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A literature review on effect's of multidimensional balance training exercises in patient with traumatic brain injury

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Abstract

Background of the study: Traumatic Brain Injury (TBI) is a major public health issue that can lead to physical, cognitive, and emotional disabilities. It often impairs balance and coordination, making daily activities difficult. These balance issues typically result from damage to the vestibular system, motor control, and sensory integration. training has proven effective in improving stability and reducing falls in TBI patients. While traditional methods focus on static balance, multidimensional balance training (MBT) incorporates dynamic exercises, cognitive tasks, and proprioceptive activities. This comprehensive approach is crucial for recovery, as it addresses the often-compromised sensorimotor functions following TBI.

Methodology: A comprehensive literature study was done using the specified search criteria ' To carry out a literature review, the search phrases ","TBI (traumatic brain injury)," "multidimensional," "Balance," and "exercise" were employed between the years 2014 and 2024. We have discovered 15 publications with complete text and methodologies for additional examination from diverse academic journals.

Results: We discovered 15 publications that included a certain balance training exercise protocol in all participants. All papers designed for balance training exercises patients showed benefits in all intervention groups.

Conclusion: We discovered 15 publications that had distinct balance training exercises for all individuals. All articles designed for balance training exercises patients showed benefits in all intervention groups.

Keywords: Traumatic Brain Injury; Multidimensional; Balance; Exercise

1. Introduction

Traumatic brain injury is defined as an alteration in brain function caused by an external force. Brain tissue damage can be categorized into two types: primary injury and secondary injury. Primary injury is caused by direct trauma to the parenchyma. Secondary injury results from a cascade of biochemical, cellular, and molecular events that are triggered by the initial injury, along with injury-related hypoxia, elevated intracranial pressure, and oedema .1

There are two types of head injuries: open head injury, which is associated with skull fractures, and closed head injury, which occurs in isolation without skull fractures. The blood supply to the brain may also be indirectly affected due to injuries to the face and neck. Most cases of TBI are caused by road traffic accidents (RTA). The severity of brain injury is categorized as mild, moderate, or severe.2

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In cases of mild traumatic brain injury, minimal damage to the neuroanatomical structures is observed, with slight or no permanent impairment. A Glasgow Coma Scale score of more than 13 is classified as mild TBI. In moderate TBI, a GCS score between 8 and 13 is noted, along with post-traumatic amnesia lasting between 1 to 24 hours. Severe TBI is indicated by a GCS score of less than 8.

After a traumatic brain injury (TBI), patients may experience changes in consciousness, sensorimotor function, cognition, emotions, and behavior. They might also face issues with attention, balance, dizziness, visual dysfunction, spasticity, and post-traumatic headache.2

Balance disorders are a common consequence of traumatic brain injury. Balance refers to a state in which the center of mass remains within the stability limit and base of support (BOS).

It depends on three key systems

- The sensory and perceptual systems, which are responsible for detecting body motion and position.
- The motor systems, which are responsible for producing coordinated movements.
- The central nervous system (CNS), which integrates sensory information and generates action plans.

Balance relies on two vestibular reflexes: the vestibulo-ocular reflex (VOR) and the vestibulospinal reflex (VSR). To enhance balance after TBI, therapies focusing on vestibular rehabilitation and visual treatments are commonly employed.8

Motor disabilities following TBI are prevalent, as damage to various areas of the nervous system can affect motor performance, leading to reduced muscle power and muscle tone disorders, which in turn can impair balance.6

Focal or diffuse spasticity may arise after TBI. The time elapsed since the injury is a crucial factor, as spontaneous neurological recovery may continue for 9 to 15 months post-injury. Motor impairment can also stem from prolonged immobilization and bed rest during the acute phase. Such extended immobility can negatively affect multiple body systems, significantly impacting motor function. Therefore, motor rehabilitation is essential for helping patients regain their independence following TBI.7,8

1.1. Need of the study

The current body of literature on balance training for post-TBI patients has predominantly been focused on unidimensional interventions. While some benefits have been shown, the complex nature of post-TBI symptoms, which can include a combination of motor, sensory, and cognitive deficits, is often neglected. Thus, the effects of multidimensional balance training on improving the multifaceted balance problems faced by TBI survivors need to be explored.

1.2. Objective of the study

This literature review will specifically examine the existing evidence regarding the effect's of multidimensional balance training exercises in patient with traumatic brain injury

2. Materials and methods

2.1. Study Design

This review of literature is based on the PRISMA (Preferred Reporting Items for Systematic Review and Meta-Analysis) guidelines.

2.1.1. Inclusion Criteria

- Only articles published in the English language will be considered.
- The study will include full-text articles, rather than abstracts or summaries.
- Both sexes are encompassed
- The age range is from 25to 60years.
- The articles were published between 2014 and 2024.

2.1.2. Exclusion Criteria

- Articles published in languages other than the regional language were omitted.
- Articles published prior to 2014 were excluded.

3. Methodology

The evidence was gathered from online web publications obtained from different search engines, including Google Scholar, PubMed, and other obesity journals. A tailored search was conducted using keywords such as "TBI (traumatic brain injury)," "multidimensional," "Balance," and "exercise" to retrieve relevant publications. The period was designated as 2015 to 2024 to gather precise and current facts from throughout the globe over the past decade. We have identified a total of 15 articles that meet our specific criteria for inclusion and exclusion. All 15 publications were obtained in their entirety to be analysed and continued with further analysis. The results are derived using a systematic approach from all articles and displayed in a tabular format for enhanced comprehension. The selection techniques are detailed in the PRISMA

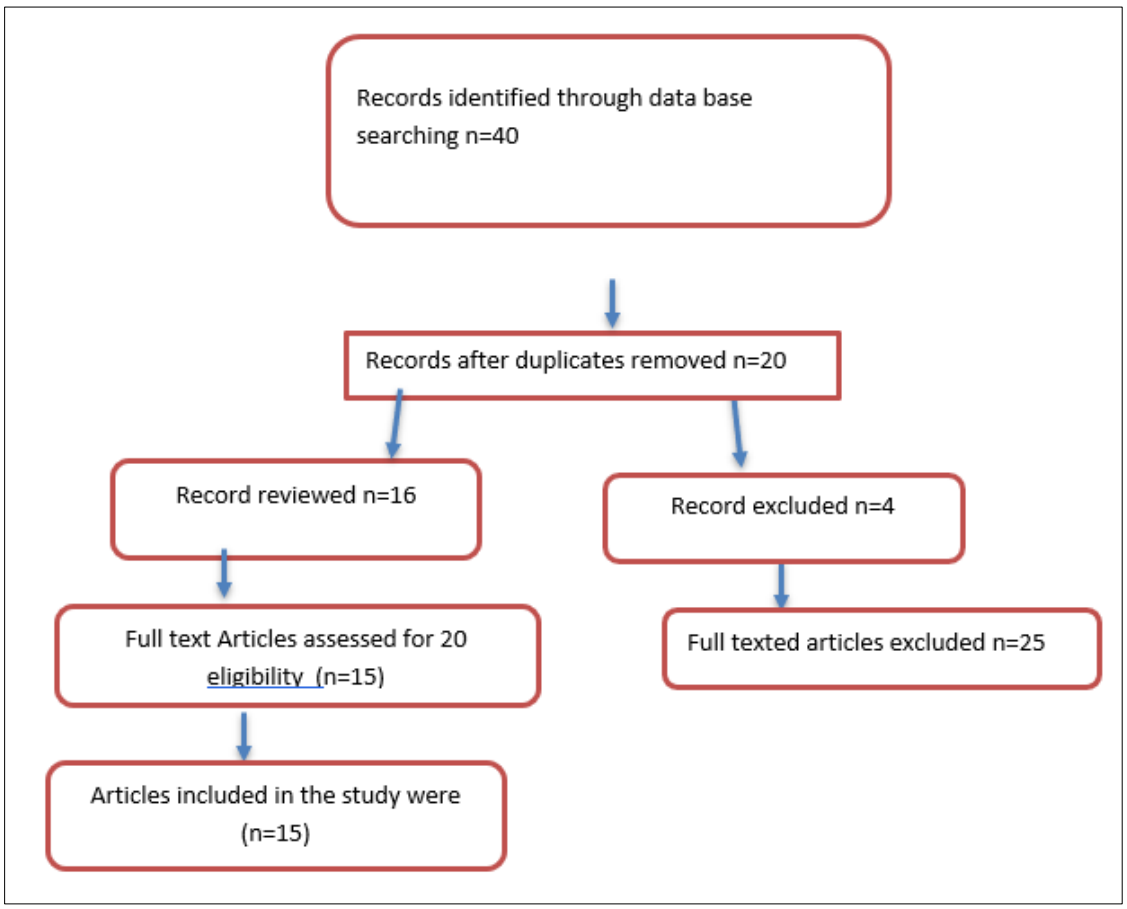

Figure 1 Flow chart

3.1. Review of literature

The characteristics of the extracted article have been listed in Table 1.

Table 1 Characteristics of articles researched on the Effect of multidimensional balance training exercises on post TBI patient

Author, Year	Total No. of Samples	Duration of the study	Exercise + Supplementation Intervention	Outcome measures	Significant Findings
Julie M. Joyce et al 2022	70	2 years	Balance and coordination training	Balance Error Scoring System (BESS), National Institutes of Health Standing Balance Test (NIH-SBT), Functional Gait Assessment (FGA), Advanced Functional Gait Assessment (FGA-A), Tandem Gait Test (TGT), Berg Balance Scale (BBS), and Walking While Talking Test (WWTT).	Provides evidence to support a stepwise approach to balance assessment that can be adapted to the broad range of balance ability found in moderate-to-severe TBI
Sally Vuu 2022		11 years	balance and coordination training	Quality assessment. Berg Balance Scale (BBS), and Walking While Talking Test (WWTT).	Demonstrated that the use of aerobic exercise is supported by mixed quality evidence and moderate certainty of evidence, yet there is limited evidence for the use of vestibular exercise for improving persistent symptoms in people with mTBI.
Eduardo Cisneros et al 2021	37	6 months	impact of cognitive difficulties in daily life by using self-guided and environmental strategies. In contrast to the CEP intervention	neuropsychological tests (Six Elements Task-Adapted [SET-A], D-KEFS Sorting test and Stroop four-color version); generalization was measured by self-reporting questionnaires about daily functioning (Dysexecutive Functioning Questionnaire, forsaken daily activities).	Study shows that older adults with TBI can improve their executive functioning, with a positive impact on everyday activities, after receiving multimodal cognitive training with the CEP. ClinicalTrials
Romana Romanov et al 2021	25	3 months	improving circulation (endurance exercises), empowering the body (strength exercises), and increasing the volume of movement and general	a Senior Fitness battery and Berg's balance scale. Attention process was assessed by a standardized d2 test.	Traumatic brain injury causes difficulties in the memory and executive functions of the body and impairs working ability. The short-term adapted physical exercise program can yield a positive change in working abilities of patients with TBI.

			flexibility of the body (stretching exercises		
Liam Johnson, et 2020	812	3 monhs	a virtual reality physical activity intervention improved mobility, assessed by the Community Balance and Mobility Scale	Balance and Mobility Scale	review consolidates the current evidence base for the prescription of physical activity for people with moderate-to-severe TBI
Pranali Kakade 2020	20	6 weeks	multidimensional exercises such as sensory training, bed mobility exercises – segmental rolling, pelvic bridging and heel slides. Active or active assisted ROM exercises to prevent contractures. Tone management by stretching and icing, proprioception training by joint compression, auditory clues by rhythmic auditory stimulation, visual feedback, vestibular rehabilitation exercises, balance and coordination training.	berg balance scale and community balance and mobility scale	On the basis of result, it can be concluded that multidimensional exercise program is effective for improving balance in TBI patients.
Shaimaa Ahmed Mohammad Abd - Eltawab et al	40	3 months	mobility exercises – segmental rolling, pelvic bridging and heel slides. Active or active assisted	berg balance scale. GCS	Early designated exercise program was effective to improve balance, mobility as well as reduced risk of falling among traumatic brain injury patients according to thetotal scores of Berg balance scale.
Vishwajeet Trivedi et al 2014	1	6 weeks	Strengthing exercises, Balance exercises	functional independence measure (FIM), berg balance scale (BBS), computer dynamography (CDG) for gait parameters	this proves that exercise regime which we have used in this case may be effective in improving balance, muscle strength , gait pattern & functional independence & thereby the quality of life of TBI survivors.
Cecelia Sartor-Glittenberg 2014	127	23 weeks	An integrative treatment approach was used, and the individuals participated in activities to minimize ataxia and improve mobility. Each of them made gains in coordination, balance, balance	Balance and Mobility Scale	An integrative treatment approach was used, and the individuals participated in activities to minimize ataxia and improve mobility. Each of them made gains in coordination, balance, balance confidence,

			confidence, endurance and mobility		endurance and mobility. The three individuals with cerebellar ataxia participated in a long-term, individualized, multidimensional physical therapy treatment program, and made improvements in all areas of impairment and activity limitations.
Anas R. Alashram et al 2020	259	3 months	experimental interventions, virtual reality (VR), vestibular rehabilitation therapy (VRT), control group interventions, and other traditional physical therapy interventions.	Berg Balance Scale (BBS),Berg Balance Scale (BBS) , Dynamic Gait Analysis (DGI) Motor Control Test (MCT), Balance Error Scoring System (BBES) , Community Balance and Mobility Scale (CB&M) , and Activities-specific Balance Confidence Scale (ABC)	The evidence about the effects of the physical therapy interventions in improving the balance ability post-TBI was limited

4. Discussion

Multidimensional balance training (MBT) has emerged as a key rehabilitative approach for patients recovering from traumatic brain injury (TBI). TBI can lead to a range of impairments, particularly in balance and postural stability, which significantly affect the patient's ability to function in daily life. Multidimensional balance training exercises aim to enhance balance by engaging multiple sensory and motor systems simultaneously, including visual, proprioceptive, and vestibular systems. These systems often face disruption in TBI patients, leading to the need for more complex and integrated approaches like MBT to facilitate recovery.

4.1. Effects of Multidimensional Balance Training Exercises in patient with Traumatic Brain Injury

Lau et al. (2016) reviewed the efficacy of MBT in individuals recovering from TBI. Their research showed that integrating balance training exercises involving dynamic postural adjustments with cognitive challenges (e.g., memory or attention tasks) significantly improved the balance scores of TBI patients compared to traditional methods. They concluded that such integrative approaches not only work on motor control but also enhance cognitive functions like attention and coordination, which are often compromised post-injury.9

Huang et al. (2019) also emphasized the cognitive benefits of MBT in their systematic review. They noted that post-TBI patients often experience a decline in cognitive processing abilities, which hampers their ability to process sensory input crucial for balance. By incorporating exercises that require participants to engage cognitive resources while balancing (such as dual-task training or exercises involving coordination between different limbs), MBT facilitates the recovery of both cognitive and motor functions. Huang et al. suggested that the cognitive load involved in MBT may lead to neuroplasticity, a process where the brain reconfigures itself and strengthens neural connections, aiding in recovery.10

4.2. Functional and Mobility Outcomes

Improvement in functional mobility, including gait and walking speed, is often a primary goal of TBI rehabilitation. Choi et al. (2017) conducted a randomized controlled trial comparing the effects of MBT and traditional static balance training on gait and functional mobility. The results indicated that the MBT group showed significant improvements in both static and dynamic balance, gait speed, and overall mobility. The authors concluded that exercises that challenge a patient's balance in varied contexts—such as on unstable surfaces or during movement transitions—promote more significant functional improvements.11

Moreover, Patterson et al. (2018) highlighted the advantages of MBT over traditional balance training in their clinical trial. The researchers found that patients who participated in MBT, which combined visual, proprioceptive, and vestibular exercises with dynamic movements (e.g., reaching, walking, and stepping tasks), demonstrated faster recovery in terms of mobility and independence. This was particularly important as TBI patients often suffer from long-term mobility impairments, and MBT's ability to improve functional mobility has significant implications for long-term recovery and reintegration into daily life. 12

Abbreviations

- TBI: Traumatic brain injury,
- MBT: Multidimensional balance training.

5. Conclusion

Multidimensional balance training (MBT) effectively improves balance, gait, and functional mobility in patients with traumatic brain injury (TBI). By engaging multiple sensory and cognitive pathways, MBT enhances motor control, reduces fall risk, and improves daily functioning. While the short-term benefits of MBT are clear, there are gaps in the literature regarding the long-term sustainability of these improvements. Future research should standardize training protocols and incorporate advanced technologies, like virtual reality, for more precise interventions. Overall, MBT presents a promising approach to TBI rehabilitation, addressing both motor and cognitive recovery, and has the potential to significantly enhance the quality of life for individuals with TBI.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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