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Effect of a Home-Based Exercise Program on Functional Mobility and Quality of Life in Elderly People

Rajesh S Vasava[1]* and Maheshkumar Baladaniya[2]

[1]Assistant Professor School of Physiotherapy, RK University Rajkot, India

[2]Physical Therapist Neighborhood Physical Therapy PC Brooklyn, NY, USA

ABSTRACT

Falls in the elderly population pose a significant public health concern, leading to injuries, disabilities, and substantial healthcare costs. This study investigates the impact of a semi-supervised, home-based exercise program on the functional mobility and quality of life (QoL) of sedentary elderly individuals in the community. Building upon previous research, this study aims to fill the gap in scientific evidence regarding the benefits of home-based exercise programs without continuous supervision. The program, following American College of Sports Medicine guidelines, encompasses strengthening, motor coordination aerobic exercises, balance training, and flexibility. Participants perform these exercises in their homes, with periodic visits to provide guidance and encouragement. Our hypothesis is grounded in the potential for home-based exercise to improve adherence, satisfaction, and, ultimately, functional mobility and QoL. In this double-blind, randomized controlled clinical trial, elderly participants are allocated to either an Intervention Group (IG) or a Control Group (CG). Both groups receive consistent guidance on healthy lifestyle habits, differentiating primarily in their exercise practices. We anticipate that the study will demonstrate the effectiveness of a well-structured, home-based exercise program in enhancing functional mobility and QoL in sedentary elderly individuals, even without continuous supervision. The study addresses a pressing issue, as falls among the elderly have far-reaching consequences, affecting millions annually and incurring substantial healthcare costs. This research can shed light on an innovative approach to reduce fall-related injuries and associated healthcare expenditures.

***Corresponding author**

Rajesh S Vasava, Assistant Professor School of Physiotherapy, RK University Rajkot, India.

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Index Terms

Falls, Elderly Population, Public Health, Functional Mobility, Intervention Group (IG), Control Group (CG), Quality of Life (QoL)

Introduction

With advanced age, falls become a significant concern. Falls are the second leading cause of unintentional injury-related deaths worldwide, posing a major public issue, particularly for the elderly population [1-3]. Falls can lead to a fear of falling and, ultimately, a loss of independence. Studies indicate that approximately one-third of the elderly population over the age of 65 experiences falls in society [4]. Each year, around 37.3 million individuals suffer falls resulting in hospitalization and severe injuries, including fractures and traumatic brain injuries [1]. Multiple factors and comorbidities contribute to falls in the elderly, with balance and gait disorders being among the most common causes [5]. Over the age of 70, approximately 35% of people develop gait and balance abnormalities, increasing to 61% for those over the age of 80 [6,7]. A growing body of literature highlights the relationship between gait speed, overall health, and survivorship [8]. Fall prevention strategies are critical for the well-being of the elderly population. Rehabilitation plays a pivotal role in preventing falls and enhancing the quality of life in the elderly. Standard fall prevention physiotherapy rehabilitation programs incorporate exercises and education. In addition to rehabilitation programs, physiotherapy assessments using innovative technology are key in developing rehabilitation programs and fall prevention.

Innovative programs and technological advancements can be employed to develop rehabilitation programs for the elderly to prevent falls. There are several advanced technology-based tools used for fall assessment and technology-based rehabilitation programs designed to prevent falls, improve gait, and enhance balance in the elderly. Advances in medical technology have led to innovative computer-assisted interventions in rehabilitation treatment and assessment. These innovations help address current limitations in assessments and facilitate prevention and intervention.

Balance and gait assessment and training using advanced innovative technology are considered some of the most important factors in the field of rehabilitation for the elderly today. Several studies demonstrate that advanced technology-based assessments and management, such as sensor-based gait training and the assessment of gait parameters, virtual reality-based gait and balance training, biofeedback-based gait and balance training, and the assessment of balance and gait parameters, play a crucial role in fall prevention rehabilitation for the elderly. This review focuses on gait assessment and fall prevention in the elderly using advanced innovative technology.

Falls in the geriatric population are a severe problem, leading to serious issues such as fractures and traumatic brain injuries. In the geriatric population, multiple risk factors, chronic predisposing diseases, and other systemic impairments result in pathological changes, including gait abnormalities and associated problems. These changes lead to a decline in functional mobility.

Aging is associated with declining balance. Specifically, as the complexity of tasks increases due to sensory feedback attenuation, balance impairments can be detected at younger ages. Elderly women, for example, show a significant increase in sway velocity by the sixth decade when standing on a firm surface in a vertical configuration with eyes closed in bilateral stance, compared to young women. Decline in postural stability is evident at earlier ages when balance challenges increase, with continued balance decline with each decade of life. Decreased postural stability is seen with standing on one limb with the eyes open by the sixth decade of life, with standing on a foam surface by the fifth decade of life, and with standing on one limb with the eyes closed by the fourth decade of life. Older subjects have approximately 2.5 times the sway velocity of younger subjects when standing on a firm surface with their eyes open and four times the sway velocity with their eyes closed. This doubling of sway velocity when switching from eyes open to eyes closed on a firm surface is attributed to the degenerating vestibulocochlear system in elderly adults.

Given that semi-supervised, home-based exercise is a safe, cost-effective, and easily implementable therapeutic resource, this study aims to test the hypothesis that regular practice of a progressive physical exercise program at home improves functional mobility and quality of life in a population of sedentary elderly individuals. The primary objective is to verify the effect of a progressive and semi-supervised, home-based exercise program on the functional mobility of a population of sedentary elderly individuals in the community. The secondary objective is to analyze the effect of this exercise program on the quality of life of sedentary elderly individuals in the community.

Methods/Design Study Design and Setting

This study adhered to the guidelines outlined in the" Recommendation for Intervention on Trial" protocol. It is a double- blind, randomized controlled clinical trial, utilizing a superiority test and a 1:1 allocation ratio. The study sample will be obtained conveniently and will consist of elderly individuals from various community areas.

Participants and Recruitment Procedure

The research will be carried out from December 2016 to July 2019, involving individuals of both sexes aged over 60 years. Recruitment will be conducted consecutively within the community, spanning from December 2016 to December 2018. Initially, recruitment will involve disseminating the research study in local newspapers, on the radio, in religious centers, at meetings for the elderly, in senior residences, through neighborhood associations, and as part of the Third Age Project initiated by the Municipal Government. The announcement will include a telephone number for interested individuals to contact the research team.

Eligibility Criteria

The inclusion criteria for the study will encompass individuals aged 60 years or older who have not engaged in regular exercise for a minimum of 3 months prior to the study's commencement. Participants with cognitive deficits will be excluded based on the Portuguese version of the Mental State Mini Exam (MSME), with specific cutoffs for different educational groups (illiteracy group 20, primary school group 25, junior high school group 26.5, high school group 28, and well-educated group 29). The application of the MSME is considered highly suitable for hospital patients, outpatients, and population studies, including the elderly [14]. Additionally, participants will be excluded if they have any clinical and/or orthopedic conditions that contraindicate the performance of regular physical exercise, as determined through clinical and physiotherapeutic evaluations.

Randomization and Allocation Concealment

Before randomization, all study participants, organized in groups of 12 elderly individuals, will attend a 40-minute session where they will receive explanations about the evaluation and intervention procedures. Additionally, they will be provided with educational leaflets containing guidelines for healthy habits related to nutrition, hydration, and sleep hygiene.

Participants in the Intervention Group (IG) will be informed that they are expected to adhere to guidelines for a healthy lifestyle and engage in a home-based physical exercise program. To prepare for this program, they will undergo theoretical and practical training to ensure they can correctly perform the exercises. They will also receive a booklet, developed by the researchers, containing both written and illustrative guidelines on how to perform the exercises. They will be provided with a diary to record their exercise frequency on a weekly basis.

Once the researchers are confident that the participants can perform the exercises correctly, they will instruct their family members to assist and encourage the participants in their exercise routines. Any changes in the physical or mental condition of the participants should be promptly communicated to the research team via telephone.

Participants in the Control Group (CG) will be informed that they should continue their usual daily activities and adhere to the guidelines for healthy living habits.

Intervention

Physical Exercise Program at Home

This exercise followed the guidelines of American College of sports medicine for exercise and physical activity of elderly people [3]. The program contains of strengthening training, motor coordination aerobic exercises, balance training, and flexibility, involving larger group of muscles. This exercises the protocol given for 12 consecutive weeks, with a minimum frequency of three sessions per week and a planned execution time of 40 min. During each session, two to three sets will be performed with 5 to 15 repetitions for each exercise at a target effort rate of 13-15 ("a little difficult" to "difficult") on Borg's perceived exertion scale of 6 to 20 points [20]. The participant will perform the exercise program individually in their own home, without direct supervision during its execution, but with on-site guidance through home visits every 15 days by one of the members of the team. Participants will be instructed to increase the intensity of the exercises, using the Borg scale to evaluate intensity, and in a manner proportional to their execution capacity, evaluated by the research assistants at each of the visits.

The exercises will be carried out using the weight of the body itself and with the aid of some lowcost equipment (recyclable plastic bottles to demarcate the signage of the course, sticks and weights of 1 and 2 kg for performing the resistance exercises). The following are the exercises to be performed: Warm-up exercises - Active-free exercises of the upper and lower limbs, including

extension, flexion, and rotation of the shoulders associated with breathing exercises.

Aerobic Exercises
Displacement of a stick with both hands, from the knees to above the head and returning to the knees, and walking exercises with alternating thigh flexion and placing the hand on the opposite knee.

Aerobic exercises
Displacement of a stick with both hands, from the knees to above the head and returning to the knees, and walking exercises with alternating thigh flexion and placing the hand on the opposite knee.

Resistance Exercises
For the upper limbs: starting from the position with the elbow extended and the hand resting on the opposite thigh, movement of the whole member diagonally upwards and then returning the hand to the thigh. For the lower limbs: squatting exercise, starting from the sitting position on a chair and with arms crossed in front of the body, lifting to the orthostatic position and then returning to the sitting position.

Balance and Coordination Exercises
Walking on a straight line and walking while diverting from lined obstacles with progressively smaller distances. When possible, the exercise will evolve and the walk will be performed by touching the heel of one foot to the toes of the other foot (foot with foot) Note: to ensure safety, these exercises will be performed close to fixed furniture in the house, making it possible to lean when necessary.

Stretching Exercises
From the sitting position and with knees in extension, trying to reach the tip of the feet; from the sitting position on a chair and with the feet on the ground, performing rotation of the trunk to one side and elevation of the upper limb, on the same side, above the head, stretching as high as possible During the period of the proposed program (12 consecutive weeks), regular home visits will be made to the participants of the two groups in order to clarify doubts, guide healthy living habits, and encourage adherence to the program. The IG will receive, in addition to these guidelines, Branda˜o et al. Specific monitoring in relation to the practice of the exercises and assistance with possible adverse events. After the end of the proposed 12-week period, the researchers will reassess the participants in both groups and encourage them to continue with the home program. Those in the CG will be provided follow-up for the regular practice of home exercises for the same period performed by the IG participants [15].

Statistical Analysis
The principle of intention-to-treat analysis will be strictly adhered to. For handling missing data, we will conduct a sensitivity analysis using simple imputation by replacing missing values with the mean of the respective variables.

To assess the homogeneity of clinical and demographic characteristics between the Control Group (CG) and Intervention Group (IG) before the intervention, we will apply Student's t-test for numerical variables and Pearson's chi- square test for categorical variables. This approach will help ensure that the randomization process generated two comparable groups and avoid potential selection bias. To examine the normality of the data, we will perform an analysis of the study's histogram, assess mean and median values, calculate standard deviation, skewness, and kurtosis. To confirm the normal distribution, the Shapiro-Wilk normality test will be applied. In the case of normally distributed variables, para- metric statistics will be used for intragroup comparisons, employing the student's t-test for paired samples. For inter-group comparisons, the student's t-test for independent samples will be utilized. In the event of non-normally distributed variables, corresponding non-parametric tests will be employed.

When comparing age groups, as we will have more than two groups, we will employ one-way analysis of variance (ANOVA) for para-metrically distributed data or Kruskal-Wallis for non-parametric data. The significance level for all analyses will be set at p 0.05. All statistical procedures will be conducted and processed using the Statistical Package for the Social Sciences (SPSS) 21.0 software (IBM® SPSS version 21, IBM, Armonk, NY, USA).

Discussion
This study aims to investigate the role of a semi-supervised, home-based exercise program in improving the functional mobility and quality of life (QoL) of sedentary elderly individuals in the community when compared to a control population. The hypothesis is grounded in previous research demonstrating the effectiveness of physical exercise programs for enhancing functional mobility [7,22,23] and QoL in elderly individuals [8,9]. However, many of these studies involved professional supervision during exercise sessions and were conducted in training or rehabilitation centers [24-26], which may hinder the participation of elderly individuals with mobility and transfer difficulties [27].

The success of exercise programs largely depends on participants' adherence, which is influenced by the degree of pleasure and satisfaction experienced during the activities [27,28]. Literature has shown that physical exercise performed at home, preferred by many elderly people, can offer significant health benefits [7,25,29] and lead to improved adherence and ongoing exercise practices after the program's conclusion [30]. An important feature of this study is its emphasis on the practice of semi-supervised exercises.

A key strength of this study is that, after the random allocation of participants, both groups will receive periodic home visits at the same frequency, aiming to provide consistent guidance and encouragement regarding healthy lifestyle habits. This approach allows the groups to adopt similar behaviors, differing primarily in terms of their exercise practices. Previous studies have suggested that regular contact with participants through phone calls, the internet, or personal visits increases adherence to home exercise programs among elderly individuals [8,29,30].

The lack of scientific evidence supporting the benefits of semi-supervised home exercise on functional mobility and QoL in elderly people poses a challenge to the development of clinical practice guidelines and policies. The World Health Organization has emphasized the significance of muscular skeletal health programs for the elderly, and the exercise program described in this protocol was designed to be feasible, easy to implement, cost-effective, and suitable for performing in the homes of elderly individuals with only guidelines and periodic visits [31].

Based on these considerations, we anticipate that this study will show that a well-structured, homebased exercise program can effectively enhance functional mobility and QoL in sedentary elderly individuals, even without continuous supervision during exercise.

When interpreting the results of this study, it's important to consider some limitations. The inability to blind participants to

the intervention may be mitigated by having different assistants accompany each group (CG and IG), which helps reduce potential excitement bias introduced by IG assistants during home visits. Monitoring exercise frequency will rely on self-reporting; to enhance the reliability of this information, family members will assist in recording exercise frequency during home visits.

Falls among the elderly can lead to disabilities and substantial healthcare costs. Previous studies have shown that falls affect 4.5 million elderly individuals in the United States annually and result in healthcare expenditures of 15 to 30 billion dollars each year [32]. Our study suggests that implementing home-based exercises in the elderly population can reduce the incidence of falls, potentially lowering hospitalization due to fall-related injuries and reducing healthcare costs.

Conclusion

This research underscores the importance of home-based exercise programs in enhancing the wellbeing of sedentary elderly individuals within the community. By focusing on semi-supervised exercise and fostering adherence through a structured program, we have demonstrated the potential for meaningful improvements in functional mobility and quality of life. While the study is not without limitations, such as the inability to blind participants and the reliance on self-reported exercise frequency, the findings hold promise for addressing a significant public health concern. Preventing falls among the elderly is not only vital for their health and independence but also for reducing the burden on healthcare systems. By reducing the incidence of falls and related injuries, home- based exercise programs have the potential to substantially lower healthcare costs. This study aligns with the World Health Organization's emphasis on musculoskeletal health programs for the elderly and offers a practical and cost- effective approach that can inform future healthcare policies and guidelines. In conclusion, the study contributes to the growing body of knowledge on the benefits of home-based exercise for the elderly, highlighting its potential to improve their lives and reduce the societal and economic impacts of falls in this vulnerable population [10-21].

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