in all the parameters.

Table 4: Comparison of BBS, FES-I and quality of life of Group A pre and post intervention program

Variables	Pre test		Post test		P value
	Mean	SD	Mean	SD	
BBS	36.87	4.25	45.43	4.18	<0.001
FES-I	31.70	4.26	23.07	2.85	<0.001
SF-36 subscales					
Physical functioning	61.50	18.99	75.10	14.81	<0.001
Role limitations due to physical health	18.67	21.81	63.00	16.01	<0.001
Role limitation due to emotional problem	4.44	11.52	55.22	21.37	<0.001
Energy/fatigue	46.17	14.84	61.00	12.55	<0.001
Emotional wellbeing	61.30	11.93	76.77	8.60	<0.001
Social functioning	64.73	15.33	81.13	9.06	<0.001
Pain	67.42	8.87	83.88	9.79	<0.001
General health	65.00	16.61	74.67	14.20	<0.001

Table 5 noted that Group B geriatric population after BOSU ball exercise showed significant improvement in all the parameters.

Table 5: Comparison of BBS, FES-I and quality of life of Group B pre and post intervention program

Variables	Pre test		Post test		P value
	Mean	SD	Mean	SD	
BBS	36.93	2.33	48.27	1.86	<0.001
FES-I	32.77	5.06	20.90	1.81	<0.001
SF-36 subscales					
Physical functioning	60.33	9.55	84.53	6.39	<0.001
Role limitations due to physical health	19.17	20.26	72.67	16.12	<0.001
Role limitation due to emotional problem	3.33	10.17	62.39	20.06	<0.001
Energy/fatigue	47.00	11.49	68.33	9.59	<0.001
Emotional wellbeing	60.63	10.31	81.72	6.84	<0.001
Social functioning	63.42	19.47	89.50	9.57	<0.001
Pain	68.50	20.34	88.58	12.36	<0.001
General health	66.83	9.96	82.83	10.88	<0.001

As for the comparison between Group A and Group B Table

6 shows that there was a significant difference for BBS, FES-I, physical functioning, role limitations due to physical health, energy/fatigue, emotional well-being, social functioning and general health, but no significant difference was observed for role limitation due to emotional problem and pain parameters.

Table 6: Comparison of BBS, FES-I and quality of life of Group A and Group B post-intervention program

Variables	Group A		Group B		P
	Mean	SD	Mean	SD	value
BBS	45.43	4.18	48.27	1.86	0.002
FES-I	23.07	2.85	20.90	1.81	0.001
SF-36 subscales					
Physical functioning	75.10	14.81	84.53	6.39	0.003
Role limitations due to physical health	63.00	16.01	72.67	16.12	0.023
Role limitation due to emotional problem	55.22	21.37	62.39	20.06	0.186
Energy/fatigue	61.00	12.55	68.33	9.59	0.014
Emotional wellbeing	76.77	8.60	81.72	6.84	0.017
Social functioning	81.13	9.06	89.50	9.57	0.001
Pain	83.88	9.79	88.58	12.36	0.108
General health	74.67	14.20	82.83	10.88	0.015

Thus, BOSU ball exercise shows more significant improvement than wobble board exercise on balance, fear of fall and has positive impact on quality of life in geriatric population on BBS, FES-I and SF-36 questionnaire.
Hence, the study accepts the alternative hypothesis and rejects null hypothesis.

Fig 1

Fig 2

Discussion

A total of 60 subjects were recruited in the study, which were divided in two groups with 30 in each group. Group A was given Wobble board exercise and Group B was given BOSU ball exercise along with warm up and cool down in addition to set treatment protocol 2 times a week for 4 weeks. Balance, fear of fall and quality of life were measured before commencing the treatment and after the termination of the treatment. The mean of the pre and post values were compared using paired t test for intragroup results and unpaired t test for intergroup results. The results showed statistical significant difference within the groups ($p<0.001$) for all parameters and statistically significant between group difference were found for BBS ($p=0.002$), FES-I ($p=0.001$), physical limitations due to physical health ($p=0.023$), energy ($p=0.014$), emotional well-being ($p=0.001$) and general health ($p=0.015$) but no statistical significant between-group difference were found for role limitations due to emotional problem ($p=0.19$) and pain ($p=0.11$) suggesting BOSU ball exercise showed more significant improvement than wobble board exercise.

BOSU ball exercise seems to have worked based on the following mechanism: On BOSU ball, with eyes open (EO) to keep hold of balance the most frequently used strategy is ankle strategy due to control using distal musculature this is because in antero-posterior direction vision has stronger effect on variability of sway, whereas in mediolateral plane it was observed that under eyes open (EO) conditions, vision and proprioception controls antero-posterior movements. However under eyes closed (EC) conditions, hip strategy is used predominantly. This improves mediolateral displacement due to increased hip abductors and adductors muscle activity and proprioception improvement proves effective in antero-posterior movement [37]. On Wobble board, in standing posture geriatric population try to stabilize their ankles with maximum coactivation of tibialis anterior and gastrocnemius. This maximum coactivation result in disability in reacting to sudden perturbation with compensation strategies. Some reports have shown that for excursion of center of gravity (COG), ankle strategy is important and thus to improve ankle function wobble board training is effective, thereby causing A-P increase in sway [38, 39]. In geriatric population as age increases common problems faced are loss of balance, postural instability, gait impairment due to deficit in sensory, visual, vestibular and somatosensory inputs leading to high risk of fall [2]. Also studies have found that enhancing balance will help to lessen the risk of fall in elderly [40]. Vision, vestibular sense, proprioception, reaction time, muscle strength all together contribute in maintaining balance [26]. The sensory receptors (mechanoreceptors and proprioceptors) located in the skin, joints and muscles (muscle spindles, tendon organ afferent, cutaneous receptors and joint receptors) primarily are the neurological basis of proprioception [27]. Proprioception provides basic information for balance, the information such as postural instability recognition, location, joint speed, angle and movement of bodily activity is transmitted to the CNS which identifies and allows the production of normal movement, protects the joint from external injury [28, 29]. With normal aging proprioceptive acuity deteriorate and specific pathologies hinder proprioception which includes following diseases like degenerative joint diseases like osteoarthritis and peripheral neuropathy [41].

Following evidence from various studies reported that exercises has been proven to improve the balance of geriatric population. Rozzi *et al*., found that to restore ankle stability, balance training can be used improving the

adequacy of the affected proprioceptive pathways, resulting in improvement in balance ability and reduction in parameters of sway [42]. Paterson *et al*., reported that with advancing age joint flexibility decreases which in turn affects the functional ability, he found that exercises helps to improve flexibility in older adults [43]. Clemson *et al*.; 2004 reported improved lower limb strength and other physical functions in elderly by performing land based exercise. Also these exercise found to prevent falls among elderly people [44]. Stanek *et al*., revealed that BOSU ball implied to be most demanding to maintain both COP (center of pressure) and sway velocities [45]. The study by Clark and Burden investigated the biomechanical effects of balance training which showed that the associated peroneal muscular activity through periodic inversion-eversion monitored by proprioceptors and by the protective mechanism of the musculature cause an increase in activation of the afferent pathways, thereby enhancing stability [46]. The study done by Linkoko T *et al*., have shown that the exercise program focused on the balance training has proven effective on the balance, functional ability and quality of life of young old and old [47]. In this study it was thought that these two intervention would be a highly challenging for subjects with poor balance. Although no participant showed any fall event or serious medical issue. Even the participants attendance rate for both the exercise protocol was high. Our study revealed that under the supervision of Physiotherapist this exercise training could be safely performed on both Wobble board and BOSU ball by elderly people.

Our data supported alternate hypothesis that BOSU ball exercise was more effective than wobble board exercise in balance, fear of fall and has positive effect on quality of life in geriatric population. Hence, null hypothesis is rejected.

Limitation and Suggestions

In this study, no assessment was performed for muscular strength and functional limitations (for e.g. reduced mobility of vertebral column). These factors can affect postural control.

Also, no postural evaluation was done to detect postural deformities that might impede with the balance.

- Further study can be done considering the muscle strength with balance training on balance, fear of fall and quality of life in elderly.

Addition, further follow-up is needed on how to sustain wobble board exercise and BOSU ball exercise to achieve long-term effects.

Conclusion

In summary, there was significant difference between wobble board exercise and BOSU ball exercise on BBS, FES-I and SF-36 questionnaire. Thus, study concludes that BOSU ball exercise is more effective in improving balance, fear of fall and has positive effect on quality of life than wobble board exercise in geriatric population.

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