

Progressive Dual Task Training for Improving Physical Performance in Older Adults with Impaired Balance.

Sarulatha Haridass¹, Dr.M.Manikumar², Vasanthan Rajagopalan³, Dr. R.Vijayaraghavan⁴, Ramesh Kumar Jeyaraman⁵.

1. Ph.D. Scholar, Saveetha institute of medical and technical sciences, Chennai.
Professor, Dept of Physiotherapy, Sri Devaraj Urs academy of higher education & Research, Kolar, Karnataka.
2. Professor, Saveetha College of physiotherapy, Saveetha institute of medical and technical sciences, Chennai.
3. Professor, Oxford College of physiotherapy, begur main road, hogasandra, Bangalore.
4. Director, Dept of research and development, Saveetha institute of medical and technical sciences, Chennai.
5. Professor, Dept of Physiotherapy, Sri Devaraj Urs academy of higher education & Research, Kolar, Karnataka.

Abstract

The elderly population is swiftly growing and expected to reach 198 million in 2030, which implies a huge burden on the health care facilities required to treat and sustain the quality of life of older adults. Further elderly individuals demonstrate difficulty to execute motor tasks due to age related cognitive declines. To address the essential components of functional problems of this population, an effective exercise program was explored to improve their functional abilities. The study analysed the effects of progressive dual task training on physical performance in elderly people with impaired balance. Older adults between 60 to 75 years were trained with Progressive dual task exercise (DT). The effects of DT on functional performance measured as physical performance was analysed using short physical performance battery (SPPB). It was observed that dual task training group showed significant improvement on functional performance measures. ($p < 0.001$). This study highlights the importance and benefits of dual task exercises trained in a progressive manner with sequentially planned challenging tasks in improving functional performance.

Key words –dual task, falls, functional ability, older adults.

Introduction

Aging gradually reduces the ability to perform the movements and optimal functions thereby negotiating muscle power, endurance and routine activities. By 2025, the geriatric population is projected to reach 840 millions (B Mane, 2016). Worldwide the distribution of elderly aged 60 and above is expected to increase from 7.5% in 2010 to 11.1% in 2025 and in India expected to reach by 158.7 million in 2025 (Subhojit Dey, Devaki Nambiar, J. K. Lakshmi, Kabir Sheikh, 2012). This imparts greater demands on medical, economical and other resources of nation to accommodate the elderly with greater rates of morbidity and mortality.

The elderly people are susceptible for impaired functional activities. Day to day activities like moving in and out of chair, getting to counters and shelves, activities which prompts postural responses, functional activities like walking and stair case climbing becomes tasking to perform and also risky. The reduced mobility and muscle imbalance gradually eventuates

body instability and greater risk of falls. The important physical components responsible for maintaining functional abilities are jeopardized due to aging have to be recognized at the initial phase to prevent & control essential physical declines. The use of a range of physical exercises in enhancing functional activity in elderly have been focal point of emerging research in geriatric rehabilitation. The exercise procedure requires the composition of paramount combination of exercise parameters to develop musculoskeletal, neurological & cardiovascular adaptations which can facilitate ability to manage the functional activity.

Moreover, the exercise protocol needs to concentrate on the core cause of functional limitation and the essential factors such as cognitive ability, muscle power, balance control, postural responses etc (Liu & Latham, 2009). Falls in elderly population has devastating consequences on activity performance, confidence in carrying out activities of daily living (ADL), leading to institutionalization and escalation of health care costs (Soriano et al., 2007) and hence it's crucial to develop an efficient exercise program for ideal functional performance in the older adults. Majority of the routine activities demands performance of motor task, appropriate postural responses & intact cognitive abilities simultaneously, most certainly with the need of recognition and attention as a component of motor learning (Ho-Jung An, PT, PhD1), Jae-Ic Kim, PT, MS2), Yang-Rae Kim, PT, MS3), Kyoung-Bo Lee, PT & Dai -Joong Kim, MT, ME2), Kyung-Tae Yoo, PT, PhD5), Jung-Hyun Choi, PT, 2014). studies outlined that elderly people have difficulty in demonstrating dual task activities like walking and balancing activities concomitantly (Sun-Shil Shin, 2014). Few studies emphasized the uses of dual task training in prevention of falls and other related parameters in older adult population (B. Wollesen et al., 2017).

Due to the paucity of studies within the context of literature searched, the effectiveness of dual task training on physical performance which is the cardinal for active functional routines and fall prevention in elderly people lead to the scope of present study.

Methodology

Study design

The objective of this quazi experimental study was to analyse the effect of progressive dual task training on physical performance in elderly population. Declining physical and functional capacities due to advanced age, chronic illness, difficulty walking and fear of falling are all risk factors for functional independence.

23 elderly subjects were recruited from residential care homes. Approval for the study was obtained from institutional ethical committee (001/03/2016//IEC/SU). Written Informed consent was obtained from the participants who volunteered and were willing to take part in the study. Patient information sheet was provided and confidentiality and ethical principles were followed as required for the study. Elderly people between 60 to 75 years, with minimum score of 24 with mini mental state examination, able to walk at least 5m with/without support and able to stand independently for 1 min without support and with a Performance oriented mobility assessment (POMA) & activity specific balance confidence (ABC) score of less than 24 and 70% respectively were included. Participants with uncontrolled medical conditions and with considerable visual or auditory impairments, vestibular imbalance, chronic pain on activity performance with lower extremity deformities, who are into routine exercises training in the past 3 months and diagnosis like hemiplegic, Parkinson's and cancer were excluded.

Intervention program

The baseline data on age, sex, BMI, no of falls, incidence of physical discomfort were obtained and documented for data analysis (Table 1). The pre test data on physical performance was collected before commencement of dual task training and post treatment measurement after total of eight week training sessions. The functional independence through physical performance before and after intervention was assessed using SPPB scale. The Short Physical Performance Battery (SPPB) used for measuring physical performance and functional capacity in elderly implies the ability of functional independence. Low scores on the SPPB shown high predictive value for a wide range of health issues including decline in Activities of Daily Living (ADLs), reduced mobility, disability, hospitalization, admission to nursing facilities, and death (Bozkurt et al., n.d.). Participants performed totally 24 exercise sessions (3 session per week on alternate days for total of 8 weeks) and each session lasted for 40-50 minutes of structured progressive dual task training protocol.

Dual task training consisted of demanding balance activities using various upper limb movements, altering base of support, exercises on stable and unstable surface and progressed from stability to mobility activities. The participants performed the exercises from narrow standing to semi tandem and tandem standing with arm in 90 degree abduction and 90 degree flexion without and with closed eyes. Also body weight distribution with active ankle rolling movements in walk stance and tandem position was performed. The next set of training included walking, semi and tandem walking with their convenient speed for a distance of four metre and progressed to walking with altering the directions and speed with range of upper limb functions. The participants further performed walking and tandem walking on the foam, combined with upper limb functions (B. Wollesen et al., 2017). Once the elderly participants were able to perform the above activities successfully more focus on dual task was emphasized which included walking like holding a cup of water and walking, receiving and returning the cup of water, walking and conversation with a person, walking with tossing and catching the ball (Ho-Jung An, PT, Jae-Ic Kim, Yang-Rae Kim, PT, Kyoung-Bo Lee, PT & Dai -Joong Kim, Kyung-Tae Yoo, Jung-Hyun Choi, 2014). The participants performed the progressive dual task exercises efficiently between eight to twelve training sessions. Hence more importance and practice with the challenging dual task exercises were given. The participant rested for about 2-3 mins after 15-20 mins of exercise training.

Results

Statistical analysis was done using SPSS statistics version 26. Baseline homogeneity for outcome measures was established by independent t test. The SPPB was analyzed using non parametric test. Wilcoxon signed rank test was used to compare within group difference with 95% confidence level with significance level of $p < 0.05$. Pre & post test analysis showed significant improvement in of functional performance with dual task training (Table 2). Within group analysis of pretest & post test scores of functional performance showed significant improvement MDT group $z = -4.24$, $p < 0.001$.

Table 1: Baseline parameters of the study participants. Mean and SD of age, BMI, falls . (N=number)	
Baseline measures	Mean \pm SD
Age	67.7 \pm 4.5
BMI	23.65 \pm 2.94

Frequency of falls & loss of balance in past one year	0.60±0.94		
Male & female (N)	09 ; 14		
Table 2: Dual task training on physical performance in elderly population with impaired balance.			
Parameter	Groups	Mean	SD
Physical performance measured by SPPB	Pre-test	7.52	0.94
	Post-test	9.82	0.86
n = 23			

Discussion

Most of the essential activities require the involvement of cognitive focus during functional performance. The existing literature on dual task exercises delineate improvement on cognitive performance under dual task conditions. However, they differ in their assessing parameters due to their training strategy and exercises chosen. An increasing amount of evidence propose that in early stages of decline, physical function can be found or even conversed with a specific intervention(Cadore et al., 2013). This establishes the dynamic process with older adults transiting the status of disability or functional impairment. Based on this dynamic fluctuation the precise measurements of older adults being at risk for disability, exhibiting preclinical functional limitation becomes a primary baseline to raise red flags or channel intervention. Cautious measurement is also important for population-based research activities. In the field of performance-based functional tests, SPPB suggested as the best choice.(Freiberger et al, 2012).

The SPPB is the measurement with highest score in reliability, validity and has been extensively investigated in different populations ranging from intense to limited ADL or frail. The target of the SPPB is on lower extremity with nearly 34 studies investigating at least one psychometric property(Chodzko-Zajko et al., 2009).A study showed that with 6 week of strength and functional training in home based set up on cognitively impaired increased motor and functional performances. This was demonstrated with increased effects in SPPB , decreased defects in balance, gait scores. In addition, studies confirm that training in elderly adults with low base line performance levels is highly promising when an individually tailored program with adequate progression of training intensity and difficulty is applied(Hauer et al., 2017). With the improvement in physical performance, ankle velocity and sit to stand transfers augmented.

Many age-related cognitive and social shortfalls are due to poor inhibitory control. The capacity to inhibit mental routines reduces in elderly, which can be counteracted by effectively designed motor dual task training. With dual task intervention changes in inhibitory efficiency while walking observed along with improved gait performance. As cognitive ability is challenged decline in physical & ADL functions, reduction in gait speed and walking ability was observed(Hall & Heusel-Gillig, 2010). Older adults with dual task training exhibited reduction in inhibition along with a change in gait performance .The deterioration of inhibitory function is a symptom of poor functional and social activities of daily life. Likewise, in the real environment pedestrians must react to sudden changes by

quickly analyzing an ongoing action and selecting a new, appropriate one, or when routine thoughts must be held back to effectively communicate in conversation with others. The coactivation of agonist and antagonist muscle in locomotor coordination which is particularly seen in aging results in increased metabolic cost and walking efficiency, which therefore influences the regular physical performances. With a well planned target exercises like motor dual task training the association between cognition and physical performance can be strengthened (Falbo et al., 2016). Significant improvement with walking performance was demonstrated by an increased step length and gait line. These changes in kinematic gait parameters propose the effective use of the ankle joint and foot roll movements, which is an important component to overcome the gait deficiencies and maintain postural control while walking (Gillespie et al., 2012). Studies evidence that gait improved with dual task interventions along with task-managing strategies. The resources allocation model suggests that a greater amount of attention is required for motor and cognitive performance under DT conditions to manage both tasks similarly. Progressive dual task training studies showed improvements of SPPB scores from 11.05(0.95) to 11.65(0.75) and from 10.73(1.48) to 11.23(1.04). (B. Wollesen et al., 2017). The present study reported similar mean difference with the motor dual task intervention and other exercises with significant improvement in functional performance.

Balance related motor and cognitive dual task performance in healthy older adults can be developed by customized tailored exercises. Studies evidence that to gain beneficial effects; intervention needs to incorporate progressive challenging tasks, ideal intensity and duration, activity specificity, and variable task prioritization. The most reliable method to achieve motor benefits seems to be dual task training program. Dual task training demonstrated positive effects in both balance and functional performance (Bettina Wollesen & Voelcker-Rehage, 2014), (Shashank Ghai, 2017). Studies insist the switch over of attentional focus with variable task priority and to obtain most benefits with motor dual task performance with the principle of specificity (Falbo et al., 2016). DT training demands greater motor and cognitive resources than single task training, and in turn develops attention control, resource allocation and/or task automation.

Age is believed to be related with decreased neuro muscular processing efficiency and sensory and motor aspects of performance are increasingly in demand of cognitive control and guidance with advancing age (Bettina Wollesen & Voelcker-Rehage, 2014). Hence, for an execution of an activity higher demand of attention resources are required in elderly as compared to younger adults to complete the same performance level. So, the effect of dual task training shows less attention needed to perform one or two of the trained tasks. Motor dual task program influences task automation with a release of cognitive resources. Thus, exercise protocol will provide a benefit if they improve motor performance to a level that the motor task is performed more automated and frees up mental resources. Studies show that task managing will be more challenging with greater cognitive load, reduced availability of resources to perform in dual task situation and if both cognitive and motor tasks require the same internal information. Results of studies suggest that to have positive effect of cognitive and motor performance the training protocols should prefer a dual task training over an single task training, with optimal exercise load to challenge and progress, suitable duration, task specificity and variable task prioritization of the training tasks to obtain task related benefits. (Bettina Wollesen & Voelcker-Rehage, 2014). A study analyzed dual task training with balance and coordination tasks vs resistance training for 12 weeks. Stroop test with selected walking speed showed greater improvement in gait variables with dual task training. However, both types of exercises reduced fear of falling. The baseline data of the participants

in the present study was an average of 7.52 indicating much lower level of physical performance.

In a prospective study conducted in an inpatient ward setting, the baseline SPPB total score predicted serious injurious falls and fractures during the hospital stay, establishing SPPB as a valid tool to assess not only mobility, but also fall risk (Lauretani et al., 2019). In one study SPPB scores of 0–6 was significantly associated with recurrent falls while other study showed SPPB scores of 10–12 as fall risk in a group of 2710 older persons (Treacy & Hassett, 2018). This explains the use of SPPB test not only to screen physical frailty and sarcopenia but also to objectively identify a fall risk profile and possible presence of balance alterations of neurological etiology (Lauretani et al., 2019). In a study, Elderly people with history of falls, discharged from emergency department treated with home based and group exercises. SPPB baseline score was 6.2, indicating low physical performance. Exercises for endurance, mobility, balance, strengthening and functional training was given progressively. Followed by a 3 month intervention, falls rate lowered to some extent but not significant improvement in physical performance. It was reflected by the difference of 0.6 on SPPB score and a difference in SPPB score from 0.27 to 0.55 is also clinically meaningful. With the intervention, and after 6 months follow up a significant reduction in the possibility of having at least one injurious fall and deterioration in SPPB scores from 6.2 to 5.9 in intervention group and higher deterioration of scores from 6.6 to 3.7 was reported. (Matchar et al., 2017). The reason for lack of improvement in physical performance could be the heterogeneous high-risk population. Moreover training and addressing the key elements for falls needs to be addressed in the exercise protocol similar to other falls-prevention programs (Matchar et al., 2017). It was clearly stated that cognitive impairment persisted as a strong predictor of falls and the impact of cognitive interventions in falls prevention merits further study. This throws light on the area of incorporating cognitive training with motor activities used in this present study. The recommendations and lacunas of the earlier studies have been addressed with interventions like motor dual task exercises which resulted in improvements of physical performance. SPPB scores of less than 6 is related with a higher fall rate in elderly of both genders; in females, even an SPPB score between 7 and 9 identifies subjects at a greater chance of being recurrent fallers. With a loss of muscle strength, inability to maintain a semi-tandem position for more than 10 sec, or a full tandem position for more than 2 sec, is predominant in the association with falls. Ability to hold the full tandem position is considered a key factor in older adult falls as it tests lateral postural stability by narrowing the base of support (Veronese et al., 2014).

In the present study the elderly participants improved from SPPB scores of 7.52 ± 0.94 to 9.82 ± 0.65 in motor dual task group which shows significant improvements in functional performance. Also this can be related to transition to fewer falls risk and control of future recurrence of falls. Studies reported that SPPB scores between 4 – 6 presents with a relatively greater risk of mobility related disability (2.9 to 4.9) than elderly with scores between 7-9 (1.5 to 2.1) in a period of 4 years (Treacy & Hassett, 2018). Studies demonstrated minimally clinically important difference with SPPB in elderly population between 0.54 to 2.9 (Dorfman et al., 2014). In the present study the change scores observed was 2.33 which indicated better clinically significant improvement in the level of functional performance with MDT.

This study aimed to target the important aspect of activity decline and the importance of including cognitive component in designing the exercise programs for elderly population. Participation in optimal physical activity regularly renders elderly to maintain and improve functional performance and thus maintain healthy aging. The motor dual task program intends to facilitate the task switching from a cognitive to a motor-walking task and thus

enhances allocation of resources for better functional performance in dual task situations. Exercises with progressively increased difficulty levels aids the elderly to gain skill and shift these strategies required during routine activities essential promotes functional autonomy in older adults.

Conclusion

The results of the present study demonstrate significant improvement in functional performance with motor dual task training. The cognitive component associated with motor activity balance training given in the present study would have shown a positive impact on the functional performance. Enhancing dual task training knowledge is highly essential, as most activities of daily living involve performance of more than one task at a time.

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