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The effect of Dynamic Neuromuscular Stabilization Exercises on Quality of Life and Fall Risk in the Elderly: A Systematic Review

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ABSTRACT

Aims: This systematic review aimed to evaluate the effects of dynamic neuromuscular stabilization exercises on fall risk and quality of life in older adults.

Method and Materials: A systematic review was conducted under PRISMA guidelines, searching PubMed, Scopus, Web of Science, SID, Magiran, and Iran Medex databases for original and peer-reviewed articles using selected keywords from inception to June 2025. Google Scholar was also searched for additional records. The quality of the included studies was assessed using the Joanna Briggs Institute checklist.

Findings: Out of 147 records, seven quasi-experimental studies published between 2020 and 2024 met the inclusion criteria. Intervention durations ranged from six to eight weeks. DNS reduced fall risk, as evidenced by improvements in Timed Up and Go (TUG) test scores and Fall Efficacy Scale–International (FES-I) measures, and yielded improvements in quality of life across validated questionnaires.

Conclusion: This systematic review highlights that DNS exercises may play a crucial role in enhancing QOL and reducing fall risk in older adults. Future studies should prioritize well-designed, large-scale randomized controlled trials with standardized DNS protocols to strengthen the reliability and comparability of findings.

Keywords: Older adults, Fall, Dynamic Neuromuscular Stabilization

Introduction

Aging is a critical stage of human life, and addressing the issues and needs of this period is a social necessity [1]. By 2030, one in six people worldwide will be aged 60 years or older [2]. At this time, the share of the population aged 60 years and over is expected to increase from 1 billion in 2020 to 1.4 billion [3]. With the onset of aging, changes occur in the musculoskeletal, vestibular, and visual systems, key physiological systems involved in balance, which place older adults at a high risk of serious injuries resulting from imbalance and falls [4, 5]. Falls are among the leading causes of injury and mortality in older adults, as one in three individuals over the age of 65 experiences at least one fall each year [6]. According to previous studies, falls among older adults impose substantial costs, both medical and non-medical, on individuals and society [7, 8]. Fractures, functional limitations, traumatic brain injuries, disability, additional healthcare costs, and mortality are among the most significant consequences of falls [9]. Moreover, falls are often associated with an increased risk of recurrence, further compromising the Quality of Life (QOL) of older adults [10, 11]. These outcomes represent major health threats for older adults, leading to diminished QOL and increased care-related expenditures [12]. With the growing aging population, efforts to identify and prevent these problems, as well as to improve QOL, particularly by addressing fear of falling and balance impairments, have become increasingly important [13].

Compared to other therapeutic approaches, exercise is the key strategy for preventing falls [14]. Previous studies have also demonstrated that exercise can improve health-related QOL in older adults [15, 16]. Evidence indicates that, beyond the

muscular system, focusing on the nervous system plays a crucial role in movement control, gait patterns, and motor function, particularly in older adults with mobility limitations [17]. Neuromuscular training involves specific exercises designed to target both the neural and muscular components of movement [18].

This training program aims to enhance sensorimotor control and achieve functional joint stability by addressing movement quality across all three levels of motor function [19]. Dynamic Neuromuscular Stabilization (DNS) is a novel functional approach based on developmental kinesiology models [20], derived from the natural motor development patterns of early childhood [21], which regulate posture, maintain stability against gravity, and promote targeted muscle activation [22]. The goal of DNS is to optimize body function by aligning the head and spine [23], enhancing postural awareness, integrating proper breathing patterns, and improving motor control [24]. In the DNS approach, every developmental position is considered an exercise position [25]; however, every exercise must follow basic principles, namely the restoration of a correct respiratory pattern and intra-abdominal pressure, application of the correct support during dynamic extremity activities, and ensuring biomechanical alignment during movements [26, 27].

While DNS is grounded in developmental kinesiology and has shown promise in enhancing postural control, sensorimotor integration, and functional stability [28, 29], existing research is dispersed across small-scale clinical trials, varied outcome measures, and inconsistent reporting. Furthermore, most studies focus either on fall risk or QOL separately, without providing a comprehensive review of DNS effects on both outcomes simultaneously. To date, no systematic review has critically appraised the available evidence on DNS in older adults. This gap underscores the need for a rigorous systematic review to summarize current findings, identify limitations in existing research, and guide future clinical applications and high-quality trials. We applied the PICO framework (Population, Intervention, Comparison, and Outcomes) to filter, select, and review the literature [30].

Method and Materials

This systematic review was conducted according to the PRISMA guidelines [31]. The databases PubMed, Scopus, Web of Science, SID, Magiran, and Iran Medex were searched from the databases' inception until October 2025. Google Scholar was also searched for additional records. Keywords were selected according to Table 1 and searched using Boolean operators. The search was conducted in English-language databases using English terms, and their Persian equivalents were applied when searching Persian-language sources.

Inclusion criteria comprised studies involving elderly participants (≥60 years) that investigated the effects of DNS exercises on quality of life and/or fall risk. Eligible studies included clinical trials, quasi-experimental studies, and original research articles published in peer-reviewed journals in either English or Persian. Exclusion criteria were studies unrelated to DNS, conference abstracts, review articles, case reports, and studies lacking quantitative outcome data. After searching the databases, the results were transferred to EndNote 7X software. Then, the titles and abstracts of the articles were screened by two independent researchers (E.E, SA.N). Relevant articles were selected for full-text review. In case of disagreement, the consensus method was used by the supervisor (H.M.). After extracting eligible articles, general data, study characteristics, and results were extracted from the articles and summarized in Table 2. Data extraction was performed by two independent researchers (E.E., SA.N.). The quality of the studies was assessed with the JBI tools for quasi-experimental studies (Table 3)[32].

Table 1) Search strategy used for this study

Variable	Keywords
Dynamic Neuromuscular Stabilization	("dynamic neuromuscular stabilization" OR "dynamic neuromuscular stabilization" OR DNS)
Older Adults	AND (elder* OR "older adult*" OR "older people" OR "older person*" OR "older population*" OR "older individual*" OR geriatric* OR "aging population*" OR "ageing population*" OR "aged" OR "senior*" OR "senior citizen*" OR "retired" OR "retiree*" OR "later life" OR "later adulthood" OR "advanced age" OR "late adulthood" OR "60 years" OR "≥60" OR "60 years old" OR "60 and over" OR "over 60" OR "65 years" OR "≥65" OR "65 years old" OR "65 and over" OR "over 65")
Quality of Life/ Fall Risk	AND ("quality of life" OR "health-related quality of life" OR HRQoL OR HRQL OR QoL OR "life satisfaction" OR "subjective well-being" OR "wellbeing" OR "well-being" OR "perceived quality of life" OR "health status" OR "self-rated health" OR "self-perceived health" OR "health utility" OR "health utilities" OR "patient-reported outcome*" OR PRO OR PROM OR SF-36 OR "Short Form 36" OR "SF36" OR SF-12 OR "Short Form 12" OR "SF12" OR EQ-5D OR EQ5D OR WHOQOL OR "WHO Quality of Life" OR "World Health Organization Quality of Life" OR "quality adjusted life year*" OR QALY OR QOLI), AND (fall* OR "fall risk" OR "risk of falling" OR "fall prevention" OR "fall-related injury*" OR "accidental fall*" OR "recurrent fall*" OR "history of falls" OR "fall incident*" OR "fall event*" OR "faller*" OR "balance impairment" OR "balance disorder*" OR "balance problem*" OR "impaired balance" OR "postural stability" OR "postural control" OR "postural balance" OR "loss of balance" OR "gait disturbance*" OR "gait instability" OR "mobility impairment*" OR "instability" OR "equilibrium impairment")

Findings

Figure 1 illustrates the study selection process. Initially, 147 articles were identified. After removing duplicates, 120 abstracts were screened. Based on the abstract review, 89 studies were excluded, leaving 31 articles for full-text assessment. Following a thorough evaluation of the full texts, 24 articles were excluded, resulting in 7 studies included in the final analysis (Figure 1). Table 2 presents a summary of the findings from these articles.

All included studies were conducted between 2020 and 2024, using quasi-experimental designs. Sample sizes ranged from 24 to 60 elderly participants (mean age: 60–79 years). The intervention duration ranged from six to eight weeks. Outcome measures were categorized into two domains: (1) fall risk, primarily assessed by the Timed Up and Go (TUG) test [17, 33, 37] or the Fall Efficacy Scale–International (FES-I) [4]; and (2) quality of life (QOL), assessed using validated questionnaires such as SF-36 [17], LEIPAD [35], I-QOL [36], and SF-26 [34].

Based on qualitative data synthesis, four studies, involving a total of 135 elderly participants, assessed fall risk. DNS interventions led to improvements across the previous studies.) reported reductions in Timed Up and Go (TUG) test times, indicating an enhanced risk of falling [17, 33, 37]. Mohseni et al. (2023) demonstrated improvements in Fall Efficacy Scale–International (FES-I) scores, reflecting reduced risk of falling [4]. Overall, the evidence demonstrates a positive effect of DNS on reducing fall risk in older adults.

Table 2) The characteristics of the eligible studies

Study	Design	Sample size	Intervention	Outcome measures	Result
Keshtiaray et al. (2024) (33)	quasi-experimental	45 elderly participants aged 65 to 75 years	eight weeks of dynamic neuromuscular stabilization (DNS)	Fall risk using Timed Up and Go test	The results showed aa improvement in the risk of falling among older adults (P= 0.001).
Afsari et al. (2024) (34)	quasi-experimental	60 elderly participants aged 60 years	six weeks of dynamic neuromuscular stabilization (DNS)	Quality of life using short-form survey-26 questionnaire	The results showed an improvement in the QOL among older adults (P= 0.001).
Mohseni et al.	quasi-experimental	30 elderly people aged	eight weeks of dynamic	Risk of falling using Fall Efficiency Scale	The results showed aa improvement in

(2023) (4)		over 60 years	neuromuscular stabilization (DNS)	International (FES-I)	the risk of falling among older adults (P= 0.006).
Rashid et al. (2021) (35)	quasi-experimental	28 elderly people aged over 65 years	eight weeks of dynamic neuromuscular stabilization (DNS)	Quality of life using (LEIPAD questionnaire)	The results showed an improvement in the QOL among older adults (P= 0.000).
Farzin Far et al. (2021) (36)	quasi-experimental	24 elderly people aged 60 years and over	six weeks of dynamic neuromuscular stabilization (DNS)	Quality of life using Incontinence Quality of Life Questionnaire (I-QOL)	The results showed an improvement in the QOL among older adults (P <0.05).
Rahimi et al. (2020) (37)	quasi-experimental	30 elderly people aged 60-79 years	eight weeks of dynamic neuromuscular stabilization (DNS)	Fall risk using Timed Up and Go test	The results showed aa improvement in the risk of falling among older adults (P= 0.001).
Mansori et al. (2020) (17)	quasi-experimental	30 elderly participants aged 60-70	six weeks of dynamic neuromuscular stabilization (DNS)	Risk of falling and quality of life using Timed Up and Go test and SF-36 Questionnaire, respectively	The results showed an improvement in the QOL and fall risk among older adults (P <0.05).

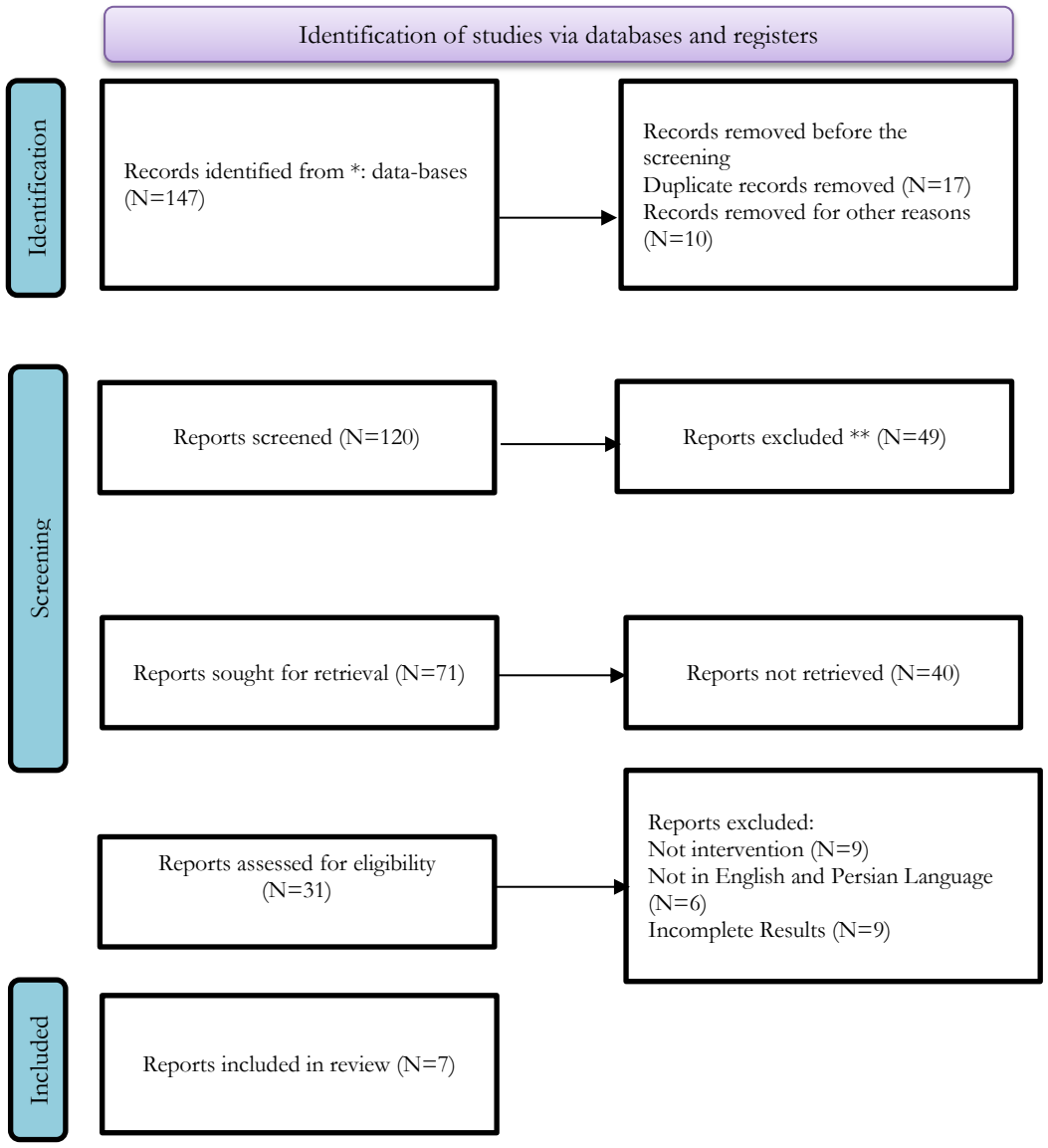

Figure 1) Flow diagram for eligible studies

Five studies, involving a total of 142 elderly participants, evaluated QOL outcomes. DNS training improved QOL scores. Afsari et al. (2024) reported improvements using the SF-26 questionnaire [34]. Rashid et al. (2021) and Farzin Far et al. (2021) demonstrated gains in LEIPAD and I-QOL domains [35, 36], respectively. Mansori et al. (2020) also showed notable improvements in multiple domains of the SF-36 [17]. In a nutshell, these findings suggest that DNS contributes to physical, psychological, and social aspects of QOL in older adults.

Regarding quality assessment, a methodological quality appraisal was conducted for all included studies using the JBI checklist. All seven studies demonstrated high methodological rigor, each achieving an overall score of 8 out of 9. The majority of studies fulfilled critical quality domains, including well-defined objectives, appropriate outcome measures, and robust data collection processes, reflecting a low risk of bias. However, a notable limitation was observed in criterion Q8 (Was follow-up complete, and if not, were differences between groups in terms of their follow-up adequately described and analyzed?), which was not satisfied by any of the studies. Despite this issue, the uniformity of high scores across studies highlights the overall strength and reliability of the included research.

Table 3) Critical appraisal results of eligible systematic reviews

	Study	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Overall Score
1	Keshtiaray et al. (2024)	Y	Y	Y	Y	Y	Y	Y	N	Y	8
2	Afsari et al. (2024)	Y	Y	Y	Y	Y	Y	Y	N	Y	8
3	Mohseni et al. (2023)	Y	Y	Y	Y	Y	Y	Y	N	Y	8
4	Rashid et al. (2021)	Y	Y	Y	Y	Y	Y	Y	N	Y	8
5	Farzin Far et al. (2021)	Y	Y	Y	Y	Y	Y	Y	N	Y	8
6	Rahimi et al. (2020)	Y	Y	Y	Y	Y	Y	Y	N	Y	8
7	Mansori et al. (2020)	Y	Y	Y	Y	Y	Y	Y	N	Y	8

Discussion

The present review aimed to investigate the effects of DNS exercises on QOL and fall risk in older adults. Findings indicate that such exercises may have a positive impact on improving QOL and reducing the risk of falls among older adults. In this regard, DNS can help reduce the risk of falls by improving postural control, balance, and movement coordination through activation of deep stabilizing muscles. Given the multi-segmental structure of the body, DNS exercises may enhance postural control and compensate for balance impairments by activating muscles responsible for postural alignment and voluntary movement coordination [38, 39]. Beyond strengthening the musculoskeletal system, DNS also engages the nervous system [27]. Utilizing developmental motor patterns enhances spinal stability and movement quality [40]. Moreover, DNS may induce neural adaptations, such as more efficient recruitment of motor units, somatosensory cortical reorganization, increased synaptic efficiency, reduced neural inhibition, and improved sensory input integration, all of which contribute to reduced fall risk [41]. With respect to the points discussed above, it has been reported that eight weeks of DNS exercises led to a meaningful lowering of the fear of falling in older adults [4, 33, 37]. Another key mechanism involves the activation of spinal stabilizers and improvement of intra-abdominal pressure, thereby enhancing core stability and trunk control [21]. From a developmental kinesiological perspective, DNS promotes postural stability by re-establishing optimal motor patterns from early growth stages and reinforcing core musculature. According to the motor systems theory, which views balance as an emergent property of multiple interacting neuromuscular systems [42], DNS optimizes this interplay. Likewise, from the neuroplasticity perspective, targeted training such as DNS may facilitate neural reorganization and improve sensorimotor processing [43].

Aging can adversely affect multiple physiological systems, leading to reduced organ efficiency, declines in both cognitive and motor performance, and ultimately a deterioration in quality of life among older adults [44]. It has been shown that DNS exercises enhance urinary control and reduce incontinence severity through activation of pelvic floor and abdominal muscles and improvement of core stability, thereby contributing to better QOL [36, 45, 46]. Furthermore, by strengthening coordination among respiratory, abdominal, and pelvic floor muscles, DNS can improve urogenital function, thereby alleviating incontinence symptoms, increasing self-confidence, and promoting social participation [24]. Beyond musculoskeletal benefits, DNS improves QOL by enhancing multisensory integration, postural control, and opportunities for social interaction [47, 48]. The psychological and social benefits of regular physical activity, such as increased vitality, improved mental health, and prevention of age-related disabilities, further contribute to QOL in older adults [49]. In relation to the aforementioned points, some studies have demonstrated that DNS may affect QOL in older adults [17, 34, 35]. The Neuro-Motor Adaptation Theory and the Motor Function and Quality of Life Enhancement Theory support these findings, suggesting that DNS facilitates improved neuromuscular coordination and motor function, thereby increasing independence and well-being [50, 51]. Consequently, DNS may boost confidence and social engagement, enhance psychological health, and serve as a safe and effective strategy within geriatric rehabilitation programs.

Caution is needed when interpreting the conclusions of the current study, considering its limitations. First, most of the included studies were conducted with single-sex groups, which limits the generalizability of the results to the broader older adult population. Second, there was considerable heterogeneity in intervention protocols, including differences in training duration, frequency, and intensity of DNS programs. Finally, there were no follow-up periods, and none of the studies assessed the long-term durability of DNS effects after cessation of the intervention.

Conclusion

This systematic review suggests that DNS exercises may play an important role in improving QOL and reducing the risk of falls among older adults. However, given the limited number of available studies, these findings should be interpreted with caution. Future research should focus on conducting well-designed, large-scale randomized controlled trials with standardized DNS protocols to enhance the reliability and comparability of results.

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Authors' Contribution

All authors contributed to the conceptualization, methodology, project administration, resources, and formal analysis. All authors helped in the investigation. All authors contributed to data curation. All authors approved the final version of the manuscript.

Conflicts of Interest

The authors have no conflicts of interest.

Ethical Permission

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