Article published online: 2024-10-21

Review Article

Effectiveness of Dynamic Neuromuscular Stabilization Technique in Neurological Conditions: An Updated Review

Himani Kaushik[1] Avi Choudhary[1] Mitushi Sharma[1]

[1] Department of Physiotherapy, Banarsidas Chandiwala Institute of Physiotherapy, Affiliated to Guru Gobind Singh Indraprastha University, Delhi, India

Address for correspondence Avi Choudhary, MPT Neurology, Banarsidas Chandiwala Institute of Physiotherapy, Affiliated to Guru Gobind Singh Indraprastha University, Delhi 110099, India (e-mail: avichaudhary@bcip.ac.in).

J Health Allied Sci[NU]

Abstract

Objective This updated review aims to identify the effectiveness of dynamic neuromuscular stabilization (DNS) techniques in neurological conditions.

Method A literature search was carried out from 2013 to 2024 on PubMed, Google Scholar, Research Gate, and Scopus databases. Following keywords were used to identify the relevant articles such as dynamic neuromuscular stabilization, reflex-mediated DNS, neurological conditions, DNS, cerebral palsy, stroke, Parkinson's disease, multiple sclerosis, neurodegenerative conditions, ataxia, Alzheimer's disease, and multiple sclerosis with Boolean operators. All the full-text, English-written articles based on inclusion and exclusion criteria were included in the review irrespective of their experiment study design, only the review article was excluded.

Results This updated review included 10 articles related to neurological conditions including, stroke, multiple sclerosis, Alzheimer's disease, Parkinson's disease, and cerebral palsy. The results show significant differences in various outcome measures of the included studies.

Conclusion The findings suggest that DNS is an effective approach to use in the rehabilitation protocol of neurologically impaired patients and is beneficial in improving their health outcomes and overall quality of life. This review concludes that more evidence is required in this area of research with good quality research and long follow-up periods.

Keywords
- DNS
- rehabilitation
- neurological conditions
- dynamic neuromuscular stabilization
- quality of life

Introduction

Neurological conditions, both fatal and nonfatal, are significant contributors to the global burden of communicable and noncommunicable diseases.[1] Disability-adjusted life years serve as an important metric for evaluating the global burden of neurological conditions, and their prevalence continues to rise worldwide.[1] Neurological conditions impact the central nervous system such as nerves, brain, and spinal cord. Individuals with these conditions face various sensory, motor, cognitive, and functional challenges, reducing overall quality of life.[1]

Cerebrovascular accidents (CVAs)/stroke involve a sudden, focal interruption or obstruction in the cerebral blood flow, leading to neurological deficit. The most common type is ischemic typically caused by embolism or thrombosis.[2] Neurodegenerative disorders influence balance, motor control, speech, respiratory and heart functions, reading abilities and cognition.[2] Diseases such as Alzheimer's disease (AD), Parkinson's disease (PD), Huntington's disease, ataxia, and

DOI https://doi.org/10.1055/s-0044-1791708.
ISSN 2582-4287.

Thieme Medical and Scientific Publishers Pvt. Ltd., A-12, 2nd Floor, Sector 2, Noida-201301 UP, India

motor neuron disease fall under this category.[2] AD leads to dementia. Pain, memory, thinking, gait, and balance deficits are common in patients with AD, with a of prevalence rate of nearly 60%.[3] PD progresses slowly and is characterized by tremors, bradykinesia, and problems in gait and posture. Huntington's disease is a genetic movement disorder characterized by progressive degeneration of the brain and neurons. Ataxia results in the loss of motor control, coordination, and difficulties with balancing and walking.[2]

Other neurological disorders encompass pathological and traumatic disorders such as amyotrophic lateral sclerosis, various kinds of seizures (epilepsy), traumatic brain injury, spinal cord and peripheral nerve injuries, cerebral palsy (CP), and brain or spinal tumors.[2] Multiple sclerosis (MS) is a central nervous system disorder, characterized by inflammation, demyelination, and degeneration.[4] Balance dysfunction in MS presents three interrelated problems, decreased ability to maintain position, limited and slow movements, and delayed response to postural displacement and perturbations.[5] CP refers to a group of disorders that affect the development of movement and posture, leading to activity limitations.[6,7] These are attributed to nonprogressive disturbances occurring in the developing fetal and infant brain.[6,7] Children with CP may exhibit a crouched posture, delayed reflex activities, decreased muscle activation, and spasticity.[6,7]

Trunk and postural control muscles, such as the abdominal muscles, are considered important biomarkers for assessing the functional status of neurologically impaired patients. Techniques such as proprioceptive neuromuscular facilitation and Bobath are used to improve motor, posture, and balance control in neurological conditions, focusing on upper limb and lower limb activities. However, there is a need for further research to target the core to improve functionality and overall health.

Dynamic neuromuscular stabilization (DNS) is a technique developed based on the principles of developmental kinesiology and reflex-mediated core stabilization concepts.[8] This approach focuses on facilitating core stabilizers, such as mainly the diaphragm, obliques, and transverse abdominis (TrA), utilizing ontogenic patterns, which are particularly helpful for individuals with reduced somatosensory function or impaired movement awareness.[8] DNS therapy involves a thorough analysis of the quality of stability and movement to restore the integrated spinal stabilization system (ISSS) through specialized functional exercises.[9] Ontogenic patterns activate the spinal stabilization system, restoring intra-abdominal pressure and enhancing movement efficacy.[10] Postural stability is improved by the subconscious activation of the postural core muscles through the strategies of facilitating motor control for posture and balance.[11]

Therefore, this updated literature review *aims* to identify the effectiveness of DNS in neurological conditions.

Methods

This updated literature review provides an overview of previous researches on the effectiveness of DNS in various neurological conditions. The literature search was carried out on PubMed, Research Gate, Google Scholar, and Scopus databases from 2014 to 2024 using keywords such as dynamic neuromuscular stabilization, reflex-mediated DNS, neurological conditions, DNS, cerebral palsy, stroke, Parkinson's disease, MS, neurodegenerative conditions, ataxia, Alzheimer's disease, and multiple sclerosis with Boolean operators. We identify relevant studies by establishing inclusion and exclusion criteria, removing duplicates, and screening titles, keywords, and abstracts in the preliminary stage. Only full-text studies comparing the effectiveness of DNS as an intervention in participants with neurological conditions were considered for the inclusion criteria. Studies not written in English were excluded, and articles on other topics like cardiovascular and musculoskeletal were also excluded from this literature review. Any other adjunctive rehabilitation protocol included in the studies and superimposing the effects of DNS training was also excluded from this review. Three independent researchers H.K., A.C., and M. S. were involved in searching and extracting the relevant data from the studies, and any differences in thought processes were resolved through discussions.

Results

In this review, 10 articles were included for the final analysis, as shown in ►**Fig. 1**, in which 269 participants were included. A total of 129 participants were affected with stroke, 64 participants were affected with MS, 30 participants were affected with AD, 30 participants were affected with PD, and 16 participants were affected with CP. All the participants underwent the DNS rehabilitation protocol.

CVA (stroke): The therapeutic effect of neurodevelopment therapy (NDT) and DNS exercises on muscular activity, core stability, and core thickness in stroke patients was examined in several studies. For instance, in a clinical study in 2017, Yoon and You, recruited 10 participants, including 5 healthy adults and 5 hemiparetic stroke patients.[12] The results showed that healthy subjects exhibited greater activation in the core TrA, and internal oblique (IO) muscles during DNS than during NDT but less activation in the superficial external oblique muscles, and improvement in muscle thickness and pressure biofeedback unit (PBU) values.[12] Both healthy and stroke participants show a significant improvement, $p \leq 0.05$, using ultrasound, electromyography (EMG), and PBU measurements.[12] These results support the theoretical hypothesis that selected stimulation of the chest zones during DNS can elicit core stabilization intervening in the monosynaptic reflexive activation system.[12] In a 2018 study by Benfiry et al, a group of stroke patients underwent an 8-week protocol of DNS and showed significant improvement in balance and quality of life using Berg Balance Scale (BBS) and 36-Item Short Form Survey (SF-36) compared to a control group ($p \leq 0.05$).[13] Another randomized controlled trial (RCT) was conducted in 2018, by Lee et al, to compare the effects of conventional core stabilization and DNS on anticipatory postural adjustment (APA) time, balance performance, and fear of falls in hemiparetic stroke patients.[11] The

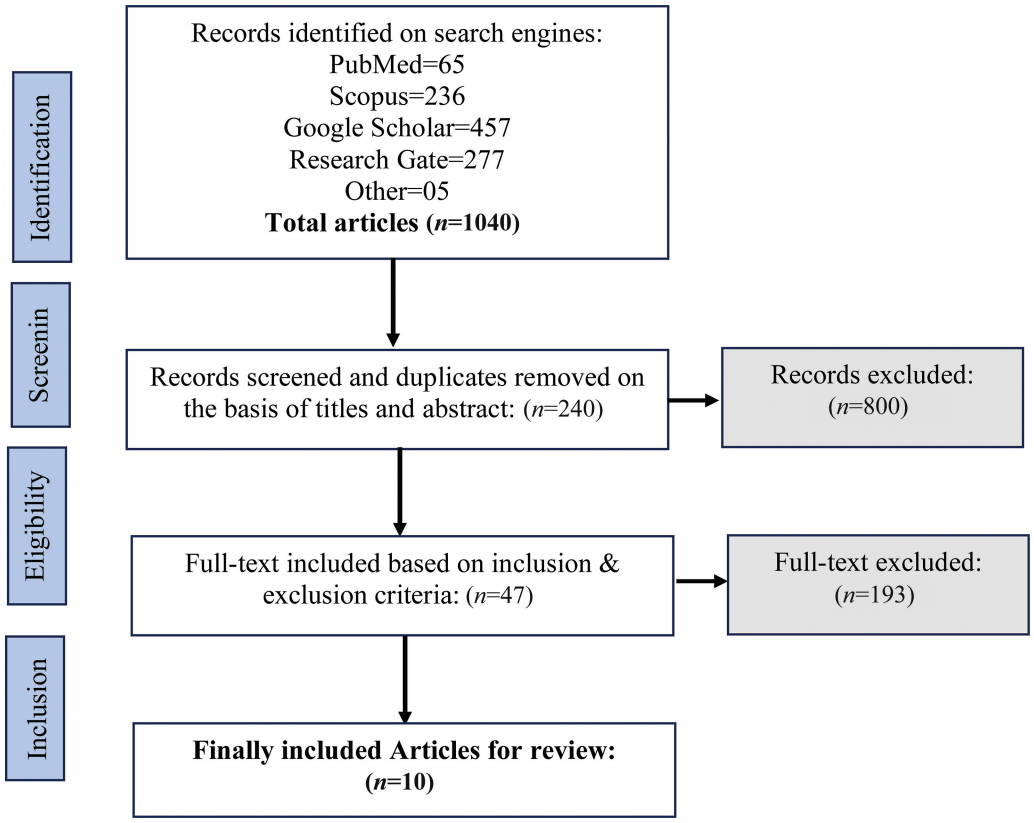

Fig. 1 Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) flowchart.

study concludes that the APA, EMG of TrA/IO and erector spinae (ES), BBS, and Trunk Impairment Scale (TIS) scores were significantly improved ($p \leq 0.008$) in the DNS group compared to the conventional group and the Fall Efficacy Scale (FES) score was also significantly improved as $p \leq 0.003$ in both the groups compared with baseline data, but FES scores remained same after the 2 years of follow-up period in the DNS group, $p \leq 0.003$.[11]

In 2020, a RCT by Yoon et al compared the effects of DNS and conventional exercise on respiratory function, fatigue, and activities of daily living in stroke patients.[14] The results revealed that the DNS group shows superior effects on respiratory function, fatigue level, and activities of daily living as compared to the NDT group, $p \leq 0.05$.[14] These results suggest that DNS was more effective than NDT as it coactivates the diaphragm muscle effectively in hemiparetic patients.[14] Furthermore, an experimental study was conducted in 2021 by Raghuveer et al on the effectiveness of diaphragm activation using reflex-mediated DNS on trunk function in hemiplegia.[15] In this study, all the outcomes significantly improved in both groups compared to the baseline data, $p \leq 0.05$.[15]

In 2014, Oppelt et al conducted a case study on using spinal manipulation with DNS care to improve the function of a post-CVA.[16] The study included a 31-year-old male with left-side hemiparesis. Chiropractic intervention was provided for 32 weeks, with the inclusion of DNS intervention over the final 16 weeks.[16] The results showed that the integration of DNS exercises in the later 8 months significantly improved the health outcomes and reached its plateau after 4 years of CVA.[16]

MS: In 2022, Abadi Marand et al designed a RCT protocol to assess the effectiveness of DNS on balance and trunk stability in people with MS.[17] Subsequently, Abadi Marand et al conducted a RCT in 2023 to compare the effect of core stabilization and DNS on balance, trunk function, mobility, falls, and spasticity in people with MS.[18] Core stabilization training focuses on the deep abdominal muscles of the trunk and is a regulated form of exercise aimed at facilitating proper stabilization of the lumbar spine and pelvis for everyday tasks.[18] In contrast, DNS exercises are novel, functional rehabilitation methods designed to improve motor activities based on human ontogenic developmental patterns.[18] The DNS group demonstrated a significant improvement in BBS score, postural stability, activities-specific balance confidence, Timed-Up-Go (TUG) test, Multiple Sclerosis Walking Scale-12, Modified Ashworth Scale, TIS, and fall rate ($p = 0.01$) compared to the core stabilization group.[18] The results suggest that DNS exercises may be more effective for people with MS as they emphasize the ISSS, precise muscle activation, timing, and coordination, leading to improved movement efficiency and trunk and muscle endurance as compared to the core stabilization group.[18]

AD: In 2022, Shah conducted a quasi-experimental study on the effectiveness of DNS exercises for patients with AD.[3] They found that patients with AD significantly improved their balance and gait parameters after the 8 weeks of DNS exercises compared to the control group.[3] TUG test, gate

velocity, step length, and step width show significant changes after receiving the DNS exercises, $p < 0.05$.[3] However, the study had limitations such as a small sample size due to difficulty accessing AD patients, a lack of long-term follow-up to examine the sustained effects of DNS exercises, and the absence of a comparative intervention group.[3] Overall, DNS can be beneficial and can improve balance in gait parameters in patients with AD.[3]

PD: Nosratikia et al conducted a quasi-experimental study on the effects of 12 weeks of DNS training on balance in individuals with PD.[19] The study included 30 elderly men and women suffering from PD, who were randomly assigned to experimental and control groups.[19] The experimental group underwent for 12 weeks with three 50-minute sessions each week.[19] The study found significant improvement in static and dynamic balance in the DNS group, as evidenced by foot scan and TUG test, $p \leq 0.05$.[19]

CP: Two studies on the effects of DNS training on CP were found through the search conducted in 2017. The first study focused on a 13-year-old with spastic hemiplegic CP, showing significant improvements in balance and gait ability after 4 weeks of DNS techniques.[20] The second study, conducted by Son et al, consisted of 15 participants with spastic diplegia CP, found that DNS intervention resulted in increased diaphragm excursion and improved abdominal muscle activity, enhancing motor control, balance, and gait ability in CP children using real-time ultrasound and EMG ($p = 0.004$).[21] Both studies support the effectiveness of DNS in improving the physical functions and quality of life of CP patients.[21]

Posterior cortical atrophy (PCA): In 2015, Francio et al conducted a case report using a chiropractic spinal manipulation with DNS and other adjunctive rehabilitation protocols on a 54-year-old male PCA patient.[22] Results showed a 60% improvement in the various outcome measures such as the health status questionnaire, back Bournemouth questionnaire, and pain and functional improvements.[22]

Outcome measures: Several outcome measures were administered in the included 10 articles. Real-time ultrasound, EMG, PBU, TIS, BBS, FES, SF-36, forced vital capacity, forced expiratory volume in 1 second, maximum inspiratory pressure, maximum expiratory pressure, Fatigue Severity Scale, Functional Independence Measure, modified Rankin scale, stroke-specific quality of life, 10-meter walk test, Activities-specific Balance Confidence, TUG test, Multiple Sclerosis Walking Scale-12, Modified Ashworth Scale, fall rate, postural stability, gait velocity, step length, step width, foot scan (center of force [COF] and ellipse area), Bruininks–Oseretsky test, and six-minute walk test.[3,11–15,18–21]

Discussion

This updated literature review aimed to evaluate the effectiveness of DNS exercises on various neurological conditions. The review included five studies on CVAs, one study on MS, one on Alzheimer's, one on Parkinson's, and two studies on CP. The findings support the findings of previous researches that DNS exercises improve the quality of life for neurological impaired patients. However, the review noted some limitations, such as few RCTs and the presentation of low-quality evidence. A previous systematic review was conducted and showed that DNS is an effective approach in improving musculoskeletal and neurological conditions, while another minireview was conducted to examine the effectiveness of DNS exercises on stroke patients and our results support the results of the previous literature.[8,23]

The included articles suggest that DNS exercises can significantly improve overall health outcomes. For stroke survivors, DNS exercises were found to enhance muscle activation, muscle thickness, respiratory functions, balance, and gait ability. Certain studies utilizing randomized controlled trials (RCTs) and semi-structured experimental designs on stroke survivors have demonstrated promosing results.[11–15]

In patients with MS, DNS exercises showed a positive effect on spasticity, trunk stability, balance, fall rate, walking, and activities of daily living. However, only one RCT was found for this condition.[18]

Similarly, in patients with AD and PD, DNS exercises were found to have positive effects on balance and walking functions. These findings were based on quasi-experimental design studies.[3,19]

In the case of CP patients, the DNS rehabilitation protocol led to significant improvement in muscle thickness and activation, balance, and walking abilities. The evidence included both a case study and experimental studies.[20,21]

Overall, the DNS rehabilitation protocol, based on ontogenic development patterns, principles of kinesiology, and reflex-mediated core stabilization concepts, has shown potential to improve the quality of life of neurologically impaired individuals. It may be a positive approach in rehabilitation protocols for treating such conditions.

Conclusion

The findings of this updated review indicate that the DNS rehabilitation protocol is an effective method for improving the quality of life of patients with neurological impairments. Further research in this area is needed to gain a better understanding of the results, with high-quality evidence and longer follow-up periods.

Authors' Contributions

Conceptualization and Methodology were conducted by H.K. and A.C. The original draft was written by H.K., A.C., and M.S., followed by review and editing from the same authors. Resources were provided by H.K., A.C., and M.S., while supervision was managed by H.K. and A.C.

Conflict of Interest

None declared.s

References

1 Mehndiratta MM, Aggarwal V. Neurological disorders in India: past, present, and next steps. Lancet Glob Health 2021;9(08): e1043–e1044

2 Moini J, LoGalbo A, Ahangari R. Foundations of the Mind, Brain, and Behavioral Relationships: Understanding Physiological Psychology. Elsevier London, UK 2023:241–267
3 Shah MF. Effectiveness of Dynamic Neuromuscular Stabilization Exercises on Balance and Gait Parameters in Patients With Alzheimer Disease. Paper presented at: International Conference on Educational Sciences, Psychology, Sport Sciences and Physical Education; 2022; Accessed September 24, 2024 at: https://sid.ir/paper/949685/en
4 Rush CA, MacLean HJ, Freedman MS. Aggressive multiple sclerosis: proposed definition and treatment algorithm. Nat Rev Neurol 2015;11(07):379–389
5 Cameron MH, Nilsagard Y. Balance, gait, and falls in multiple sclerosis. Handb Clin Neurol 2018;159:237–250
6 Rosenbaum P, Paneth N, Leviton A, et al. A report: the definition and classification of cerebral palsy April 2006. Dev Med Child Neurol Suppl 2007;109:8–14
7 Woollacott MH, Shumway-Cook A. Postural dysfunction during standing and walking in children with cerebral palsy: what are the underlying problems and what new therapies might improve balance? Neural Plast 2005;12(2-3):211–219, discussion 263–272
8 Raghumahanti R, Chitkara E, Agarwal PR. Effectiveness of dynamic neuromuscular stabilisation for improving trunk control in hemiplegic stroke: a scoping mini review. Neurosci Res Notes 2022;5(04):160
9 Gulrandhe P, Kovela RK. The effect of dynamic neuromuscular stabilisation on core strength: a literature review. J Clin Diagn Res 2023;17(07):1–5
10 Milić Z The effects of neuromuscular stabilization on increasing the functionality and mobility of the locomotor system. Sport Sci Health 2020;19(01):54–59
11 Lee NG, You JSH, Yi CH, et al. Best core stabilization for anticipatory postural adjustment and falls in hemiparetic stroke. Arch Phys Med Rehabil 2018;99(11):2168–2174
12 Yoon HS, You JSH. Reflex-mediated dynamic neuromuscular stabilization in stroke patients: EMG processing and ultrasound imaging. Technol Health Care 2017;25(S1):99–106
13 Benfiry N, Ganji Namin B, Beigi SS. The effect of 8 weeks of dynamic neuromuscular stability (DNS) exercises on the performance and quality of men and women's life with apoplexy (stroke). Egypt Acad J Biol Sci E Med Entomol Parasitol 2018;10(01):83–93
14 Yoon HS, Cha YJ, You JSH. Effects of dynamic core-postural chain stabilization on diaphragm movement, abdominal muscle thickness, and postural control in patients with subacute stroke: a randomized control trial. NeuroRehabilitation 2020;46(03): 381–389
15 Raghuveer R, Chitkara E, Raj Agrawal P. Effectiveness of diaphragm activation using reflex mediated dynamic neuromuscular stabilization on trunk function in hemiplegia. Med Sci 2021;25 (118):3132–3139
16 Oppelt M, Juehring D, Sorgenfrey G, Harvey PJ, Larkin-Thier SM. A case study utilizing spinal manipulation and dynamic neuromuscular stabilization care to enhance function of a post cerebrovascular accident patient. J Bodyw Mov Ther 2014;18(01):17–22
17 Abadi Marand L, Noorizadeh Dehkordi S, Roohi-Azizi M, Dadgoo M. Effect of dynamic neuromuscular stabilization on balance and trunk function in people with multiple sclerosis: protocol for a randomized control trial. Trials 2022;23(01):69
18 Abadi Marand L, Noorizadeh Dehkordi S, Roohi-Azizi M, Dadgoo M. Effect of dynamic neuromuscular stabilization on balance, trunk function, falling, and spasticity in people with multiple sclerosis: a randomized control trial. Arch Phys Med Rehabil 2023;104(01):90–101
19 Nosratikia R, Mahdavinejad R, Esmaeili H. Effect of 12 weeks dynamic neuromuscular stabilization training on balance in people with Parkinson's disease. Stud Sport Med 2023;14(34): 143–168
20 Kim DH, An DH, Yoo WG. Effects of 4 weeks of dynamic neuromuscular stabilization training on balance and gait performance in an adolescent with spastic hemiparetic cerebral palsy. J Phys Ther Sci 2017;29(10):1881–1882
21 Son MS, Jung DH, You JSH, Yi CH, Jeon HS, Cha YJ. Effects of dynamic neuromuscular stabilization on diaphragm movement, postural control, balance and gait performance in cerebral palsy. NeuroRehabilitation 2017;41(04):739–746
22 Francio VT, Boesch R, Tunning M. Treatment of a patient with posterior cortical atrophy (PCA) with chiropractic manipulation and dynamic neuromuscular stabilization (DNS): a case report. J Can Chiropr Assoc 2015;59(01):37–45
23 Sharma K, Chawla JK, Parasher RK. Role of dynamic neuromuscular stabilization exercises in physical rehabilitation: a systematic review. Crit Rev Phys Rehabil Med 2024;36(01):59–83

