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Effect of Balance Training on Diabetic Geriatric Population using FAME (Fitness and Mobility Exercise) Program

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Abstract: ***Background: Diabetes is one of the major significant worldwide health concerns of the twenty-first century, ranking as the fourth or fifth leading cause of death. Inactivity is associated with the repression of insulin-sensitive kinases and may boost the collection of FFA (Free Fatty Acids) in skeletal muscle. In addition to diabetes's direct effects on neurons, disruptions to the vascular system and the neuronal support provided by Schwann cells also contribute to neuropathy. Patients with persistent diabetes are experiencing an increased frequency of falls. Unfortunately, a lot of people who are vulnerable to fall become fearful of falling, which makes them less active and less mobile. As a result, their physical fitness declines. Studies have been showed that exercise training programs can greatly strengthen the balance and gait of older adults with diabetes, despite the fact that they frequently have an elevated risk of falling. An interventional approach is necessary to reduce falls in individuals with diabetes, and there is compelling evidence of a benefit in the elderly population. Fitness and Mobility Exercise program (FAME) is a community-based exercise program for individuals designed to enhance mobility and fitness and mitigate the risk of subsequent complications such as falls and fractures. Aim: To examine the effect of balance training using FAME program in diabetic geriatric population. Objectives: To evaluate the effect of balance training using FAME program in diabetic geriatric population with the help of Tinetti POMA scale and BOOMER scale. Methods: 46 participants out of which 31 males and 15 females were chosen based on the inclusion and exclusion criteria. At the beginning of the study demographic data was taken. Baseline measurements of balance, gait and functional mobility were taken using Tinetti POMA and BOOMER scale. As per the FAME protocol participants underwent a structured exercise program for 4 weeks consisting of 12 sessions, designed to enhance balance and functional mobility. Outcome measures were again assessed post intervention. Statistical analysis was performed to compare pre and post-intervention outcomes. Results: Statistically significant differences were seen in Tinneti POMA and BOOMER score. Conclusion: This study suggests that implementing a balance exercise program is crucial to enhance and maintain the advantages of exercise in individuals with diabetes. Additionally, it serves to mitigate the risks associated with falls and immobility, thereby promoting overall health and well-being in this population.***

Keywords: Diabetes, Diabetic neuropathy, Balance, Geriatrics, Fitness and Mobility exercise program (FAME).

1. Introduction

Diabetes is a major global health issue of the 21st century, consistently ranking as predominant causes of death alongside cancer, respiratory disorders, and cardiovascular disease (CVD). It is a prevalent non-communicable disease, particularly impacting developed nations. As per the evaluation of IDF, 8.8% of adults worldwide suffer from diabetes, with men having slightly higher rates (9.6%) than women (9.0%)[1] . According to the 2021 reports from the International Diabetes Federation (IDF), diabetes affects 1 in 11 adults globally and India accounts for 1 in 7 adults with diabetes worldwide[2]. The disease, particularly Type 2 diabetes, poses significant risks due to insulin resistance and reduced pancreatic beta-cell function, leading to insufficient insulin production over time. This condition causes hyperglycemia, damaging blood vessels and nerves and resulting in severe microvascular (e.g., retinopathy, nephropathy, neuropathy) and macrovascular complications affecting the heart, brain, and peripheral arteries[3],[4]. Exercise plays a crucial role in managing diabetes by enhancing insulin sensitivity, reducing free fatty acid accumulation in muscles, and improving glucose uptake without excessive reliance on insulin. Conversely, physical inactivity exacerbates insulin resistance, worsening the condition despite similar levels of adiposity [5]. Long-term diabetes significantly impacts peripheral nerves, affecting both myelinated and unmyelinated axons primarily through Schwann cell alterations. These cells, essential for peripheral nervous system stability and regeneration, suffer from reduced support due to hyperglycemia and dyslipidemia, exacerbating neuropathy [6]. Maintaining mobility and independence in older adults with diabetes becomes challenging due to postural instability, gait irregularities, and increased fall risk. These issues stem from compromised muscle strength, slower reflexes, and age-related cognitive decline [7]. Chronic diabetes often leads to postural instability and gait irregularities, requiring coordinated function of neurological, cerebrovascular, musculoskeletal, and vestibular systems for walking and stability[8]. Patients with

chronic diabetes experience increased fall frequency due to challenges in balance maintenance[9],[10]. Addressing these challenges, programs like the Fitness and Mobility Exercise (FAME) aim to enhance functional strength, agility, and balance among diabetic individuals. FAME includes stretching, standing functional strengthening exercises, agility drills, and balance training to improve overall health, reduce fall risk, and maintain independence. Such interventions target multiple domains including muscle strength, bone health, mobility, and psychological well-being, crucial for managing diabetes-related complications and enhancing quality of life [11]. In conclusion, managing Type 2 diabetes goes beyond glycemic control to include comprehensive strategies that preserve functional autonomy and extend disability-free life expectancy. Exercise-based interventions like FAME play a pivotal role in achieving these goals by mitigating the risk of falls and fractures, thereby addressing the multifaceted challenges posed by diabetes in aging populations [12].

2. Aim

To examine the effect of balance training using FAME program in diabetic geriatric population.

3. Objectives

- To evaluate the effect of balance training using FAME program in diabetic geriatric population with the help of Tinetti POMA scale.
- To evaluate the effect of balance training using FAME program in diabetic geriatric population with the help of BOOMER scale.

4. Methodology

- Study Design- Interventional study
- Study Type -Quasi-experimental study
- Sampling Method- Convenience sampling
- Study Duration- 1 year
- Duration of Data Collection- 6 months
- Sampling Calculation- Calculated using G-power
- Study Population- Geriatric individual with diabetes

a) Inclusion Criteria-

- Diabetic geriatric population (Age > 65 years)
- Patients who score less than 7 in the self-questionnaire of the Michigan Neuropathy Screening Instrument (MNSI) and more than 2.5 in physical assessment of the Michigan Neuropathy Screening Instrument (MNSI).

b) Exclusion Criteria-

- Any recent musculoskeletal or neurological condition that may hinder participation in current study.
- Any recent surgery that may restrict participation in the study.

5. Procedure

- Ethical Approval was taken
- CTRI Registration done
- Selection of participants was done on the basis of inclusion and exclusion criteria
- Informed Consent was obtained from the participants
- Outcome measures were assessed at the commencement of the study: pre-assessment
- Structured exercise regimen of Balance training for 4 weeks was taught to the participants. Outcome measures were reassessed at the end of 4 weeks: post-assessment
- Data analysis done using (SPSS version 29) paired t test

Balance Training: Fitness and Mobility Exercise (FAME) Program[11] was used for 3 Session per week for 4 weeks.
Week 1 Protocol: All the exercises of FAME Program were performed.
Week 2 Protocol: Same as week 1 protocol with increase in sets and repetitions of functional strengthening and balance exercise.
Week 3 Protocol: Same as week 2 protocol but performed without support.
Week 4 Protocol: Same as week 3 protocol.

6. Results

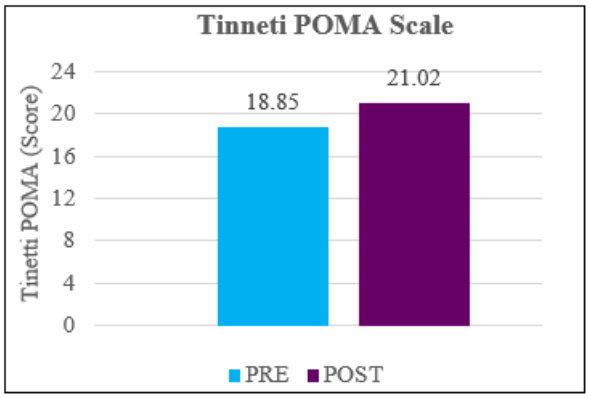
All the results were recorded and analysed by using Statistical Package of Social Science (SPSS) software version 29. The result was concluded to be statistically significant with $p<0.05$. Paired t test was used to compare between Pre and Post intervention.

Table 1: Demographic data with mean and standard deviation

Demographic Data	Male	Female	Total
No. of Participants	31	15	46
Age (in years)	72.13 (±4.731)	69.80 (±4.246)	71.37 (±4.664)

Table 2: Analysis of Pre and Post values of Tinetti POMA Scale

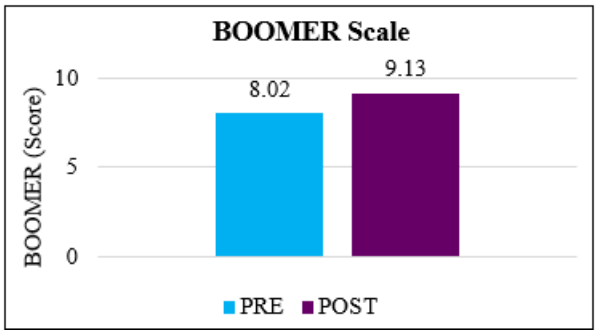
Outcome Measure	Pre	Post	P-value
Tinetti POMA (Score)	18.85 (±3.204)	21.02 (±3.461)	<0.001



Graph 1: Pre and Post values of Tinetti POMA Scale

Table 3: Analysis of Pre and Post values of BOOMER Scale

Outcome Measure	Pre	Post	P-value
BOOMER (Score)	8.02 (±2.333)	9.13 (±2.437)	<0.001



Graph 2: Pre and Post values of BOOMER Scale

7. Discussion

This study was carried out to evaluate the effect of balance training on diabetic geriatric population using FAME program. 46 subjects were recruited as a part of this study out of which 31 were males and 15 were females. Table 1 denotes the demographic data with mean and standard deviation. The age range of the sample population was 65 to 82 years, with the mean age for males and females obtained as 72.13 years and 69.80 years respectively.

Table 2 and Graph 1 depicts the pre and post score of Tinetti POMA scale. It has been seen that the pre Tinetti POMA score being minimal 18.85 (±3.204) units compared to post score being 21.02 (±3.461) units. This can be attributed to several factors such as training the individuals balance, gait and functional mobility with components namely stretching, functional strengthening, agility, and balance training used in FAME protocol.

Falls in older adults with type 2 diabetes are common and linked to Diabetic Peripheral Neuropathy (DPN), which decreases balance and increases fall risk. Age-related declines in sensorimotor and cognitive functions further complicate balance maintenance. Long-term hyperglycemia deteriorates sensory nerve fibers, exacerbating DPN and impairing balance [13]. Balance control relies on the continuous coordination of sensory, motor, and cognitive systems. Balance exercise programs can enhance central nervous system adaptation to compensate through functional sensory systems, aiding equilibrium maintenance[14].

Table 3 and Graph 2 shows the pre and post value of BOOMER Scale. When compared to pre value which was 8.02 (±2.333) units there was change in post value being 9.13 (±2.437) units which shows the significant difference in all the components post intervention. The p value obtained was <0.001, indicating statistical significance. Chronic balance issues impact daily life significantly, affecting relationships, work performance, and daily activities. Falls often involve disturbances in both gait and balance. The Tinetti POMA[15] and BOOMER scales [16] are reliable measures for assessing static and dynamic balance, gait, and functional mobility in older adults.

Regular stretching is essential for maintaining muscle flexibility, strength, and overall health. It prevents muscles from becoming tense and short, reducing the risk of joint discomfort, muscle sprains, and injuries by allowing muscles to fully expand during activities. Balanced muscles contribute significantly to preventing falls, which is especially crucial for individuals with balance issues [17]. Study shows stretching for a brief period improved balance by encouraging muscular activation [18] . Strength training of the dorsi and plantar flexors (heel and toe raises) enhances mobility, strength, and balance in older adults. Improved plantar flexor strength is associated with better balance. Proprioceptive sensory receptors in lower-extremity muscles, such as muscle spindles and Golgi tendon organs, play a crucial role in motor control and joint movements. Incorporating single-leg postures can enhance sensory input and muscular coordination, improving weight-bearing symmetry. [19],[20] .The neurological instruction provided to the leg muscles during tandem stance supports a task-sharing rule whereby the soleus muscle maintains an upright posture and the reciprocal peroneus muscle and Tendon Achilles activation supply the substitute impulses needed for frontal plane body equilibrium[21]. In contrast, tandem walking enhances hip extensor and flexor strength in antero-posterior conditions, improving sensory and motor skills crucial for balance maintenance. It also influences ankle invertor/evertor control and hip abduction/adduction mechanics, optimizing muscle loading and unloading during gait [22]. The difference in the pre and post values of Tinetti POMA scale and BOOMER scale interprets that after the intervention, the risk of fall in subjects changed from high fall risk to moderate fall risk. This suggests the need for a continuum of intervention protocol for a long-term maintenance in the geriatric individuals with diabetes.

Managing diabetes entails a comprehensive approach from early detection to patient education, counselling, exercise instruction, and maintaining blood sugar levels. This continuum of care aims to ameliorate quality of life, reduce fall risks, and preserve mobility and strength.

8. Conclusion

The study concluded that there was a statistically significant difference in all the outcome measures when compared pre and post intervention. As pre and post values of Tinetti POMA score and BOOMER score showed significant clinical and statistical change, in turn it shows improvement in balance which may indicate reduction in fall.

9. Limitation and Future scope of study

Limitations

- Functional assessment was not done which may have helped to look for translation of improvement in the activities of daily living in geriatric diabetic individuals.

Future scope of study

- Addition of resistance training along with balance exercises can be used for strengthening.
- Comparative studies comparing different types of exercise interventions could provide beneficial insights into the most efficient strategies for preventing risk of falls and balance training.

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