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Effect of Occupational Therapy Intervention of Combining Cognitive & Motor Intervention on Balance and Gait Performance Among Elderly Population

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ABSTRACT

The elderly population faces numerous challenges, including age-related cognitive decline, reduced balance and gait performance, financial insecurity, and limited access to healthcare. These conditions often limit independence and quality of life by impairing cognitive and motor abilities. This randomised controlled study's objective was to assess how combination cognitive and motor therapies affected older adults' balance and gait. 52 participants in all were selected by random sampling in accordance with inclusion and exclusion criteria, and they were divided into two groups: the control group and the experimental group. The experimental group participated in twice-weekly occupational therapy sessions for 12 weeks, which included strength, balance, and cognitive training. Traditional strength and balance training was given to the control group at the same frequency and duration. The Gait and the Berg Balance Scale (BBS) Abnormality Rating Scale (GARS) were used to evaluate the results. Results showed a significant improvement in both outcome measures following the intervention. Comparative analysis between groups revealed a GARS t-value of -5.485 and a BBS t-value of -13.610, indicating greater enhancement inside the experimental group. These results imply that combining cognitive exercises with balance and strength training effectively improves cognitive function, postural control, and gait performance. In conclusion, the study provides strong evidence that a combined cognitive and motor intervention significantly enhances equilibrium and aid in senior citizens.

KEY WORDS: BALANCE, COGNITION, ELDER POPULATION, NEUROLOGICAL CONDITION, GARS.

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INTRODUCTION

Individuals 65 years of age and above are typically considered to be part of the elderly population. Ageism, financial instability, physical restrictions, and access to care and healthcare services are just a few of the many issues that the aged population must deal with. Depressive symptoms, a sense of purposelessness, and loneliness might result from these difficulties [1]. According to the World Health Organization's (WHO) global report on health prevention, muscular weakness is common in older persons and can impair their ability to balance. Falling is a common occurrence and a serious health risk for older adults. Over half a million falls occur globally each year, primarily among people 65 and older [2].

Among the elderly, falls are the sixth most common cause of death and morbidity. the injuries they cause, and the problems they induce. They are a major source of linked mortality among those aged 65 and over one-third of all injury-related deaths. Additionally, almost one-third of senior citizens 65 and older who reside in communal housing have at least one fall occurrence annually. Fallen, their loved ones, and the general public are negatively impacted by the issue.

Neurological conditions are a leading source of morbidity and mortality in the global senior population. The prevalence of neurological disorders such as stroke, Parkinson's, Alzheimer's, and other neurodegenerative or cerebrovascular diseases is gradually increasing as the world's population ages [3]. The risk of death is greatly increased by these illnesses, particularly for those 65 and older. Neurological conditions are significantly more prevalent in the elderly, with various disorders impacting the nervous system. These ailments include epilepsy and other associated disorders, as well as neurological illnesses such stroke problems, Parkinson's disease, and Alzheimer's [4].

Globally, neurological disorders are a leading source of illness and mortality among the aged. The prevalence of neurological conditions including stroke, Parkinson's, Alzheimer's, and other cerebrovascular or neurodegenerative illnesses are gradually increasing as the world's population ages. The risk of death is greatly increased by these disorders, particularly for those 65 and older. Many ailments affect the nervous system, and neurological conditions are far more common among the elderly. These ailments include epilepsy and other associated disorders, as well as neurological diseases like Alzheimer's, Parkinson's, and stroke [5].

Age-related changes in the brain, genetic variables, and environmental factors all contribute to the increased risk of neurological problems in older persons. The World Health Organization (WHO) estimates that neurological disorders are the second most common cause of death worldwide, taking the lives of almost 9 million people annually. The deadliest illnesses that affect the elderly are stroke and Alzheimer's disease. Over 6 million people die from strokes alone each year, with older persons accounting for the great bulk of these deaths. In the majority of high-income nations, dementias, including Alzheimer's disease, rank among the top five causes of death for adults over 70. Another major factor is Parkinson's disease, which is responsible for more than 35,000 fatalities every year [6].

Neurological disorders have a major influence on day-to-day functioning and general health since they affect the nerves both the brain and the spinal cord. These ailments can include more complicated disorders like Parkinson's disease, multiple sclerosis (MS), and Alzheimer's disease, as well as more common issues like epilepsy and migraines. The nervous system is impacted differently by each disorder; some affect mobility, while others impact memory, cognition, or sensory perception [7].

When it comes to fall prevention strategies, the only intervention program that seems to control both the number of fallers and the frequency of falls among community members is motor training for strength and balance. Providing difficult balancing exercises appears to help lower the number of falls. Exercise has a secondary effect in preventing falls through its beneficial effects on cognitive function. A side benefit of exercise is that it reduces the risk of falling. Fall-related changes in households are expected to contribute to an aging population and raise the strain on the health system [8].

Additionally, falls have a substantial financial and social cost due to loss of freedom and limitation of mobility. Neural plasticity - The ability of the brain to change and adjust in reaction to experience—is fostered by cognitive and motor tasks. People may enhance current neural pathways and encourage the formation of new ones by combining cognitive work with motor exercises, which will increase muscle strength. People who have mild cognitive impairment (MCI), a syndrome that arises during the preclinical stage of Alzheimer's disease (AD), have cognitive impairment but very slight impairment in instrumental activities of daily life [9].

This study intends to give a theoretical foundation for the use of motor-cognitive intervention, guarantee that it is applied in accordance with standards and norms, create motor-cognitive intervention programs that are appropriate for local circumstances, and offer a more thorough theoretical and practical viewpoint on motor-cognitive intervention techniques. Children who are blind or visually impaired may experience imbalance and weakening in their ability to control their posture as a result of running, jumping, and playing games that might have an impact.

Researchers are particularly interested in Cognitive decline, behaviour, and health issues are prevalent in older adults. The disease known as mild cognitive impairment (MCI) initially manifests during the preclinical phase [10]. As the number of elderly people rises, MCI is becoming increasingly common in both developed and developing nations. The World Health Organization has developed development-related preventive and control measures. MCI is becoming more common.

with the number of senior persons. is rising in both industrialized and developing nations. The World Health Organization has established development-related preventative and control measures. Elderly individuals often experience a decline in both cognitive and motor functions, significantly affecting their balance and gait performance, which increases the risk of falls and limits independence. Traditional interventions typically target either cognitive or motor aspects in isolation, potentially limiting their effectiveness [8].

Recent evidence implies that a combined strategy that takes into account both cognitive and motor interventions either simultaneously or sequentially—may yield better outcomes in functional mobility. However, limited research has explored the specific effects of such integrated occupational therapy interventions on balance and gait among the elderly population. By assessing the impact of integrated cognitive and motor therapies on enhancing balance and gait performance in older persons, this study seeks to close this gap. Amal H. Mohamed claims that a combined cognitive and motor intervention had a sufficient impact on improving gait, balance, and everyday activities in elderly people who were susceptible to falls. They also suggest that health education be provided to the elderly population through efficient instruction in diet, balance, and daily living activities. Therefore, this study using a cognitive booklet in conjunction with motor therapies to provide cognitive training in this study.

MATERIAL AND METHODS

This randomized controlled study was reviewed and approved by the Institutional Ethical Committee of Santosh College of Occupational Therapy (Ref. No. SCOT/NOV-24/EC Neuro-05). Using Cochran's formula with a 95% confidence level and a 5% margin of error, the minimum sample size was calculated to be approximately 75 participants, who were then divided into two groups of 26 each. Participants were randomly selected and assigned to either the control or experimental group. Participants, both male and female, aged 50 years and above, were recruited from Yatharth and Vaid Ram Hospitals in Gautam Budh Nagar.

Prior to the start of the study, all participants received detailed information about the study's purpose and methodology and provided written informed consent. Participants were given adequate time and explanation about the study procedures. The cognitive and balance screening tools included the Free Cognitive Test, a brief tool that measures various cognitive domains such as executive function skills [11], and the Mini-Cog Test, which involves drawing a clock face with numbers and setting the hands to a specific time, followed by recalling three previously mentioned words [12].

Gait and balance were evaluated using the Gait Speed Test, where individuals were instructed to walk at their normal pace, with assistive devices permitted if necessary. Additionally, a 6-meter walk test was conducted to further assess balance and functional mobility. Participants in the experimental group performed a combination of cognitive, strength, and balance exercises. Cognitive exercises included counting money, naming pictures, repeating designs, arranging items in alternate patterns, and dot copying, each held or repeated for 5–10 seconds or 10 repetitions. Strength exercises included sit-to-stand, mini-squats, knee and hip flexor and extensor exercises (held for 5–10 seconds), and 10-meter walking (forward, backward, sideways, and figure-of-eight) twice daily.

Balance exercises involved single-leg stands (10–15 seconds), step taps, and narrow stance reaches (10 repetitions each), followed by a 5-minute cool-down of arm and leg marches. The control group performed only strength and balance exercises similar to those in the experimental group, including the same cool-down routine. Pre-assessment questionnaires, including the Berg Balance Scale (BBS) and the Gait Abnormality Rating Scale (GARS), were administered to eligible participants before the intervention, and post-assessment using the same outcome measures was conducted after completing the 12-week intervention program.

Outcome Measures: The Berg Balance Scale (BBS) is a widely used assessment tool comprising 14 functional activities, each rated on a 5-point scale (0–4), with a maximum total score of 56 points. It evaluates both static and dynamic balance within approximately 20 minutes but does not assess gait13. Interpretation of scores indicates that 0–20 suggests likely wheelchair dependency, 21–40 implies the need for a walking aid, and 41–56 denotes independent walking with a low fall risk. The BBS demonstrates excellent inter-rater reliability (0.97–0.98) and strong validity in predicting functional mobility and identifying older adults at risk of falls.

Complementing this, the Gait Abnormality Rating Scale (GARS) is used to assess gait characteristics and fall risk through video analysis of sixteen aspects of human stride. It is a reliable and robust tool for documenting gait abnormalities among older adults in the community (Jessie M. VanSwearingen, 2024). Scoring on a 4-point scale (0 = good function, 3 = poor function), the GARS can take 10 minutes to an hour depending on the version. The GARS-M demonstrates excellent inter-rater reliability (ICC = 0.989) and strong rater dependability (ICC = 0.878), with concurrent validity indicating a significant relationship between GARS-M scores, walking speed, and stride length, indicating that walking speed and stride length are related to the GARS-M score.

Table 1.0 Descriptive Statistics of experimental vs control Group								
Outcome measure	Experimental Group				Control Group			
	Average		Standard deviation		Average		Standard Deviation	
	Pre	Post	Pre	post	Pre	Post	Pre	Post
BERG BALANCE	28.27	31.81	3.157	4.157	27	45.08	3.815	2.726
GARS	29.31	33.35	3.728	3.212	26.88	38	2.930	2.898

RESULTS

The table 1.0 shows pre- and post-test results for Berg Balance Scale (BBS) and Gait Assessment and Rating Scale (GARS) in both groups. At baseline, scores were similar, with the experimental group slightly lower in both measures. Post-test, the control group showed modest improvement (BBS: 28.27 → 31.81; GARS: 29.31 → 33.35), while the experimental group had much larger gains (BBS: 27.00 → 45.08; GARS: 26.88 → 38.00). This indicates the intervention produced substantially greater gains in gait and balance in contrast to the experimental group's control group.

Table 2.0 Pre-Post Data Analysis using outcome measure of BERG Balance:					
Scale	t-value		P- value		interpretations
	Pre	Post	Pre	Post	
Experimental	1.307	-13.610	0.197	0.000	Not Significant
Control	-3.538	2.565	-4.574	-2.502	Significant

Table 3.0 Pre-Post Data Analysis using outcome measure GARS Balance:					
Scale	t-value		P- value		interpretations
	Pre	Post	Pre	Post	
Experimental	2.605	-5.485	0.012	0.000	Significant
Control	-4.03	1.076	-4.473	0.694	Significant

For statistical analysis, to assess within -group changes from before to after intervention paired sample t-tests were used (Table 2 and 3). The findings indicate that the Berg Balance scores during the pre-test showed no appreciable change. ($p = 0.197$, $t = 1.307$) Nonetheless, the post-test showed a highly significant improvement ($t = -13.610$, $p < 0.001$), suggesting that the intervention improved balance.

The findings indicate that GARS scores were Pre-test A significant difference was found in the data ($t = 2.605$, $p = 0.012$). Additionally, a highly significant difference was also observed in the post-test findings ($t = -5.485$, $p < 0.001$), indicating a significant improvement after the intervention.

DISCUSSION

The present study offers a robust and multifaceted evaluation Provides a combined cognitive and motor intervention on senior people's gait and balance, backed by thorough statistical validation and a thorough demographic study. The open reporting of the age and gender distribution in this study is one of its most notable aspects; it reveals a notable imbalance, especially the underrepresentation of male people in the control and experimental groups. The experimental team, for instance consisted of 25 females and only 1 male, and the control group included just 2 males out of a comparable total. While such imbalance is a limitation for generalizability, it also mirrors real-world participation trends in elderly physical activity programs, where women often outnumber men [14].

By explicitly acknowledging this, the study demonstrates methodological transparency, a quality not always evident in similar interventions. In terms of outcome assessment, the study employed two well-validated tools The Gait Assessment and Rating Scale and the BERG Balance Scale (GARS), which are widely recognized for their reliability and sensitivity in elderly populations [15].

Pre- and post-intervention data showed clear improvements in both balance and gait within the experimental group. Specifically, BERG scores improved significantly from a mean of 28.27 to 31.81, and GARS scores increased from 29.31 to 33.35. These changes were not only statistically significant ($p < .001$ for both outcomes) but also revealed large impact sizes (Cohen's $d = -1).380$ for balance and -3.752 for gait—underscoring the magnitude of the intervention's impact. Compared to similar studies, which often report moderate effect sizes (e.g., $d < 0.8$) in balance training programs [16].

The results here are particularly noteworthy and very large to extremely large effect sizes (Hedges' g values also being substantial) elevate this study's findings beyond those of typical interventions, suggesting that the dual-targeted cognitive-motor approach offers superior benefits.

Moreover, the use of paired-sample t-tests and the inclusion of confidence intervals adds a layer of statistical rigor that strengthens the conclusions. The t-values of -7.035 (BERG) and -19.132 (GARS), both with $p < .001$, reflect not only significance but also consistency across the sample. This level of analytical detail is often absent in prior research, where either motor or cognitive functions are assessed in isolation and often without standardized metrics. In contrast, this study's dual-focus intervention aligns with emerging literature emphasizing the neuroplastic synergy of cognitive-motor programs in older adults.

What further distinguishes this study is its emphasis on both statistical and practical significance. The combination of high effect sizes, low standard errors, and narrow confidence intervals conveys not just that the intervention works, but that it does so reliably and meaningfully. Many studies limit their discussion to p-values alone, which can obscure the real-world applicability of findings. By integrating effect size analysis and using robust tools, this research provides a compelling case for adopting combined cognitive-motor interventions in geriatric rehabilitation settings.

This study not only confirms the success of a motor-cognitive intervention in enhancing equilibrium and gait among elderly individuals but does so with a level of methodological thoroughness and statistical strength that surpasses many prior works. While gender imbalance remains a caveat, the clear documentation, strong outcomes, and large effect sizes position this research as a superior contribution to the field of geriatric physical rehabilitation. Building upon the already compelling findings, the additional pre- and post-test results further confirm the efficacy of the combined motor and cognitive intervention, particularly in enhancing balance, and the efficacy of the combined motor and cognitive intervention, particularly in enhancing balance. and gait performance among elderly participants.

Both control and experimental groups showed a significant skew in gender distribution, with females greatly outnumbering males. This restricts the generalizability of the findings, particularly in understanding how the intervention may impact elderly men. The study measured outcomes immediately after the intervention. There was no long-term monitoring to ascertain whether the gains in gait and balance were maintained over time. Future research should assess how the cognition and balance strength exercise affect the elderly population. Larger sample size should be used in future research on this population to account for the responsive training. Neurological conditions in elderly population age groups should be the subject of future research.

CONCLUSION

In conclusion, the study provides strong evidence that a combined cognitive and motor intervention significantly enhances equilibrium and aid in senior citizens. The aging population benefits from improved mobility, physical stability, and general quality of life because to this integrated strategy.

Ethical Clearance
SCOT/NOV-24/ECNeuro-05 ,9/11/2024.

Conflict of interest statement - NONE.

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