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EFFECT OF VESTIBULAR ADAPTATION EXERCISE ON DYNAMIC BALANCE AND QUALITY OF LIFE AMONG ELDERLY

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ABSTRACT

Background of the study: Balance impairments in the elderly are often linked to a decline in sensory systems, including the vestibular system, which plays a crucial role in maintaining posture and equilibrium. Vestibular adaptation exercises involve repetition movements designed to enhance sensory-motor integration and improve dynamic balance by stimulating the vestibular system's plasticity. The study aims to evaluate the effect of vestibular adaptation exercises on dynamic balance in elderly individuals. With aging, balance deterioration is a significant concern, leading to increased fall risks. Vestibular adaptation exercises are believed to enhance the function of the vestibular system, potentially improving balance and preventing falls. **Methodology:** The study was conducted using a quasi experimental design. The study followed a Comparative pre and post study. The sampling method used in the study was convenient random sampling. The study was conducted at the Outpatient, Faculty of Physiotherapy, ACS Medical College and Hospital. The study included 30 subjects, comprising 14 males and 16 females. The intervention was administered for60 min per day /3 days per week /4 weeks (12 sessions). The duration of the study was six months. Inclusion criteria was Adults aged 60 and above, Diagnosed with mild to moderate balance issue, Able to participate in exercise interventions, No history of severe neurological disorders (e.g., stroke, Parkinson's disease). Outcome measures were Balance and Quality of life, and Measurement Tools were Y balance Test and Quality of life: Questionnaire. **Result:** Group A showed significant improvement in balance and quality of life, with notable changes in Y balance test and FOGQ scores ($p<0.0001$). **Conclusion:** Vestibular exercises improve balance and quality of life in elders and should be included in routine physiotherapy.

Keywords: Vestibular adaptation, Dynamic balance, Elderly, Balance exercise, Fall prevention, vestibular rehabilitation, aging, balance disorders, Quality of life.

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INTRODUCTION

Dynamic balance refers to the ability to maintain control and stability while moving or changing positions, requiring the integration of sensory inputs, muscular responses, and cognitive processing to adjust movements and maintain equilibrium in a constantly changing environment [(1)].

Balance disorders are a common problem, especially among the elderly. A study in Turkey found that the prevalence of balance disorders was 34.3% in community-dwelling elderly individuals. In terms of dynamic balance, research suggests that it develops and changes throughout adolescence. Lifestyle factors, such as participating in certain sports, can also impact dynamic balance [1-4].

The Incidence of dynamic balance disorders in India and worldwide is not explicitly stated in the available research. However, studies suggest that balance disorders, including dynamic balance issues, are common among the elderly population. In terms of specific statistics, a study published in the Lancet reported a prevalence of Parkinson's disease, which often involves dynamic balance disorders, of 44.6 per 100,000 people in Beijing, China [5-7].

According to various studies, the prevalence of balance disorders, including dynamic balance issues, is higher in Western countries, particularly in the United States .A study published in the Journal of Gerontology found that the prevalence of balance disorders was 35.4% in the United States, compared to 23.1% in Japan and 17.1% in China .Another study published in the European Journal of Neurology found that the prevalence of vestibular vertigo, a common cause of dynamic balance disorders, was higher in Germany (17.3%) and the United Kingdom (15.7%) compared to India (4.3%) and other Asian countries.

The higher prevalence of balance disorders in Western countries may be attributed to various factors, including: Aging population: Western countries have a higher proportion of elderly individuals, who are more prone to balance disorders. Sedentary lifestyle: A sedentary lifestyle, common in Western countries, can contribute to balance problems. Higher rates of chronic diseases: Western countries have higher rates of chronic diseases, such as diabetes and hypertension, which can increase the risk of balance disorders [8-10].

Age-related decline is a significant contributor, as dynamic balance abilities naturally deteriorate with age, making older adults more susceptible to balance related injuries and falls[1]. Neurological disorders, such as Parkinson's disease, multiple sclerosis, and stroke, can also affect the brain's ability to integrate sensory information and maintain balance [11,12].

Additionally, musculoskeletal disorders, including weakness or instability in the muscles and joints, can contribute to dynamic balance problems[13].

Dynamic balance disorders can manifest with a range of clinical features, including impaired postural control, difficulty with walking or changing direction, and increased risk of falls. Individuals with dynamic balance disorders may exhibit abnormal movement patterns, such as a wide-based gait or difficulty with single-leg stance. They may also experience dizziness, light-headedness, or vertigo,

particularly when changing positions or moving in crowded or complex environments[14].

Treatment for dynamic balance disorders typically involves a multidisciplinary approach that incorporates physical therapy, occupational therapy, and medical management. Physical therapists often use exercises such as balance training, gait training, and strengthening exercises to improve muscle function and balance. Occupational therapists focus on activities of daily living, such as bathing, dressing, and cooking, to improve functional independence. Medical management may involve medications to treat underlying conditions such as vertigo, dizziness, or anxiety. Additionally, vestibular rehabilitation therapy (VRT) is a specific type of physical therapy that targets the vestibular system and can be effective in improving balance and reducing symptoms of dizziness and vertigo [15,16].

Vestibular adaptation exercises, also known as vestibular rehabilitation therapy (VRT), were first introduced by Dr. Susan Herdman and Dr. Richard Clendaniel in the 1990s. These exercises aim to promote compensation and adaptation of the vestibular system, which is responsible for balance and equilibrium. Vestibular adaptation exercises have been shown to be effective in improving balance, reducing dizziness and vertigo, and enhancing overall quality of life in individuals with vestibular disorders. In addition to vestibular disorders, these exercises can also be used to treat other conditions such as benign paroxysmal positional vertigo (BPPV), labyrinthitis, vestibular neuritis, and concussion. Furthermore, vestibular adaptation exercises have also been used to treat balance and dizziness problems in individuals with conditions such as multiple sclerosis, Parkinson's disease, and stroke [17,18].

The Y Balance Test (YBT) is a functional assessment tool used to evaluate dynamic balance, flexibility, and strength. It was first introduced by Marshall et al. in 2005 as a modification of the Star Excursion Balance Test (SEBT). The YBT requires individuals to stand on one leg while reaching as far as possible with the other leg in three different directions, forming a "Y" shape. The test has been shown to be a reliable and valid measure of dynamic balance and functional movement patterns. Research has demonstrated that the YBT is sensitive to changes in balance and movement patterns, making it a useful tool for assessing and monitoring progress in individuals with various orthopedic and neurological conditions, such as ankle sprains, knee injuries, and stroke. The YBT has also been used as a predictive tool for identifying individuals at risk of injury or falls[19, 20].

Aim of the study: The aim of this study is to investigate the effect of vestibular adaptation exercises on dynamic balance and quality of life among elderly individuals aged 30-40 years and above, and to determine whether these exercises can improve functional outcomes and reduce the risk of falls in this population.

Need of the study: The elderly population, particularly those aged 80-100, is at a higher risk of falls and related injuries due to age-related declines in balance and vestibular function. Vestibular disorders, such as benign paroxysmal positional vertigo (BPPV), are common among older adults and can significantly impact quality of life. Despite the importance of maintaining balance and vestibular function in older age, there is a lack of research on the effectiveness of vestibular

adaptation exercises in improving dynamic balance and quality of life in this population. This study aims to address this knowledge gap by investigating the effect of vestibular adaptation exercises on dynamic balance and quality of life among elderly individuals aged 80-100. The findings of this study can inform the development of evidence-based exercise programs tailored to the needs of this vulnerable population.

METHODOLOGY

The study was conducted using a quasi experimental design. The study followed a Comparative pre and post study. The sampling method used in the study was convenient random sampling. The study was conducted at the Outpatient, Faculty of Physiotherapy, ACS Medical College and Hospital. The study included 30 subjects, comprising 14 males and 16 females.

The intervention was administered for60 min per day /3 days per week /4 weeks (12 sessions). The duration of the study was six months. Inclusion criteria was Adults aged 60 and above, Diagnosed with mild to moderate balance issue, Able to participate in exercise interventions, No history of severe neurological disorders (e.g., stroke, Parkinson's disease). Outcome measures were Balance and Quality of life, and Measurement Tools were Y balance Test and Quality of life: Questionnaire.

Procedure: 30 people with mild to moderate balance issue were included in the study based on the inclusion and exclusion criteria. People with mild to moderate balance issue problems were included in the study using convenient random sample method. Informed consent were obtained from all the participants both male and female clients with mild to moderate balance issue at the age group of above 60 and having severe cognitive impairment disorders and cardiovascular or musculoskeletal conditions were excluded from the study. The purpose of the study and exercise were explained to all the participants. Pretest core were taken initiating the vestibular adaptation exercises using Y balance test and quality of life questionnaire and Post test score were taken after 4 weeks. The pretest and post test score were compared.

Intervention: Participants were treated with visible or Vestibular adaptation exercises aim to improve dynamic balance and reduce dizziness by enhancing central compensation mechanisms.

Gaze Stability Exercises: Hold a target (e.g., a letter on a card) at arm's length.

- Move the head horizontally while keeping eyes fixed on the target for 30 seconds.
- Repeat with vertical head movements.
- Perform 3 sets per direction daily.

Postural Stability Exercises: Tandem Stance: Stand with one foot in front of the other for 30 seconds, then switch feet.

Single-Leg Stance: Stand on one leg for 10–15 seconds, then switch.

Sway Exercises: Shift weight forward-backward and side-to-side while standing on a firm surface.

Progression: Perform these exercises on a foam surface or with eyes closed.

Repeat the exercise for 3 times per day.

Balance exercises:

Heel-to-Toe Walking: Walk in a straight line, placing heel in front of the toes of the opposite foot.

Obstacle Walking: Step over cones or objects placed at varying distances.

Turning Exercises: Walk in a small circle in both directions.

Progression: Increase speed or perform on uneven surfaces.

Perform 10–15 minutes per session, 3 times a day.

Functional Mobility & Quality of Life Enhancement:

Sit-to-Stand Training: Rise from a chair without using hands.

Stepping in Different Directions: Step forward, backward, and sideways.

Dual-Task Training: Walk while carrying an object or talking.

Progression: Increase speed and add cognitive challenges.

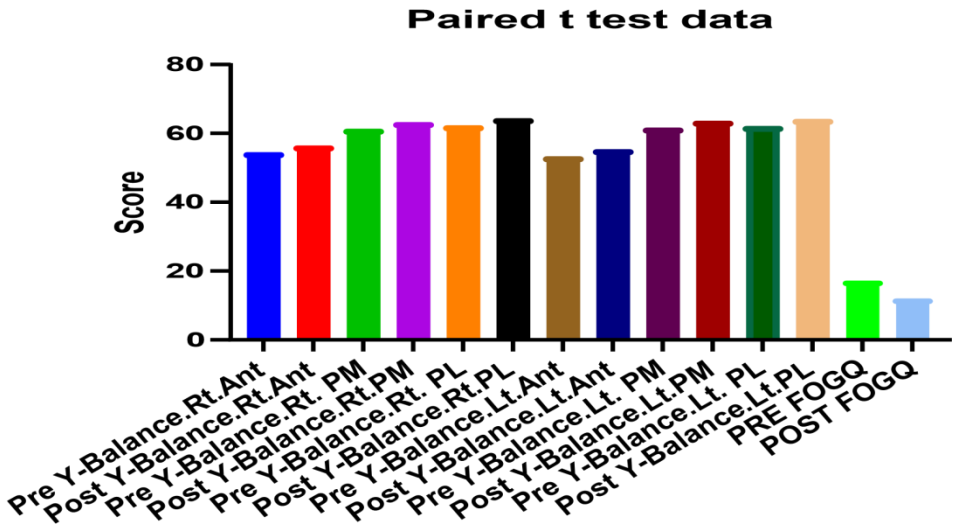
Perform daily for 10–15 minutes.

Data Analysis: The collected data were tabulated and analyzed using both descriptive and inferential statistics. All the parameters were assessed using Graph Prism Pad version 8.4.3, with a sign of p value less than 0.05 and a 95% confidence interval set for all analysis. Paired t-test was adopted to find the statistical difference within the groups (Student t-Test) was adopted to find statistical difference in the group.

Table-1. Paired t test within group a on Y BAL. ANT. (RT), Y BAL. PM. (RT), Y BAL. PL. (RT), Y BAL. ANT. (LT), Y BAL. PM. (LT), Y BAL. PL. (LT), FOGQ

Group A	Number of Pairs	Mean Diff.	SD, SEM	df	t	P value	Sig. Diff. (P < 0.05)
Y Bal. Ant. (Rt)	30	1.97	0.18 0.03	29	59.00	<0.0001	****
Y Bal. PM. (Rt)	30	1.93	0.25 0.05	29	41.74	<0.0001	****
Y Bal. PL. (Rt)	30	2.07	0.36 0.067	29	31.00	<0.0001	****
Y Bal. Ant. (Lt)	30	2.03	0.18 0.03	29	61.00	<0.0001	****
Y Bal. PM. (Lt)	30	1.96	0.18 0.03	29	59.00	<0.0001	****
Y Bal. PL. (Lt)	30	2.07	0.37 0.67	29	31.00	<0.0001	****
FOGQ	30	5.23	1.01 0.18	29	28.48	<0.0001	****

The above table 1 shows significant difference in Y Bal. Ant. (Rt), Y Bal. PM. (Rt), Y Bal. PL. (Rt), Y Bal. Ant. (Lt), Y Bal. PM. (Lt), Y Bal. PL. (Lt), FOGQ within Group A with mean difference of 1.97, 1.93, 2.07, 2.03, 1.96, 2.07 and 5.23, respectively and P value of >0.0001



Presentation of Y BAL. ANT. (RT), Y BAL. PM. (RT), Y BAL. PL. (RT), Y BAL. ANT. (LT), Y BAL. PM. (LT), Y BAL. PL. (LT), FOGQ WITHIN GROUP A

RESULT

Total 30 participants, of 14 male and 16 female subjects were included in the study based on specific selection criteria. Participants were with age group between 60 and 75 years.

Group A was effective on Y Bal. Ant. (Rt), Y Bal. PM. (Rt), Y Bal. PL. (Rt), Y Bal. Ant. (Lt), Y Bal. PM. (Lt), Y Bal. PL. (Lt), FOGQ tests with mean score difference of 1.97, 1.93, 2.07, 2.03, 1.96, 2.07 and 5.23, respectively.
Group A intervention found effective on Y Bal. Ant. (Rt), Y Bal. PM. (Rt), Y Bal. PL. (Rt), Y Bal. Ant. (Lt), Y Bal. PM. (Lt), Y Bal. PL. (Lt), FOGQ with significant difference in P value 0.0001.

DISCUSSION

The purpose of the current study was to assess how vestibular adaptation exercises affected the quality of life and dynamic balance of older adults. For 4 weeks, 30 participants in all received vestibular adaptation exercises 3 times a week for 60 minutes each day as part of a planned intervention program. The outcomes demonstrated the therapeutic significance and efficacy of vestibular adaptation exercises in geriatric rehabilitation, with both dynamic balance and quality of life improving statistically significantly after the intervention.

The vestibular system suffers anatomical and functional alterations with aging, such as hair cell degradation, vestibular nerve fibre diminution, and a decline in central processing

efficiency. These alterations cause imbalance, which raises the risk of falls and causes unsteadiness and vertigo. Baloh et al. (2001) claim that age-related vestibular deterioration plays a major role in balance difficulties in older persons, which frequently result in lower quality of life and limits in everyday activities[20].

Vestibular-related dizziness or imbalance affects more than 30% of people over 70. Lower results on tests of physical function and health-related quality of life are linked to these deficits. These results are corroborated by the current investigation, which demonstrates that vestibular mechanism-focused therapies can directly improve balance and psychosocial outcomes[21].

Vestibular adaption exercises are intended to increase gaze stability and vestibulo-ocular reflex (VOR) function. These exercises help the central nervous system compensate for vestibular impairments by requiring head movements while maintaining visual concentration. Dynamic stability and confidence were improved in our study by workouts such as VOR x1 and x2, dynamic postural challenges, and balance retraining. In a controlled study by Herdman et al. (2003), vestibular adaptation training dramatically decreased symptoms and enhanced balance in older patients with chronic vestibular hypofunction. These results are consistent with our own, which showed that four weeks of organized vestibular training improved the dynamic balance of older participants[22].

vestibular rehabilitation dramatically improved older persons' ability to balance and reduced their chance of falling. They underlined that customized vestibular exercises boosted self-esteem and autonomy, which is supported by higher post-intervention quality of life scores in our study. According to Enticott et al. (2005), vestibular exercises have the neuroplastic potential to assist re-calibrate sensory- motor integration through repetitive head and eye movement training. Our participants' improvements were probably influenced by this adaption process [23].

Additionally, interactive and captivating vestibular training has been added in recent studies. The clinical importance of multi-modal techniques in vestibular rehabilitation is supported by Szturm et al. (2011), who employed interactive video-game-based vestibular exercises and observed notable improvements in postural stability and cognitive engagement among older persons[(37)].

Older individuals' subjective dizziness and fear of falling can restrict their ability to interact socially and independently. These constraints frequently result in a decreased quality of life. Significant gains in reported quality of life were noted after the intervention in our study. The psychosocial benefits of vestibular rehabilitation are notable reductions in anxiety, improved mood, and greater participation in activities of daily living[24].

These psychosocial gains were evident in our participants as well, demonstrating that physical improvements from vestibular exercises also contribute to emotional well-being. Kawashima et al. (2014) also emphasized the role of vestibular rehabilitation in promoting functional independence and social integration. Their study showed that elderly individuals who underwent regular vestibular training experienced fewer falls and higher satisfaction with life[25].

Additionally, Davis et al. (2012) discovered that systematic vestibular and balance training led to improved health scores, decreased hospitalization from falls, and increased physical activity among older adults living in the community. This illustrates how, when used methodically, vestibular rehabilitation can have a wide-ranging effect on public health [26].

Although Tai Chi, weight training, and proprioceptive exercises are useful alternate ways for improving balance, vestibular-specific therapies target vestibular dysfunction directly, which is frequently the underlying cause of balance impairment in the elderly. According to a review by McDonnell and Hillier (2015), vestibular rehabilitation reduces dizziness and fall risk in older persons with vestibular dysfunction more effectively than general balance exercises[27].

CONCLUSION

This study demonstrates that vestibular adaptation exercises are effective in improving dynamic balance and quality of life in elderly individuals. The results are in agreement with several well-established studies, reinforcing the need for integrating such exercises into routine geriatric physiotherapy. Future research with larger sample sizes, control groups, and long-term follow-up is recommended to establish broader clinical implications.

In this study, the implementation of vestibular exercises such as gaze stabilization, head movement coordination, and postural tasks led to better integration of visual, vestibular, and somatosensory input. This multisensory integration is crucial for maintaining balance during dynamic activities, especially in the elderly, where sensory deficits are common.

Clinically, improved dynamic balance translates into a reduced risk of falls, greater confidence in mobility, and an increased ability to participate in daily activities independently. As balance improves, anxiety and fear of falling decrease, which in turn enhances psychosocial well-being and overall quality of life. This explains the concurrent improvements observed in both balance outcomes and quality of life measures following vestibular adaptation exercises.

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