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Balance Training and Aerobic Exercise in Diabetic Peripheral Neuropathy: A Systematic Review

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Abstract

Background: Diabetic peripheral neuropathy (DPN) is a common complication of diabetes mellitus in older adults and is associated with impairments in balance, mobility, and functional capacity that negatively affect quality of life.

Objective: To evaluate the effectiveness of balance training and aerobic exercise on quality of life and related functional outcomes in older adults with diabetic peripheral neuropathy.

Methods: This systematic review followed the PRISMA 2020 guidelines. Literature searches were conducted in PubMed, Google Scholar, SAGE, and ScienceDirect for randomized controlled trials published between 2020 and 2025. Studies involving balance training and/or aerobic exercise in older adults or patients with DPN were included. Methodological quality was assessed using the PEDro scale. Due to heterogeneity across studies, a narrative synthesis was performed.

Results: Seven randomized controlled trials involving 382 participants were included from 993 identified records. Balance training consistently improved postural control, balance stability, and functional mobility, while aerobic exercise demonstrated beneficial effects on glycemic control, cardiovascular capacity, and walking performance. Multimodal interventions combining balance and aerobic exercise produced broader improvements in functional outcomes and quality-of-life domains than single interventions.

Conclusion: Balance training and aerobic exercise are effective in improving functional performance and quality of life in older adults with diabetic peripheral neuropathy and should be considered integral components of rehabilitation programs.

Keywords
Aerobic Exercise; Aged; Postural Balance; Diabetic Neuropathies; Quality of Life

Introduction

Diabetes mellitus is a chronic metabolic disorder with a rapidly increasing global prevalence, particularly among older adults. One of the most common and disabling long-term complications of diabetes is diabetic peripheral neuropathy (DPN), which affects up to 50% of individuals with longstanding disease.[1] DPN is characterized by progressive sensory, motor, and proprioceptive impairments, primarily involving the distal lower extremities, and is associated with pain, numbness, muscle weakness, and impaired neuromuscular control. These impairments substantially compromise balance, mobility, and functional independence, thereby exerting a profound negative impact on quality of life in older populations.[2]

In older adults, the functional consequences of DPN are compounded by age-related physiological changes, including sarcopenia, reduced postural reflexes, diminished joint proprioception, and slower neuromuscular responses.[3] As a result, older individuals with DPN exhibit greater balance instability, gait disturbances, and reduced walking speed compared with age-matched individuals without neuropathy.[4] These impairments contribute to an increased risk of falls, activity limitation, and loss of independence, which are critical determinants of health-related quality of life.[5,6]

Balance dysfunction represents a central clinical problem in DPN. Sensory loss in the plantar surface of the feet and impaired proprioceptive input disrupt postural control mechanisms, forcing greater reliance on visual and vestibular systems.[5,6] This sensory reweighting is often insufficient in older adults, leading to excessive postural sway and poor dynamic balance. Fear of falling is highly prevalent among older adults with DPN and has been shown to further restrict physical activity, social participation, and functional mobility.[2,7 8] The resulting cycle of inactivity and deconditioning accelerates functional decline and contributes to poorer quality-of-life outcomes.

Exercise therapy has been widely recommended as a non-pharmacological strategy to mitigate the functional and metabolic consequences of DPN. Aerobic exercise, in particular, has demonstrated consistent benefits in improving glycemic control, insulin sensitivity, lipid profiles, and cardiovascular fitness in individuals with type 2 diabetes.[9] Improved metabolic control is clinically relevant in DPN, as chronic hyperglycemia and insulin resistance are key contributors to nerve damage and neuropathic progression.[10] In addition to metabolic benefits, aerobic exercise has been associated with improvements in walking performance, lower-extremity strength, and selected domains of quality of life in patients with DPN.[11]

Balance training and sensorimotor exercises directly target neuromuscular coordination, postural stability, and proprioceptive integration, which are critical for fall prevention and functional mobility in older adults with neuropathic impairments. Systematic reviews have reported that balance-oriented exercise interventions can significantly improve static and dynamic balance, reduce postural sway, and enhance confidence in balance-related activities among individuals with DPN.[12,13] These improvements are clinically meaningful, as balance confidence and mobility are strongly associated with independence and perceived quality of life in older populations.

Emerging evidence suggests that multimodal exercise programs combining aerobic and balance training may provide synergistic effects by simultaneously addressing metabolic dysfunction, neuromuscular control, and functional performance. Such

integrated approaches have been reported to yield broader improvements in balance, mobility, pain, and functional capacity compared with single-modality interventions.[14,15] Furthermore, innovative delivery models such as telerehabilitation and mindfulness-based exercise programs have shown promise in enhancing accessibility, adherence, and patient-reported outcomes, including quality of life.[16]

Despite the growing body of evidence supporting exercise interventions in DPN, existing studies predominantly focus on isolated physical outcomes, such as balance performance, glycemic markers, or pain reduction. Fewer studies explicitly evaluate quality of life as a multidimensional outcome, particularly in older adults with DPN. Moreover, available evidence remains fragmented, with balance training and aerobic exercise often examined separately, limiting the ability to draw comprehensive conclusions regarding their combined effects on quality of life.

Therefore, a systematic synthesis of randomized controlled trials is needed to clarify the effectiveness of balance training and aerobic exercise on quality of life and related functional outcomes in older adults with diabetic peripheral neuropathy. This systematic review aims to evaluate current evidence regarding these interventions and to provide clinically relevant insights to inform rehabilitation strategies for this growing and vulnerable population.

Methods

Study Design

This study was conducted as a systematic review and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines. The review aimed to synthesize evidence from randomized controlled trials evaluating the effects of balance training and aerobic exercise on quality of life and related functional outcomes in older adults with diabetic peripheral neuropathy (DPN). The review protocol was not registered in the International Prospective Register of Systematic Reviews (PROSPERO).

Data Sources and Search Strategy

A comprehensive literature search was performed across four electronic databases: PubMed, Google Scholar, SAGE, and ScienceDirect. Searches were conducted between August and October 2025 to identify eligible studies published from January 2020 to October 2025. The search strategy combined Medical Subject Headings (MeSH) terms and free-text keywords related to balance training, aerobic exercise, quality of life, aging, and diabetic peripheral neuropathy.

The primary search strategy used in PubMed was as follows: (“Balance Training” OR “Postural Balance”) AND (“Aerobic Exercise”) AND (“Quality of Life”) AND (“Aged” OR “Older Adults”) AND (“Diabetic Peripheral Neuropathy” OR “Diabetic Neuropathy”). Equivalent search strings were adapted for each database to account for variations in indexing and search interfaces. Boolean operators (“AND,” “OR”) were applied to maximize search sensitivity. Reference lists of included articles were also manually screened to identify additional relevant studies.

Eligibility Criteria

Studies were eligible for inclusion if they employed a randomized controlled trial design and involved participants diagnosed with diabetic peripheral neuropathy or older adults with diabetes-related peripheral neuropathy. Included studies evaluated balance training and/or aerobic exercise interventions, either as single modalities or in combination, and reported outcomes related to quality of life, balance, mobility, functional performance, metabolic parameters, or neurological function. Only articles published in English, available as full-text with open access, and published between 2020 and 2025 were considered.

Studies were excluded if they used observational, cross-sectional, case-report, or review designs; involved participants without diabetic peripheral neuropathy; focused exclusively on pharmacological interventions; or were published in languages other than English or without full-text availability.

Study Selection Process

All identified records were imported into a reference management system, and duplicate articles were removed prior to screening. Two reviewers independently screened titles and abstracts to assess initial eligibility. Full-text articles were retrieved for studies that met the inclusion criteria or where eligibility was unclear. Disagreements between reviewers during the screening and selection process were resolved through discussion and consensus.

The study selection process followed the PRISMA flow diagram, documenting the number of records identified, screened, excluded, and included at each stage of the review process.

Data Extraction

Data were extracted independently by two reviewers using a standardized data extraction form to ensure consistency and methodological rigor. The extracted data included authorship and year of publication, study design and sample size, participant characteristics, and detailed descriptions of the interventions, including type, frequency, and duration. In addition, information regarding outcome measures and the main findings related to balance, functional performance, metabolic outcomes, neurological function, and quality of life was systematically collected. Any discrepancies identified during the data extraction process were resolved through discussion between the reviewers until consensus was achieved, thereby ensuring the accuracy and reliability of the extracted data.

Outcome Measures

Primary outcomes of interest included quality of life assessed using validated instruments, such as the Short Form-36 (SF-36) and the Diabetes Mellitus Quality of Life Scale (DMQLS). Secondary outcomes included balance performance, functional mobility, walking speed, pain, neurological function, and metabolic parameters.

Balance and mobility outcomes were commonly assessed using standardized and validated instruments, including the Berg Balance Scale, Timed Up and Go test, Functional Reach Test, Four Square Step Test, Performance-Oriented Mobility Assessment, and gait speed measures. Neurological outcomes were evaluated using nerve conduction velocity, sensory testing, and neuropathy severity scales, while metabolic outcomes included fasting blood glucose, glycated hemoglobin (HbA1c), insulin resistance indices, and lipid profiles.

Methodological Quality Assessment

The methodological quality of included randomized controlled trials was assessed using the Physiotherapy Evidence Database (PEDro) scale. The PEDro scale consists of 11 items evaluating eligibility criteria, random allocation, allocation concealment, baseline comparability, blinding of participants, therapists, and assessors, adequacy of follow-up, intention-to-treat analysis, between-group comparisons, and reporting of point estimates and variability.

Each study received a PEDro score ranging from 0 to 10, with higher scores indicating better methodological quality. Studies scoring 6 or higher were considered to have good methodological quality, scores of 4–5 indicated moderate quality, and scores below 4 indicated low quality. Methodological quality assessment was conducted independently by two reviewers, and disagreements were resolved by consensus.

Risk of Bias Considerations

Although only randomized controlled trials were included, potential sources of bias were considered in the interpretation of findings. Common methodological limitations identified included lack of allocation concealment, limited blinding of participants and therapists, and absence of intention-to-treat analysis. In addition, publication bias was considered, as studies reporting positive or significant results may be more likely to be published and indexed in major databases.

Data Synthesis

Due to substantial heterogeneity across studies in terms of intervention types, intensity, frequency, duration, participant characteristics, and outcome measures, quantitative meta-analysis was not conducted. Instead, a narrative synthesis approach was employed to summarize and compare study findings.

The narrative synthesis focused on identifying patterns and consistencies across studies regarding the effects of balance training, aerobic exercise, and multimodal interventions on balance, functional mobility, metabolic control, neurological function, and quality of life. Findings were interpreted in relation to methodological quality and clinical relevance to older adults with diabetic peripheral neuropathy.

Results

Study Selection

The study selection process followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines. A total of 993 records were identified through database searching, including PubMed (n = 429), Google Scholar (n = 539), SAGE (n = 14), and ScienceDirect (n = 11). After removing duplicate records (n = 173), 820 articles remained for title and abstract screening. During the screening stage, 440 records were excluded because they were not relevant to the study objectives. Full-text articles were retrieved for 25 potentially eligible studies. Of these, 18 articles were excluded due to lack of open access, use of non-randomized study designs, or focus on specific disease conditions unrelated to diabetic peripheral neuropathy.

Finally, seven randomized controlled trials met the inclusion criteria and were included in the qualitative synthesis.

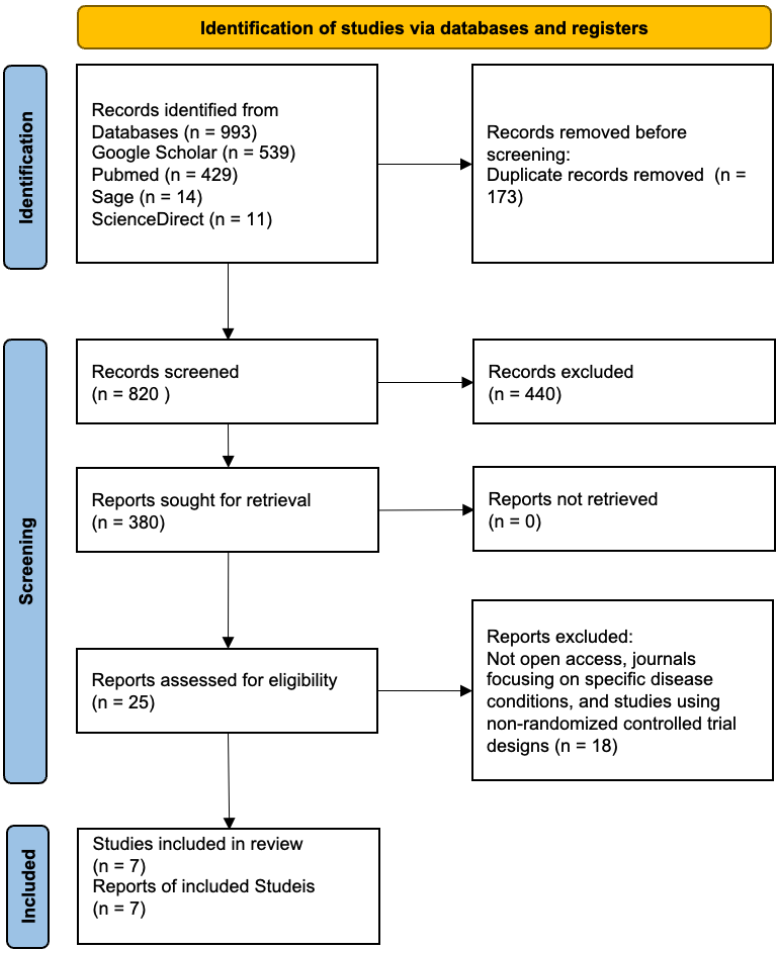

Figure 1. PRISMA flow diagram of study selection process.

Characteristics of Included Studies

The seven included studies comprised a total of 382 participants with diabetic peripheral neuropathy, predominantly older adults. Sample sizes ranged from 20 to 120 participants, with intervention durations varying between 4 and 12 weeks. Exercise frequency ranged from two to four sessions per week.

Interventions included balance training, aerobic exercise, aerobic-functional training, sensorimotor and multisystem exercise programs, integrated exercise approaches, mindfulness combined with aerobic exercise, and telerehabilitation-based exercise programs. Outcome measures varied across studies but primarily assessed balance performance, functional mobility, walking speed, metabolic parameters, neurological function, and quality of life.

Table 1. Summary of Included Randomized Controlled Trials

No	Study	Design and Sample	Intervention	Outcome Measures	Main Results (Mean ± SD / Median [IQR])
1	Irshad et al. [14]	RCT; n = 60; 3×/week	Aerobic exercise training and balance training	Berg Balance Scale (BBS)	AE: 52.65 ± 3.34; BT: 48.25 ± 6.23
2	Chaiwan et al. [15]	RCT; n = 39; 2×/week	Exercise via telerehabilitation	BBS; 10-Meter Walk Test (10MWT)	BBS Intervention: 55 [51.8–56]; Control: 46 [45–48]; 10MWT: 9.9 ± 3.3 vs 12.8 ± 3.5
3	Khurshid et al. [16]	RCT; n = 42; 3×/week	Multisystem exercise (sensorimotor–balance)	BBS, FRT, TUG, 10MWT, NPRS	BBS: 51.04 ± 1.59 vs 47.09 ± 1.99; FRT: 13.18 ± 0.76 vs 10.78 ± 0.77
4	Beigi et al. [17]	RCT; n = 20; 4×/week	Aerobic-functional training	BMI, FBS, HOMA-IR, TG, HDL, LDL	FBS: 145.9 ± 19.04 vs 174 ± 39.87; HOMA-IR: 2.09 ± 0.87 vs 3.87 ± 1.37
5	Heidari et al. [18]	RCT; n = 40; 3×/week	Integrated exercise	FBS, 2-h PP glucose, HbA1c; sensory tests	FBS: 140 ± 39 vs 187 ± 60; sensory improvements reported
6	Weng et al. [19]	RCT; n = 120; 3×/week	Mindfulness, aerobic exercise, combined	SNCV, MNCV, TCSS, MAAS, DMQLS	SNCV: 39.52 ± 2.82; MAAS: 70.63 ± 6.89
7	Jimenez-Mazuelas et al. [20]	RCT; n = 41; 2–3×/week	Sensorimotor exercise	FSST, TUG, POMA, SF-36, FES	QoL median change: 1.99 [–6.34 to 16.47]

Abbreviations: AE, aerobic exercise; BT, balance training; BBS, Berg Balance Scale; FRT, Functional Reach Test; TUG, Timed Up and Go; FBS, fasting blood sugar; SNCV, sensory nerve conduction velocity; DMQLS, Diabetes Mellitus Quality of Life Scale.

Methodological Quality Assessment (PEDro Scale)

The methodological quality of the included randomized controlled trials was assessed using the Physiotherapy Evidence Database (PEDro) scale. PEDro scores across the seven studies ranged from 4 to 7 out of a maximum score of 10, indicating overall moderate to good methodological quality. Most studies demonstrated adequate random allocation, baseline comparability between groups, and appropriate reporting of between-group comparisons and outcome variability. However, allocation concealment, blinding of participants and therapists, and intention-to-treat analysis were inconsistently reported across studies. Despite these limitations, the majority of included trials met key methodological criteria required for randomized controlled trials in rehabilitation research.

Table 2. PEDro Scale Assessment of Included Studies

PEDro Criteria	(14)	(15)	(16)	(17)	(18)	(19)	(20)
Eligibility criteria	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Random allocation	1	1	1	1	1	1	1
Concealed allocation	0	1	0	0	0	0	0
Baseline comparability	0	1	1	1	1	1	1
Blinding of participants	0	0	1	0	0	0	0
Blinding of therapists	0	0	0	0	0	0	0
Blinding of assessors	0	1	1	0	1	0	1
Adequate follow-up	1	1	0	1	1	1	1
Intention-to-treat analysis	0	0	0	0	0	0	0
Between-group comparisons	1	1	1	1	1	1	1
Point estimates and variability	1	1	1	1	1	1	1
Total PEDro score (/10)	4	7	6	5	6	5	6
Quality level	Moderate	Good	Good	Moderate	Good	Moderate	Good

Note: Item 1 (eligibility criteria) is not included in the total PEDro score.

Effects on Balance and Functional Mobility

All studies evaluating balance outcomes reported significant improvements following exercise interventions. Balance training, sensorimotor exercise, and multisystem programs consistently increased Berg Balance Scale scores and improved performance on functional mobility tests, including the Timed Up and Go and Functional Reach Test. Improvements in walking speed, as measured by the 10-Meter Walk Test, were also observed in studies incorporating functional and telerehabilitation-based exercise programs.

Effects on Metabolic and Neurological Outcomes

Aerobic and aerobic-functional exercise interventions demonstrated favorable effects on metabolic parameters, including reductions in fasting blood glucose, insulin resistance, and lipid profiles. Neurological outcomes, such as sensory nerve conduction velocity and peripheral sensation, showed measurable improvements in studies employing integrated and multimodal exercise approaches. These findings indicate enhanced neuromuscular and metabolic function following structured exercise programs.

Effects on Quality of Life

Two studies directly assessed quality of life using validated instruments. One study reported significant improvements across multiple quality-of-life domains following a combined mindfulness and aerobic exercise intervention, as measured by the Diabetes Mellitus Quality of Life Scale. Another study reported significant short- and medium-term improvements in quality of life assessed using the SF-36, although results were presented in median values rather than mean scores. The remaining studies did not explicitly

assess quality of life but reported clinically relevant improvements in balance, mobility, pain, and metabolic control, which are closely associated with health-related quality of life.

Narrative Synthesis

Due to heterogeneity in intervention modalities, outcome measures, and reporting formats, quantitative meta-analysis was not performed. Instead, a narrative synthesis was conducted, integrating findings across studies while preserving their methodological and clinical characteristics.

Discussion

This systematic review synthesized evidence from randomized controlled trials evaluating the effects of balance training and aerobic exercise on quality of life and related functional outcomes in older adults with diabetic peripheral neuropathy (DPN). The findings indicate that structured exercise interventions consistently improve balance performance, functional mobility, metabolic control, and selected neurological outcomes, which collectively contribute to enhanced health-related quality of life in this population.

Balance Training and Functional Outcomes

Balance impairment is a hallmark of DPN and a major contributor to falls, mobility limitations, and loss of independence among older adults.[1-3] The present review demonstrates that balance-oriented interventions, including sensorimotor and multisystem exercises, consistently improved static and dynamic balance, postural stability, and functional mobility. These findings align with previous systematic and umbrella reviews reporting that balance training effectively enhances postural control and reduces fall risk in individuals with DPN. [12]

The observed improvements in balance outcomes may be explained by enhanced sensory integration and neuromuscular coordination. DPN disrupts afferent input from plantar mechanoreceptors and joint proprioceptors, leading to impaired postural responses.[5,6] Balance training likely promotes compensatory mechanisms by improving central sensory reweighting and motor planning, thereby improving stability during both static and dynamic tasks. These adaptations are particularly relevant in older adults, in whom age-related declines in postural reflexes further compromise balance control.[2]

Aerobic Exercise and Metabolic Regulation

Aerobic exercise interventions included in this review demonstrated consistent benefits in glycemic control, insulin resistance, and lipid profiles. These findings are in accordance with established evidence indicating that aerobic exercise improves metabolic regulation in individuals with type 2 diabetes.[9,10] Improved metabolic control is clinically meaningful in DPN, as chronic hyperglycemia and insulin resistance are strongly associated with nerve damage, impaired nerve conduction, and progression of neuropathic symptoms.[11,21]

Beyond metabolic effects, aerobic exercise was also associated with improvements in walking performance and functional capacity. Enhanced cardiovascular fitness and muscle endurance may improve tolerance for daily activities, thereby supporting functional independence. These functional gains are closely linked to physical domains of quality of life, particularly in older adults with chronic disease.[11,22,23]

Multimodal Exercise Approaches

An important finding of this review is that multimodal exercise programs combining balance and aerobic components produced broader and more comprehensive benefits than single-modality interventions. Integrated approaches were associated with concurrent improvements in balance, mobility, metabolic outcomes, and neurological function. These findings are consistent with previous reviews suggesting that combined exercise modalities address multiple pathophysiological mechanisms underlying DPN more effectively than isolated interventions.[12,14]

In addition, innovative delivery methods such as telerehabilitation and mindfulness-based exercise demonstrated promising results. Telerehabilitation may improve accessibility and adherence to exercise programs, particularly for older adults with mobility limitations or geographic barriers. Meanwhile, mindfulness combined with aerobic exercise may provide additional benefits by addressing psychological factors such as stress, pain perception, and self-efficacy, which are increasingly recognized as important contributors to quality of life in chronic disease.[19, 24]

Quality of Life Considerations

Only a limited number of studies included in this review directly assessed quality of life using validated instruments. However, improvements in balance, mobility, pain, and metabolic control observed across studies are well-established determinants of health-related quality of life in older adults with DPN.[4,5,6] Studies that directly measured quality of life reported improvements predominantly in physical and daily activity domains, supporting the clinical relevance of exercise-based interventions.[19,20]

The indirect effects of exercise on quality of life should not be underestimated. Enhanced balance confidence, reduced fear of falling, and improved functional independence may facilitate greater participation in social and recreational activities, thereby positively influencing psychosocial well-being.[7,8]

Methodological Considerations and Limitations

The methodological quality of included studies ranged from moderate to good based on PEDro scores. While most trials demonstrated appropriate randomization and outcome reporting, limitations were noted in allocation concealment, blinding procedures, and intention-to-treat analyses. These methodological constraints may introduce bias and should be considered when interpreting the findings.

Additionally, substantial heterogeneity in intervention protocols, duration, outcome measures, and reporting formats precluded quantitative meta-analysis. Not all studies directly measured quality of life, limiting the ability to draw definitive conclusions regarding this outcome. The literature search was also restricted to selected databases and English-language publications, raising the possibility that relevant studies were not identified.

Clinical Implications and Future Research

Despite these limitations, the findings of this review have important clinical implications. Balance training and aerobic exercise should be considered essential components of physiotherapy and rehabilitation programs for older adults with DPN. Clinicians are encouraged to adopt multimodal exercise approaches tailored to individual functional capacity and comorbidities.
Future research should prioritize high-quality randomized controlled trials with standardized exercise protocols and consistent measurement of quality of life as a primary outcome. Long-term follow-up studies are also needed to determine the sustainability of exercise-induced benefits and their impact on fall incidence, disability progression, and healthcare utilization in this growing population.

Conclusion

Balance training and aerobic exercise are effective interventions for improving functional performance and quality of life in older adults with diabetic peripheral neuropathy. Balance-focused exercise programs enhance postural stability, dynamic balance, and functional mobility, thereby reducing fall risk and supporting greater independence in daily activities. Aerobic exercise contributes to improved glycemic control, cardiovascular capacity, and walking performance, which are closely associated with physical domains of quality of life.

Multimodal exercise interventions that integrate balance and aerobic components provide more comprehensive benefits than single-modality programs, addressing both neuromuscular and metabolic impairments underlying diabetic peripheral neuropathy. Although only a limited number of studies directly assessed quality of life, consistent improvements in balance, mobility, pain, and metabolic outcomes across trials indicate meaningful indirect benefits for health-related quality of life in this population.

These findings support the incorporation of structured balance training and aerobic exercise as essential components of physiotherapy and rehabilitation programs for older adults with diabetic peripheral neuropathy. Future research should focus on high-quality randomized controlled trials with standardized intervention protocols and quality of life as a primary outcome, as well as long-term follow-up to evaluate the sustainability of exercise-related benefits.

Author Contribution

Farita Adhynda Amithya: Conceptualization, Methodology, Data curation, Formal analysis, Writing—original draft.
Dwi Rosella Komalasari: Conceptualization, Formal analysis, Writing—review & editing, Supervision.
Safari Wahyu Jatmiko: Methodology, Writing—review & editing.

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Conflict of Interest Statement

The authors declare no conflict of interest.

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Ethics Statement

Ethical approval was not required for this study as it was a systematic review of previously published studies.

References

1. Timar B, Simu M, Velea I. Age as an independent factor for the development of neuropathy in diabetic patients. Clin Interv Aging. 2016;11:313–318.
2. Khan KS. The impact of diabetic neuropathy on activities of daily living, postural balance and risk of falls: a systematic review. J Diabetes Sci Technol. 2022;16(2):289–294.
3. Hicks CW, Selvin E. Epidemiology of peripheral neuropathy and lower extremity disease in diabetes. Curr Diab Rep. 2024;19(10):[pages not available].
4. Tavares NMB, Silva JM, Silva MDM, Silva LDT, Souza JN, Ithamar L, et al. Balance, gait, functionality and fall occurrence in adults and older adults with type 2 diabetes mellitus and associated peripheral neuropathy. Clin Pract. 2024;14(5):2044–2055.
5. Riandini T, Khoo EYH, Tai BC, Tavintharan S, Phua MSLA, Chandran K, et al. Fall risk and balance confidence in patients with diabetic peripheral neuropathy: an observational study. Front Endocrinol (Lausanne). 2020;11:573804.
6. Gupta G, Maiya GA, Bhat SN, Hande MH, Dillon L, Keay L. Fear of falling and functional mobility in elders with diabetic peripheral neuropathy in coastal Karnataka, India: a hospital-based study. Curr Aging Sci. 2022;15(3):252–258.
7. Gracia-Sanchez A, Lopez-Pineda A, Nouni-Garcia R, Zunica-Garcia S, Chicharro-Luna E, Gil-Guillen VF. Impact of exercise training in patients with diabetic peripheral neuropathy: an umbrella review. Sports Med Open. 2025;11(1):[article number].
8. Kanaley JA, Colberg SR, Corcoran MH, Malin SK, Rodriguez NR, Crespo CJ, et al. Exercise and physical activity in individuals with type 2 diabetes: a consensus statement from the American College of Sports Medicine. Med Sci Sports Exerc. 2023;54(2):353–368.
9. Fitriyah O. Effect of aerobic exercise on lower extremity function in diabetic peripheral neuropathy. Pros Semin Nas Kesehat. 2024;[volume not available]:101–[pages not available].
10. Hernando-Garijo I, Medrano-de-la-Fuente R, Mingo-Gomez MT, Martin SL, Ceballos-Laita L, Jimenez-Del-Barrio S. Effects of exercise therapy on diabetic neuropathy: a systematic review and meta-analysis. Physiother Theory Pract. 2024;40(9):2116–2129.
11. Gholami F, Naderi A, Saeidpour A, Lefaucheur JP. Effect of exercise training on glycemic control in diabetic peripheral neuropathy: a GRADE assessed systematic review and meta-analysis of randomized controlled trials. Prim Care Diabetes. 2024;18(2):109–118.

12. Akbari NJ, Naimi SS. The effect of exercise therapy on balance in patients with diabetic peripheral neuropathy: a systematic review. J Diabetes Metab Disord. 2022;21(2):1861–1871.
13. Dhouibi J, Migaou H, Chaabeni A, Kalai A, Salah S, Boudokhane S. Physical activity in the management of diabetic neuropathic pain: mechanisms, evidence, and clinical perspectives. Cureus. 2025;17(10):e94960.
14. Irshad M, Mehr UN, Rashida M, Muhammad F, Muazzem N, Muhammad A, et al. Effectiveness of aerobic exercise training and balance training on balance in patients with diabetic peripheral neuropathy: a randomized controlled study. J Health Rehabil Res. 2024;4(3):1–7.
15. Chaiwan P, Srisawasdi G, Prachgosin P, Aekwattanaphol P, Jirapongthai N. Effects of exercise through telerehabilitation on balance and walking speed in older adults with diabetic peripheral neuropathy: a randomized controlled trial. Siriraj Med J. 2025;77(6):403–410.
16. Khurshid S, Saeed A, Kashif M, Nasreen A, Riaz H. Effects of multisystem exercises on balance, postural stability, mobility, walking speed, and pain in patients with diabetic peripheral neuropathy: a randomized controlled trial. BMC Neurosci. 2025;26(1):[article number].
17. Beigi S, Shabkhiz F, Kordi M, Haghi-Ashtiani B. Aerobic-functional training improves fasting blood sugar, insulin resistance, and lipid profile in patients with diabetic peripheral neuropathy: a randomized controlled trial. Biomed Hum Kinet. 2022;14:177–182.
18. Heidari M, Zolaktaf V, Ghasemi G, Nejadian SL. Integrated exercise and glycemic and peripheral sensation control in diabetic neuropathy: a single-blind randomized controlled trial. Int J Prev Med. 2021;12:169.
19. Weng X, Liao S, Wang F, Wang H, Yang L. Mindfulness training combined with aerobic exercise on neurological function and quality of life in patients with type 2 diabetic peripheral neuropathy. Contrast Media Mol Imaging. 2022;2022:7665483.
20. Jimenez-Mazuelas MJ, Gonzalez-Perez de Villar N, Casas-Albendea S, Martinez-Gimeno L, Jimenez-Gonzalez S, Angulo-Carrere MT. Somatosensory and dynamic balance improvement in older adults with diabetic peripheral neuropathy through sensorimotor exercise: a multisite randomized controlled trial. J Bodyw Mov Ther. 2024;40:2062–2073.
21. Mulya FN, Trisnawati N. Buerger Allen exercise and ankle brachial index improvement in patients with type 2 diabetes mellitus. J Keperawatan Muhammadiyah. 2025;10(2):148–153.
22. Hewston P, Deshpande N. Falls and balance impairments in older adults with type 2 diabetes: thinking beyond diabetic peripheral neuropathy. Can J Diabetes. 2016;40(1):6–9.
23. Tavares NMB, Silva JM, Silva MDM, Silva LDT, Souza JN, Ithamar L, et al. Balance, gait, functionality and fall occurrence in adults and older adults with type 2 diabetes mellitus and associated peripheral neuropathy. Clin Pract. 2024;14(5):2044–2055.
24. Ernandes RD, Brech GC, Luna NMS, Bega A, Guimaraes DS, Bocalini DS, et al. Impact of diabetic neuropathy on quality of life and postural balance in Brazilian older adults. Acta Ortop Bras. 2020;28(6):275–279.