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RESEARCH ARTICLE
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ROLE OF STATIC AND DYNAMIC BALANCE EXERCISES TO IMPROVE BALANCE AMONG GERIATRIC POPULATION TO PREVENT FALLS.

Mandeep Kaur[1], Sandeep Kaur[2*], Hargurdas Singh[3], Prabhjot Kaur Gill[4]

[1]Registered Physiotherapist, Springbook Health and Wellness, Brampton, Ontario. mandeepsanghera83@gmail.com
[2*]Assistant Professor, Dept of Physiotherapy, Sri Guru Ram Das Institute of Medical Sciences and Research, Sri Amritsar, Punjab, India. schatrath1984@gmail.com
[3]Assistant Professor, Dept of Internal Medicine, Sri Guru Ram Das Institute of Medical Sciences and Research, Sri Amritsar, Punjab, India. hargurdas@gmail.com
[4]Professor, Department of Genetics, Sri Guru Ram Das Institute of Medical Sciences and Research, Sri Amritsar, Punjab, India. pjkgill@gmail.com

***Corresponding Author:** Sandeep Kaur
*Assistant Professor, Dept of Physiotherapy, Sri Guru Ram Das Institute of Medical Sciences and Research, Sri Amritsar, Punjab, India. schatrath1984@gmail.com

ABSTRACT

INTRODUCTION: The physical act of falling is very common among the geriatric population and one that presents a substantial health problem due to the overwhelming rise in human life expectancy. The study was undertaken to improve balance in the geriatric population by means of static and dynamic balance exercises in order to reduce the risk of falls.
MATERIAL AND METHODS: It was an experimental study. A specified protocol of dynamic and static exercises was implemented on 30 geriatric patients, and balance was assessed at baseline and post-intervention by using the Berg Balance Scale and Dynamic Gait Index.
RESULTS: On applying a paired t-test within a group for the variables Berg balance scale, the calculated t-value showed the significant difference that is the P<0.00. Similarly, on applying the paired t-test within a group for the Dynamic Gait Index, the calculated t-value showed a significant difference. In this present study, it has been found that more is the age, the greater the risk of falls. The results obtained in this study supported the alternate hypothesis. Both static and dynamic balance exercises improved balance as the Berg Balance Scale showed greater value, depicting the improvement in balance and reduction in the fall risk.
CONCLUSION: The present intervention study showed an improvement in the patients with impaired balance when a well-designed exercise regimen was implemented in geriatric patients. This study concluded that the lifestyle of elderly individuals can be improved to a greater extent by means of balance exercises, as the risk of injuries due to impaired balance can be put to control.

KEYWORDS: Geriatric, Fall, Static balance, Dynamic balance, Physiotherapy.

INTRODUCTION:

Balance is the capability to restore the body's centre of mass over its base of support[1]. Balance of the body is the result of a complex interaction of the sensory (afferent) system, which is responsible for identification of the position of the body and motion, and the motor (efferent) system, responsible for execution of motor responses and CNS integration processes. Static and dynamic balance are both equally important for an active lifestyle.

Falls among the elderly are popular and it is evident that each year one in three people over the age of 65 years experience a fall once or more[2,3]. Moreover, falls are recognised as the major cause of death from injury in people older than 65 years, and mortality from falls has been expanded by 42% over the past decade[4]. Fractures, loss of independence, functional limitations, and mortality are some of the serious complications in elderly individuals experiencing falls due to impaired balance[5,6]. Elderly people are more prone to falls both at their homes as well as outside in the community[7]. Elders show reduced ability to maintain balance when enforced with the perturbations imposed by functional demands such as splitting attention between tasks, as is required to maintain balance while walking in a crowd or crossing road. Various risk factors for falls have been distinguished and can be delegated either intrinsic or extrinsic. Extrinsic factors are related to the environment or hazardous activities, for instance, slippery surfaces, loose carpets, footwear, use of an assistive device, obstacles, and inadequate lighting [9]. Intrinsic factors are legitimately identified with the patients and these incorporate age, chronic disease, arthritis, gait disorders, muscle weakness, fear of falling, altered mental status, cognitive impairments, medications, sensory impairments, etc[10,11]. While evaluation of fall risk, history related to medication, including type, frequency of drugs, etc., should also be incorporated along with engaged assessment[12].

A wide range of research has emphasised on balance improvement and fall prevention by means of exercise programs in older adults[13-20]. Therapeutic exercises are the most effective tool in fall prevention when incorporated with comprehensive interventions focusing on health, surroundings, and possible risk factors that contribute to falls. It is mandatory to provide appropriate protections while providing therapeutic exercises, as there is a tendency for an individual to fall while active participation[21]. It has been found in previous studies that strength and flexibility exercises, balance training, Taiichi, and coalition of these activities, fetched in a class situation or individually[22-25] have enhanced strength, improved balance, and functional status along with the reduction in fall risk. Thus, a multi-focus approach including home-based evaluation, fall prevention education, and medications in combination with an exercise protocol has been proven to be beneficial[26,27]. The key component of this approach emphasizes the use of static and dynamic balance exercises. The idea of this research is to evaluate and implement an effective plan for balance training in the geriatric population to help in improving balance in patients who are vulnerable to the risk of falls.

MATERIAL AND METHODS:

This study was conducted at the tertiary care hospital and medical institute in Amritsar, Punjab. The study was carried out after ethical approval and after obtaining written informed consent from the patients.

The study design was a quasi-experimental design based on participants and convenience sampling. Full knowledge about the procedure of the study was given to each of the subjects both verbally as well as in written. A total of 30 subjects were enrolled in the study, meeting the inclusion criteria.

Inclusion criteria:

- Subjects aged 55-75 years.
- Both genders were included.
- Subjects able to understand instructions.
- Patients having a history of falls at least 4-5 times per month after 55 years of age.

Exclusion criteria:
• Subjects having central vestibular dysfunction.
• Migraine-related vestibulopathy.
• Head traumas.
• Multiple Sclerosis.
• Brainstem Stroke.
• Having an episode of epilepsy.
• American Heart Association Class D.
• Having a malignant condition.

The Subjects satisfying the inclusion criteria were then assessed at the baseline using the Berg Balance Scale (BBS)[32] and the Dynamic Gait Index (DGI)[36,37]. After assessment, they were provided with a well-designed regimen of static and dynamic balance exercises for overall 2-hour session a day, which was conducted twice, 4 times per week for 4 weeks. Patients were re-assessed after completion of intervention by using same assessment tools, that is, BBS and DGI. The interventions applied are as listed in Table 1[38].

Exercises demonstrated were as follows:
Static Balance Exercises:
• Standing with a wide base of support, then gradually reducing it (varying arm positions).
• Standing on a wobble board.
• Tandem walk position.
• Sitting on a vestibular (Swiss) ball.

Dynamic Balance Exercises:
• Sit-to-stand-to-sit.
• Step up and down.
• Stepping in all directions (forward, sideways, and backwards).
• Sideways reach tasks.

Table 1 - Depicting incorporated interventions

Intervention	Response required	Progressing the Challenge
1. Sit-to-stand-to-sit	Lower limb strength. Functional ability. Multiple tasks.	Lower the height of chair. With or without upper limb assistance. Add a cognitive task to the manual task.
2. Stepping in all directions (forwards, side, and back)	Choice step reaction time. Lower limb strength and coordination.	Use a mirror to provide visual feedback, increase speed of step. Performing stepping on soft surface, close eyes.
3. Reaching to limits of stability	Challenging limits to stability. Vestibular stimulation and integration. Upper and lower limb strengthening.	Stick objects on a wall in the front by reaching to limits in all directions up and down while keeping feet in one position. Lunge forwards to pick up objects that are shifted to a high shelf to the side and behind, progress by reaching further and increasing weight and size of objects.
4. Step up and down	Lower limb strengthening and endurance. Step reaction time.	Step up forwards, backwards, and sideways over the blocks of various heights, increase height, repetitions, and speed of stepping.
5. Ankle, hip, and upper limb balance strategy practice.	Lower limb strengthening. Balance strategy training.	Stand in front of a wall with toes touching a line 1/2 meter from the wall. Lean back towards the wall, keeping balance and dorsiflexing feet, and using arm movement to balance while lowering towards the wall.
6. Sideways reach task	Medio-lateral muscle strengthening in lower limb. Vestibular stimulation and	Stand between high and low table positioned on either side, pick up objects from one table and transfer to other table.

	integration. Challenging limits of stability. Multiple tasks and confounded proprioceptive input.	Move the tables further apart and increase weight and size of objects to increase challenge. The participants undertake the task standing on an exercise mat on the floor.
7. Ball games	Multiple tasks. Hand-eye coordination. Vestibular stimulation. Ballistic upper and lower limb activity.	Use inflated beach balls and progress to smaller or harder balls, or 2 or 3 balls at once. Add a cognitive task, such as nominating an animal that starts with 'G', while throwing and catching or kicking the ball.

RESULTS:

The present study among the geriatric population having risk of falls showed an improvement in the balance after following the exercise regimen designed with specific static and dynamic balance exercises. Both types of exercises improved balance, as the Berg Balance Scale showed higher values depicting the improvement in the balance and reduction in fall risk.

On applying Paired t-test within a group for the variable BBS, the calculated t-value showed the significant difference ($P<0.001$). In Table 1.1, the mean value of BBS pre-intervention was 40.53 with 8.689 standard deviation, and post-intervention mean was 46.73 with 6.565 standard deviation. Similarly, on applying the Paired t-test within a group for the variable DGI, the calculated t-value showed a significant difference ($P<0.001$). The mean value of DGI pre-intervention was 16.20 with 3.112 standard deviation, and post-intervention mean of DGI was 18.67 with 2.440 standard deviation, as shown in Table 1.1.

On applying Anova within two pre-intervention groups for the variable age, the calculated t-value showed significant difference. In Table 1.2, the mean value of pre-intervention BBS for age group of 55-64 years was 43.44 with a 6.308 standard deviation, and the mean value of pre-intervention BBS for age group of 65-75 years was 36.17 with 10.143 standard deviation. On applying Anova within two post-intervention groups for the variable age, the calculated t-value showed significant difference. The mean value of post-intervention BBS for age group of 55-64 years was 48.94 with 5.162 standard deviation, and the mean value of post-intervention BBS for age group of 65-75 years was 43.42 with 7.242 standard deviation, as shown in Table 1.2.

On applying Anova within two pre-intervention groups for the variable age, the calculated t-value showed significant difference. In Table 1.3, the mean value of pre-intervention DGI for age group of 55-64 years was 17.11 with 2.518 standard deviation, and the mean value of pre-intervention DGI for the age group of 65-75 years was 14.83 with 3.112 standard deviation. On applying Anova within two post-intervention groups for the variable age, the calculated t-value showed significant difference. The mean value of post-intervention DGI for age group of 55-64 years was 19.28 with 2.052 standard deviation, and the mean value of post-intervention DGI for age group of 65-75 years was 17.75 with 2.768 standard deviation as shown in Table 1.3.

In this study, it was found that more is the age, the greater the risk of falls. Thus, the results obtained by the present study support the alternate hypothesis. The data was analysed using SPSS version 16. Then the statistical analysis was done using a paired t-test and ANOVA.

Table 1.1: Paired t-test for variables BBS and DGI before and after intervention within the group.

VARIABLE	**PRE-INTERVENTION (Mean ± Standard deviation)**	**POST-INTERVENTION (Mean ± Standard deviation)**	**t-TEST**
BBS (Berg Balance Scale)	40.53±8.68	46.73±6.565	(P<0.05)
DGI (Dynamic Gait Index)	16.20±3.112	18.67±2.440	(P<0.05)

Table 1.2: ANOVA test for pre- and post-intervention BBS within two age groups.

VARIABLE (AGE)	BBS Pre-Intervention (Mean ± Standard deviation)	BBS Post-Intervention (Mean ± Standard deviation)	t-Test
55-64yrs	43.44±6.308	48.94±5.162	(P<0.05)
65-75yrs	36.17±10.143	43.42±7.242	(P<0.05)

Table 1.3: ANOVA test for pre- and post-intervention DGI within two age groups.

VARIABLE (AGE)	DGI Pre-Intervention (Mean ± Standard deviation)	DGI Post-Intervention (Mean ± Standard deviation)	t-Test
55-64yrs	17.11±2.518	19.28±2.052	(P<0.05)
65-75yrs	14.83±3.112	17.75±2.768	(P<0.05)

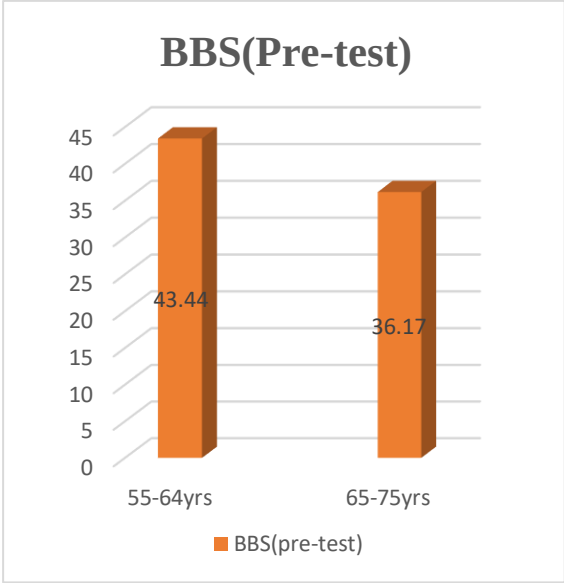

Fig 1. Anova mean difference in pre-intervention BBS between two age groups.

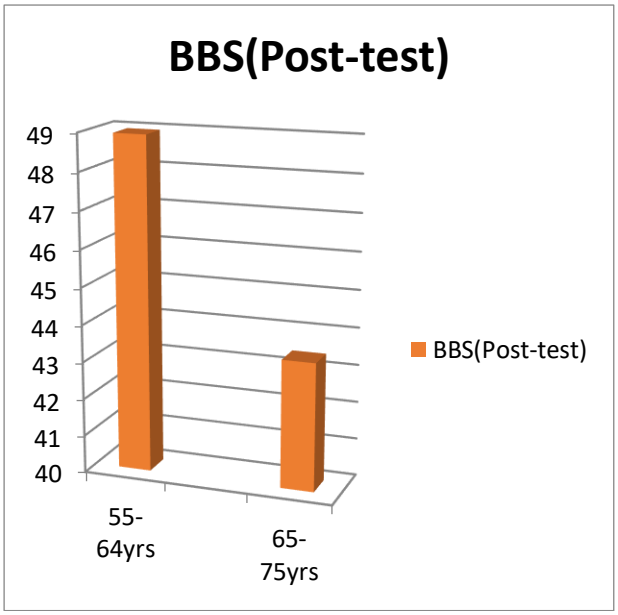

Fig 2. Anova mean difference in post-intervention BBS between two age groups**.**

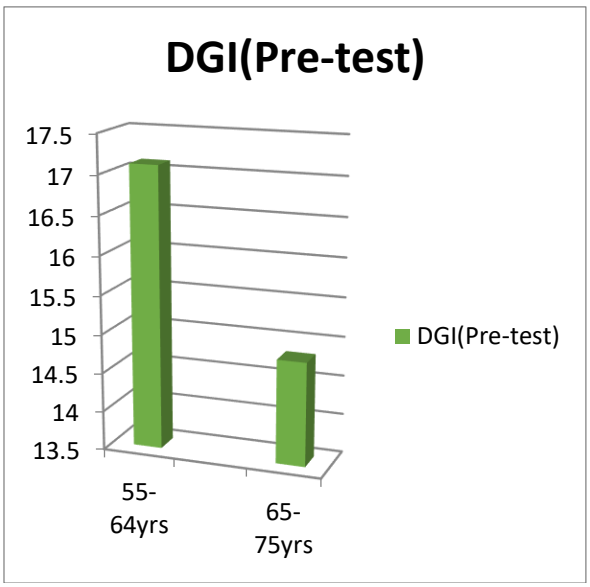

Fig 3. Anova mean difference in pre-intervention DGI between two age groups

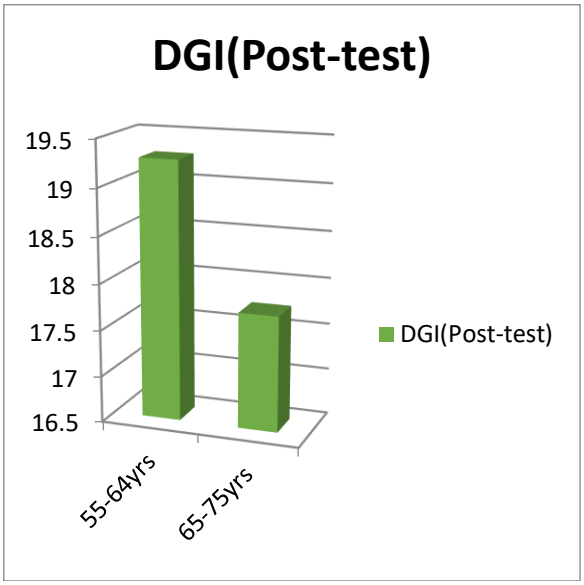

Fig 4. Anova mean difference in post-intervention DGI between two age groups.

DISCUSSION:

The main purpose of this study was to improve the balance among geriatric population by means of various static and dynamic balance exercises and reduce the risk of falls. Similarly, Max R. Paquette et al (2014) conducted a similar study in which they inspected the outcomes of 8 weeks supervised reactive balance training program in older adults.[28] They accentuated on the balance improvement and fall prevention through exercise regimen in which 25 participants were incorporated and completed 8-week intervention, two sessions of 30 minutes each per week. They utilized quick board reaction drill, forward foot speed drill, and backward foot speed drill. They concluded that dynamic balance exercises demonstrated a clear trend for the reduction in sway velocity when eyes of an individual were closed.

In contrast to recent study, Sherrington A.C. (2011) conducted systematic review update that included 54 randomized controlled trials and confirmed that exercise can prevent falls.[29] It revealed interventions that included balance training and contained a greater dosage of exercise, excluding walking training. They recommended that exercise for fall prevention should allow a moderate or high challenge to balance and should be undertaken for at least 2 hours per week on an ongoing basis. Additionally, it focused on fall prevention exercises in a group or home-based setting.

Also, Hatekar A.R. et al. (2015) conducted a study on the changes in postural stability and balance in multitasking with increasing task demands in normal healthy individuals of different ages.[30] It was found that 1 in every 3 adults over the age of 65 suffered from fall, and these numbers were expected to rise, making balance disorder a major health care crisis.

Choi H.J PT, and Kim J (2015) conducted a study on the effects of balance training and ankle training on gait of elderly people who have fallen.[31] The purpose of this study was to examine the impact of balance training and muscle training around ankle joint on the gait of elderly people who have experienced fall. Elderly individuals with risk of falling and Berg Balance scale score of 37 to 50 points who had experienced a fall in the last year were randomly and equally assigned to either a balance training group or an ankle training group. The balance training group received training on a hard floor, training while maintaining balance on a cushion ball in a standing position, and training while maintaining balance on an unstable platform in a standing position. The ankle training group received training to strengthen the muscles around the ankle joint and conducted stretching exercises for the muscles around the ankle joint. They concluded that both balance training and ankle joint training are affecting in enhancing the gait ability of elderly people with a risk of falling. In particular, balance training is effective in improving the gait velocity of elderly people who have experienced a fall compared with ankle joint training.

Also, Berg KO Maki B (1992) assessed validity of the Berg Balance Scale by examining how scale scores were related to clinical judgment and self-perceptions of balance, laboratory measures of postural sway, and external criteria reflecting balancing ability.[32] If scores could predict falls in elderly, and how they were related to motor and functional performance in stroke patients. 30 elderly subjects were assessed by clinical laboratory indicators reflecting balancing ability, the score correlated materiality with caregiver ratings, self-ratings, and laboratory measures of sway. Differences are mean scale scores where consistent with the use of mobility aids by elderly residents and differentiation of stroke patients by location of balance score, predictive of multiple falls in elderly individuals, and were strongly correlated with functional and motor performance in stroke patients.

Moreover, Blum Lisa, Bitensky et al (2008), The Berg Balance Scale is widely used clinical test of person's static and dynamic balance ability.[33] The BBS was recently identified as most commonly used assessment tool across the continuum of stroke rehabilitation. The BBS has been strongly established as valid and reliable, but there are yet several factors that may indicate that BBS should be used in conjunction with other balance measures, such as ceiling affect and floor effect, which have been reported for the BBS when used with community-dwelling older adults. The BBS is often used by physiotherapists and occupational therapists to determine the functional mobility of an individual. The test can be administered prior to treatment for an elderly individuals and patients with a history, but not limited to stroke.

Likewise, previous intervention studies concentrated on different frequencies and time frames over which the interventions were employed. Hauer et al. indicated 12 weeks of intervention, three times per week, to have a good effect on improving functional capacity, as did Gillies et al., who provided twice-weekly intervention.[22,34] However, Gardner et al. suggested that exercise programmes for falls prevention should become a lifetime propensity.[35] Workstations encourage this continuance with the tasks easily copied in the home condition.

This current study emphasizes mainly in improving balance by means of a guided exercise program that is purely institution-based to allow thorough observation. The home-based approach was not considered appropriate in this study because of lack of evident settings. Moreover, the exercise regimen was revised and simplified as per patient's ability to allow easy access to exercises, and frequency of static and dynamic exercises has been increased.

As per present study, the approach was experimental in which total of 30 subjects were enrolled in the study with age limit of 55-75 years, having history of frequent falls at least 4 to 5 times a month. This group of 30 subjects was involved in exercise protocol designed with specific static and dynamic balance exercises for period of 4 weeks. Meanwhile, they were assessed at baseline and after completion of the intervention by using Berg Balance Scale and Dynamic Gait Index. Initially, when assessment was taken at the baseline, it was noted that subjects with advanced age had greater risk of fall as their BBS score and DGI score were low and it was found that the score got improved when group was reassessed after the application of proper exercise regimen. That shows that there was significant improvement in the balance of these subjects and the risk of fall was reduced to greater extent.

LIMITATIONS:
• The sample size was less.
• Long-term follow-up was required.

FUTURE SCOPE:
• A future study can be done on increased sample size.
• Comparison between fallers and non-fallers can be highlighted more thoroughly.

CONFLICT OF INTEREST
Nil

SOURCE OF SUPPORT
Nil

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