



## EFFICACY OF INTEGRATED DUAL TASK COGNITIVE AND BALANCE EXERCISES IN PREVENTING FALLS IN CEREBELLAR ATAXIA PATIENTS

### Physiotherapy

|                                |                                                                                                                                                                                                                                                                      |
|--------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Balamurugan Janakiraman</b> | Faculty of Physiotherapy, Meenakshi Academy of Higher Education and Research (MAHER), Tamil Nadu, India., SRM College of Physiotherapy, Faculty of Medicine and Health Sciences, SRM Institute of Science and Technology (SRMIST), Kattankulathur, Tamil Nadu, India |
| <b>Vijayaraj Vediappan</b>     | Professor & Principal, Nehru College of Physiotherapy, The TamilNadu Dr MGR Medical University, Chennai.                                                                                                                                                             |
| <b>Mahesh Kumar</b>            | PG, Professor, Meenakshi Academy of Higher Education and Research, Chennai                                                                                                                                                                                           |
| <b>Nafiz Hasan.I</b>           | B.P.T Internee Nandha College of Physiotherapy, TamilNadu Dr MGR Medical University, Chennai.                                                                                                                                                                        |
| <b>Janani Muthusamy*</b>       | Research Scholar, Meenakshi Academy of Higher Education and Research, Chennai., Associate Professor, Nandha College of Physiotherapy, TamilNadu Dr MGR Medical University, Chennai. *Corresponding Author                                                            |

### ABSTRACT

Cerebellar ataxia describes a collection of symptoms that affect the cerebellum or its connection. It is characterized by lack of coordination, trunk and cognitive impairment. The incidence associated with cerebellar ataxia is 8.22 per every 100000 population. The dual-task exercise plays a vital role in helping the patient to overcome the risk of falling. The study aims to determine the efficacy of integrated dual-task cognitive and balance exercises in preventing falls in cerebellar ataxia patients. There are around 56 participants between 45 and 60 years old with cerebellar ataxia. The patient underwent an evaluation with SARA and TUG before and after an intervention. It consists of dual-task training, including cognitive and balance, 5 times a week for 12 weeks. Significant improvement was observed in the progression in balance and reduced fall in post-intervention. The SARA scale score increased by 35%, while the TUG score improved by 25%. Dual-task exercise can be an efficient method for improving balance and reducing falls. This case report highlights the potential benefits of incorporating dual-task exercise.

### KEYWORDS

Cerebellar Ataxia, Accidental Falls, Incidence, Cognitive Dysfunction, Cerebellum.

### INTRODUCTION

The cerebellum is integral to the regulation of balance and the coordination of voluntary movements. Degeneration of the cerebellum results in ataxic symptoms, which manifest as instability in stance, gait, and limb movement. Furthermore, there is an increasing body of evidence indicating that the cerebellum also plays a significant role in cognitive functions, particularly in executive control processes such as working memory and language, as well as potentially in visuospatial abilities. This assertion is bolstered by findings from studies involving human cerebellar lesions and functional brain imaging conducted on healthy individuals.

Ataxia is prevalent among both children and adults worldwide. Ongoing advancements in genetic research and neuroimaging techniques have enhanced our understanding of cerebellar diseases, prompting several revisions in their classification. Recent global epidemiological studies have estimated an overall prevalence rate of 26 cases per 100,000 individuals in children, with a prevalence rate of 2.7 cases per 100,000 for dominant hereditary cerebellar ataxia and 3.3 cases per 100,000 for recessive hereditary cerebellar ataxia.

### Balance Improvement

Research shows that dual-task exercises can significantly reduce postural sway in patients with cerebellar ataxia, especially under challenging conditions (Jacobi et al., 2015).

### Cognitive Load

Patients exhibit increased sway and longer stabilization times when performing dual tasks, indicating a prioritization of balance over cognitive performance (Kang & Park, 2015).

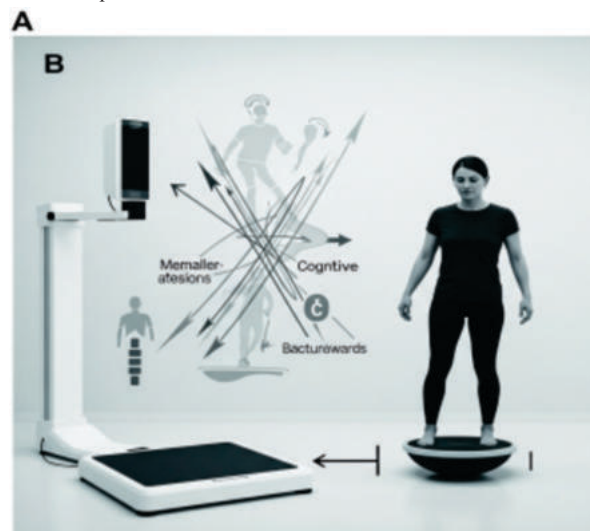
### Training Efficacy

A randomized controlled trial demonstrated that cognitive-coupled intensive balance training improved dual-task performance and dynamic balance, although it did not significantly reduce fall rates (Winser et al., 2024).

The methodology for assessing cerebellar ataxia in patients aged 45 to 60 years involves a structured approach that includes neurological examinations, balance evaluations, and specific scales to measure

ataxia severity. The study employs the Berg Balance Scale (BBS) and the Scale for the Assessment and Rating of Ataxia (SARA) to evaluate balance and the impact of ataxia on activities of daily living (ADL) respectively.

All patients underwent a thorough neurological assessment to identify balance impairments.



Jacobi et al. 2015

Figure 1 Jacobi et al

### Berg Balance Scale (BBS)

This scale confirmed the diagnosis of static and dynamic balance issues, with scores below 1 indicating significant impairment (Choi et al., 2018).

### SARA Assessment

SARA was utilized to evaluate the severity of ataxia, with a focus on its

correlation with ADL independence(Moulaire et al., 2022).

Sample Selection Criteria

**Inclusion Criteria:** Patients were included based on willingness, age, gender, and specific ataxia types (e.g., spinocerebellar ataxia) with SARA scores above 40.

**Exclusion Criteria:** Individuals with other neurological issues or who did not complete the BBS were excluded, ensuring a focused sample

Study Design and Duration

**Quasi-Experimental Design:** The study utilized a pre-and-post experimental design over six months, with treatment sessions four days a week for eight weeks(Grobe-Einsler et al., 2023).

**Sample Size:** A total of 56 patients were included, selected through convenient sampling methods.

Table 1 Statistical Analysis

| STATISTICAL ANALYSIS | BERG BALANCE SCALE | SARA  |
|----------------------|--------------------|-------|
| MEAN DIFFERENCE      | 30.32              | 20.3  |
| STANDARD DEVIATION   | 3.96               | 3.95  |
| PAIRED T TEST        | 57.31              | 38.43 |

Procedure

The incorporation of dual-task dynamic balance exercises, which integrate cognitive and motor activities, has demonstrated considerable advantages in rehabilitation, particularly for individuals with conditions such as Parkinson's disease. These exercises not only improve physical balance but also enhance cognitive functions, thereby serving as a valuable element of physiotherapy. The subsequent sections delineate the fundamental components of dual-task training. Dual-task training is a widely recognized method in physiotherapy and rehabilitation, involving the simultaneous performance of two tasks that require different cognitive, motor, or behavioral responses. This approach mimics real-life situations where individuals often juggle multiple tasks, making it highly relevant for improving functional abilities. The integration of dynamic balance exercises with cognitive or motor tasks has been shown to enhance rehabilitation outcomes, particularly in populations with balance impairments or cognitive deficits. Below is a detailed exploration of dual tasks, their types, and their applications in rehabilitation, supported by evidence from relevant studies. Dual-tasking refers to the ability to perform two tasks simultaneously, requiring the allocation of attentional resources and coordination between different cognitive or motor processes. These tasks can be categorized into cognitive, motor, or a combination of both. The effectiveness of dual-task training lies in its ability to simulate real-world scenarios, where individuals must often divide their attention between multiple activities (Dhlamini, 2022). In the context of rehabilitation, dual-task training is particularly useful for improving balance, gait, and overall functional mobility. Studies have demonstrated that incorporating dual tasks into rehabilitation protocols can lead to significant improvements in both motor and cognitive functions, especially in older adults and individuals with neurological impairments (Tao et al., 2022) (Zadeh et al., 2018).

Dual tasks can be broadly classified into two categories: cognitive tasks and motor tasks. These tasks are often combined in rehabilitation settings to challenge both cognitive and motor systems simultaneously.

Cognitive Tasks

Cognitive tasks are designed to challenge attention, memory, executive functions, and problem-solving abilities. Common examples include:

1. Counting Backward: Participants are asked to count backward from a specific number, such as from 10 to 1, or to count the days of the week backward. This task requires sustained attention and working memory (Zadeh et al., 2018).
2. Naming Objects: Participants are asked to name objects starting with a specific letter, such as "F" or "S." This task enhances lexical retrieval and attention (Zadeh et al., 2018).
3. Spelling and Memory Tasks: Participants may be asked to spell words backward or recall the number of letters in a word. These tasks engage executive functions and memory (Zadeh et al., 2018).
4. Decision-Making Tasks: For example, participants are instructed to say "yes" when the word "red" is mentioned and "no" when the word "blue" is mentioned. This task requires selective attention and cognitive flexibility (Zadeh et al., 2018).

Motor Tasks

Motor tasks are designed to challenge coordination, balance, and fine motor skills. Examples include:

1. Object Manipulation: Tasks such as transferring objects (e.g., money, keys, or a pencil) from one hand to another or buttoning and unbuttoning a shirt. These tasks require hand-eye coordination and dexterity (Zadeh et al., 2018).
2. Carrying Objects: Participants may be asked to carry a glass of water on a tray while performing a cognitive task. This task requires balance and coordination (Zadeh et al., 2018).
3. Ball Transfers: Transferring a ball from one hand to the other or rolling a ball backward or forward with the free leg. These tasks enhance motor coordination and balance (Zadeh et al., 2018).
4. Dynamic Balance Exercises: Activities such as twisting jumps or stabilizing balance in a one-legged stance after high knee running. These exercises improve dynamic balance and overall motor control (Zadeh et al., 2018).

Dual-task training is widely applied in rehabilitation settings to address a variety of conditions, including aging-related cognitive impairment, balance disorders, and neurological deficits. The rationale behind this approach is to simulate real-life scenarios where individuals must perform multiple tasks simultaneously, thereby enhancing functional abilities and reducing the risk of falls and injuries. Balance is a critical component of functional mobility, and dual-task training has been shown to improve balance in various populations. For example, studies have demonstrated that combining cognitive tasks with dynamic balance exercises, such as one-legged stance or twisting jumps, can enhance balance control in elderly women (Zadeh et al., 2018). Similarly, motor tasks such as transferring objects or carrying a glass of water on a tray have been used to improve balance and coordination in individuals with balance impairments (Zadeh et al., 2018). Cognitive-motor dual tasks are particularly effective in addressing aging-related cognitive impairment. These tasks combine cognitive challenges, such as counting backward or naming objects, with motor tasks, such as walking or transferring objects. The integration of these tasks has been shown to improve both cognitive and motor functions, leading to better overall rehabilitation outcomes (Tao et al., 2022) (Zadeh et al., 2018). Gait training is another area where dual-task training has been successfully applied. For example, participants may be asked to perform a cognitive task, such as counting backward, while walking. This approach has been shown to improve gait performance and reduce the risk of falls in older adults (Zadeh et al., 2018). The integration of dual tasks into rehabilitation protocols has been shown to have positive effects on both balance and cognition. These effects are attributed to the ability of dual tasks to challenge multiple systems simultaneously, leading to improved functional outcomes. Dual-task training has been shown to enhance balance control by challenging the motor system to adapt to changing conditions. For example, dynamic balance exercises, such as one-legged stance or twisting jumps, require the integration of sensory input, motor output, and cognitive processing. These exercises have been shown to improve balance in elderly women and reduce the risk of falls (Zadeh et al., 2018). Cognitive tasks, such as counting backward or naming objects, have been shown to improve attention, memory, and executive functions. These tasks are often combined with motor tasks to challenge both cognitive and motor systems simultaneously, leading to improved overall functional abilities (Tao et al., 2022) (Zadeh et al., 2018).

Table 2 Comparison of Dual Tasks and Their Effects

| Task Type       | Description                                                                           | Effects on Rehabilitation                                                                                                                                     |
|-----------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Cognitive Tasks | Counting backward, naming objects, spelling, and decision-making tasks.               | Improves attention, memory, and executive functions. Enhances cognitive-motor integration (Zadeh et al., 2018).                                               |
| Motor Tasks     | Object manipulation, carrying objects, ball transfers, and dynamic balance exercises. | Enhances motor coordination, balance, and overall functional mobility. Reduces the risk of falls (Zadeh et al., 2018).                                        |
| Dual Tasks      | Combination of cognitive and motor tasks, such as counting backward while walking.    | Improves gait performance, balance control, and cognitive-motor integration. Enhances real-life functional abilities (Tao et al., 2022) (Zadeh et al., 2018). |

## CONCLUSION

Dual-task training is a powerful tool in rehabilitation, offering a wide range of benefits for both cognitive and motor functions. By challenging individuals to perform multiple tasks simultaneously, dual-task training simulates real-life scenarios, leading to improved functional outcomes and reduced risk of falls and injuries. The integration of cognitive and motor tasks, such as counting backward while performing dynamic balance exercises, has been shown to be particularly effective in addressing balance impairments and cognitive deficits. As research continues to uncover the full potential of dual-task training, its application in rehabilitation is expected to expand, offering new and innovative approaches to improving functional abilities in diverse populations.

## REFERENCES

1. Azim Zadeh, Elham, et al. "The Effect of Dual-Task Training on Balance of Elderly Women: With the Motor and Cognitive Approach." *Research in Sport Management & Motor Behavior*, vol. 8, no. 15, 1 Aug. 2018, pp. 103–110, <https://doi.org/10.29252/jrsm.8.15.103>. Accessed 19 Nov. 2020.
2. Choi, Sung Won, et al. "Evaluation of Ataxia in Mild Ischemic Stroke Patients Using the Scale for the Assessment and Rating of Ataxia (SARA)." *Annals of Rehabilitation Medicine*, vol. 42, no. 3, 1 June 2018, pp. 375–383, [www.ncbi.nlm.nih.gov/pmc/articles/PMC6058584/](http://www.ncbi.nlm.nih.gov/pmc/articles/PMC6058584/), <https://doi.org/10.5535/arm.2018.42.3.375>. Accessed 14 Dec. 2020.
3. Grobe-Einsler, Marcus, et al. Scale for the Assessment and Rating of Ataxia (SARA): Development of a Training Tool and Certification Program. 15 Mar. 2023, <https://doi.org/10.1007/s12311-023-01543-3>.
4. Jacobi, Heike, et al. "Dual Task Effect on Postural Control in Patients with Degenerative Cerebellar Disorders." *Cerebellum & Ataxias*, vol. 2, no. 1, 8 May 2015, <https://doi.org/10.1186/s40673-015-0025-z>. Accessed 29 Dec. 2019.
5. Kang, Bangsoo, and Jin-Hoon Park. "Effects of Dual Tasks on Balance Ability in Patients with Cerebellar Ataxia." *The Journal of Korean Physical Therapy*, vol. 27, no. 5, 30 Oct. 2015, pp. 292–298, <https://doi.org/10.18857/jkpt.2015.27.5.292>. Accessed 22 Mar. 2022.
6. Moulairé, Paul, et al. "Temporal Dynamics of the Scale for the Assessment and Rating of Ataxia in Spinocerebellar Ataxias." *Movement Disorders*, vol. 38, no. 1, 23 Oct. 2022, pp. 35–44, <https://doi.org/10.1002/mds.29255>. Accessed 5 Sept. 2023.
7. Subramony, Sub H. "SARA—a New Clinical Scale for the Assessment and Rating of Ataxia." *Nature Clinical Practice Neurology*, vol. 3, no. 3, 6 Feb. 2007, pp. 136–137, [www.nature.com/articles/ncpneuro0426](http://www.nature.com/articles/ncpneuro0426), <https://doi.org/10.1038/ncpneuro0426>. Accessed 26 Jan. 2020.
8. Tao, Xue, et al. "Cognitive-Motor Dual Task: An Effective Rehabilitation Method in Aging-Related Cognitive Impairment." *Frontiers in Aging Neuroscience*, vol. 14, 18 Oct. 2022, <https://doi.org/10.3389/fnagi.2022.1051056>. Accessed 20 Nov. 2022.
9. Taşvuran Horata, Emel. "BIBLIOMETRIC ANALYSIS of DUAL-TASK STUDIES PUBLISHED in PHYSIOTHERAPY and REHABILITATION." *Kocatepe Tıp Dergisi*, vol. 24, no. 2, 5 Apr. 2023, pp. 213–220, <https://doi.org/10.18229/kocatepetip.1102503>. Accessed 25 Sept. 2024.
10. Winsor, Stanley J., et al. "Effectiveness and Cost of Integrated Cognitive and Balance Training for Balance and Falls in Cerebellar Ataxia: A Blinded Two-Arm Parallel Group RCT." *Frontiers in Neurology*, vol. 14, 2023, p. 1267099, [pubmed.ncbi.nlm.nih.gov/38313407/](http://pubmed.ncbi.nlm.nih.gov/38313407/), <https://doi.org/10.3389/fneur.2023.1267099>. Accessed 19 Mar. 2024.