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Review Article

The efficacy of task-oriented training in patients with diabetic peripheral neuropathy: a narrative review

Simranjeet Kaur, Pankajpreet Singh, Supreet Bindra, Shavez Mansoori*

Department of Physiotherapy, Sri Guru Granth Sahib World University, Fatehgarh Sahib, Punjab, India

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***Correspondence:**
Dr. Shavez Mansoori,
E-mail: dr.shavez99@gmail.com

ABSTRACT

Diabetic peripheral neuropathy is one of the most common complications of diabetes mellitus and is frequently associated with impaired balance, reduced proprioception, gait abnormalities, and an increased risk of falls. Various rehabilitation interventions have been developed to address these deficits and improve functional performance in affected individuals. The aim of this review is to determine the effectiveness of task oriented training in patients with Diabetic Peripheral Neuropathy. A review of literature was conducted using 11 studies published between 2011 and 2025. The selected studies investigated different rehabilitation approaches, including task-oriented training, balance and stability training, Biodex Balance System training, biofeedback-based interventions, multisensory training, augmented feedback training, and sensorimotor gait training. Information related to study objectives, methodology, interventions, outcomes, and conclusions was extracted and analyzed. A total 11 studies reviewed, 10 reported significant improvements in balance and postural stability, 3 demonstrated improvements in coordination, 3 reported enhanced gait performance and functional mobility, 3 evaluated task-oriented training, and 1 investigated sensorimotor training. Technology-assisted interventions such as Biodex Balance System and Stability Trainer exercises showed superior outcomes compared to conventional physiotherapy in several studies. Improvements were also observed in proprioception, muscle activation, balance confidence, and fall-risk reduction. The findings of this review indicate that rehabilitation interventions are effective in improving balance, coordination, gait performance, proprioception, and functional mobility among individuals with diabetic peripheral neuropathy. Interventions incorporating task-oriented activities, sensory feedback, biofeedback technology, and progressive balance challenges appear to provide the greatest benefits.

Keywords: Diabetic peripheral neuropathy, Balance training, Task-oriented training, Sensorimotor training, Gait rehabilitation, Biodex balance system, Proprioception, Fall risk, Rehabilitation.

INTRODUCTION

Diabetic peripheral neuropathy (DPN) refers to symmetrical, length-dependent sensorimotor polyneuropathy which is attributed to metabolic and micro vessel alterations due to hyperglycaemia and cardiovascular risk.[1] Peripheral Neuropathy is associated with increased pain, Morbidity and mortality. Diabetes decreased functioning lower extremity. Many factors may contribute to decreased lower extremity function in diabetes, including nerve function.[2] Diabetic distal symmetric polyneuropathy (DSPN) is the most representative form of DPN. As one of the most common complications of diabetes, its prevalence increases with the duration of diabetes. 10-15% of newly diagnosed T2DM patients have DSPN, and the prevalence can exceed 50% in patients with diabetes for more than 10 years.[3] As estimated 15% of patient develop foot ulcers.[4] Bilateral limb pain, numbness, and paraesthesia are the most common clinical manifestations in patients with DPN, and in severe cases, foot ulcers can occur, even leading to amputation. The

aetiology and pathogenesis of diabetic neuropathy are not yet completely clarified, but hyperglycaemia, disorders of lipid metabolism, and abnormalities in insulin signalling pathways are currently considered to be the initiating factors for a range of pathophysiological changes in DPN. In the presence of abnormal metabolic factors, the normal structure and function of the entire peripheral nervous system are disrupted, including myelinated and unmyelinated nerve axons, perikaryon, neurovascular, and glial cells. In addition, abnormalities in the insulin signalling pathway will inhibit neural axon repair and promote apoptosis of damaged cells.[3] The painful symptoms are burns ('pins and needles'or paraesthesia), shooting (like electric shock) or lancing (stab-bing) are present in around one third of patients with Diabetic Peripheral Neuropathy and around 20% of all diabetic patients. Diabetic Peripheral Neuropathy starts in the toes and gradually moves proximally. Once it is well established in the lower limbs, it affects the upper limbs, with sensory loss following the typical 'glove and stocking' pattern of distribution. Significant motor deficits are not common in the early stages of Diabetic Peripheral Neuropathy. These symptoms are generally worse at night and disturbs sleep.[5]

Rehabilitation plays a vital role in managing diabetic peripheral neuropathy related impairments. Task related training is a rehabilitation strategy that involve the practice of goal directed functional movement in ethical environment to help patient derive optimal control strategy for elevating movement disorders in a Task Oriented training program the patient is required in task specific or self-driven or gold-driven activity. Task oriented training includes a wide range of interventions such as sit to stand exercises, reaching a task for improving balance, endurance training, walking training, treadmill training.[6]

PATHOPHYSIOLOGY

The hyperglycaemia is thought to be involved in peripheral nerve damage while oxidative stress caused by AGE creates microscopic vascular damages, hindering blood supply to the peripheral nerves. Certain proinflammatory cytokines including IL-6 and TNF-α, are also elevated during hyperglycaemia and are thought to contribute to nerve cell damage. A cascade of events following the nerve damage leads to abnormal expression of sodium channels along the axon at the site of peripheral nerve damage, leading to ectopic neural discharge. There is an altered expression of Na+, K+, and Ca2+ channels in the nociceptive neurons of the dorsal root ganglion, as well as abnormal proliferation and sprouting of sympathetic neurons. The result of these events is exaggerated or spontaneous pain sensation. DPN is significantly more common in type 2 than in type 1 diabetes. Pain tends to be bilateral and although it predominantly involves lower limbs, specifically the foot, in some cases, upper extremities may be involved, including fingertips and palms. This distribution pattern occurs because the longest sensory axons are usually the first to be affected by diabetes. Patients typically describe their neuropathic pain by using words such as "hot", "burning", "electric", "jolts", "sharp", "tingling", and "pins and needles". It may also be accompanied by allodynia (painful response to normally non-painful stimuli) and hyper algesia (exaggerated response to mild pain stimuli). Pain is often worse during the night, as well as under stress and fatigue.[7]

METHODS

A literature search was performed using electronic databases including PubMed, Google Scholar, and Cochrane Library. The search included articles published between 2010 and 2025. Keywords used during the search were: Diabetic Peripheral Neuropathy, Task-Oriented Training, Functional Training, Balance Training, Gait Training, Functional Mobility and Quality of Life. Studies involving patients diagnosed with diabetic peripheral neuropathy. Randomized controlled trials, clinical trials, case series, and case reports. Studies investigating task-oriented training interventions. Studies assessing balance, gait, functional mobility, or quality of life outcomes. Full-text articles published in English. The Review articles and meta-analyses and the studies involving severe musculoskeletal or neurological disorders unrelated to Diabetic peripheral neuropathy are excluded. Total 7 studies were selected to balance; gait and coordination exercises and 3 studies were selected to demonstrate the effect of task-oriented training in patient with diabetic peripheral neuropathy and 1 study reported the effect of sensorimotor training for diabetic peripheral neuropathy.

Table 1: Criteria for including studies.

Criteria	Inclusion criteria
Design	Randomized controlled trial, Quasi experimental studies, case reports, case studies.
Participants	Male and female with peripheral neuropathy
Intervention	Task oriented training
Comparisons	Comparison for any other conventional therapy
Outcome measures	Berg balance scale, timed up and go test, functional reach test, single leg stance test, 10m walk test, stride length and step width.

Articles were not to be considered for reviews if the studies featuring on Articles featuring on other than condition of the diabetic peripheral Neuropathy, Unpublished articles and only abstracts, Articles published in other than English language, Studies done before 2010, Articles involving pharmacological interventions without physiotherapy component.

Table 2: A summary of the main characteristics of each study.

S. no	Author/ year	Study design	Age group (years)	Outcome measures	Intervention	Result
1	Ajimsh et al[7]	Randomized control trial	33 patients in two groups	Berg balance scale, Michigan Neuropathy disability symptoms scale, Fear of Falling Avoidance Behaviour Questionarrie.	The Control Group received conventional physiotherapy including relaxation exercises, ankle ROM exercises, functional balance training, wobble board training, and gait training. The Experimental Group received the same conventional physiotherapy plus 15 minutes of Stability Trainer balance training using progressively unstable foam pads (green, blue, and black levels). Exercises included bipedal heel raises, one-leg standing, hip flexion, hip extension, and knee bending tasks with progressive sensory challenges and altered visual input.	Balance training using a Stability Trainer in addition to conventional physiotherapy is more effective than conventional physiotherapy alone for improving functional balance in Type II diabetic patients with distal sensory neuropathy. It may help reduce fall risk and improve quality of life.
2	Salsabili et al[8]	Time series study	14 patients	14 patients with diabetic neuropathy. Assessments were conducted at initial, pre-training, post-training, and follow-up sessions. Outcome measures included Ground Reaction Forces (GRF), Timed Get Up and Go (TGUG), and Fall Efficacy Scale-International (FES-I).	Participants underwent 45-minute Task-Oriented gait training sessions twice weekly for 12 weeks. Training included stepping patterns, progressively challenging walking tasks, combined upper- and lower-limb activities, balance tasks, and treadmill-paced gait training based on motor-learning principles.	Significant improvements were observed in vertical and horizontal ground reaction forces, gait biomechanics, TGUG performance, and FES-I scores. Participants demonstrated improved walking performance, balance confidence, muscle timing, coordination, and reduced fall risk.
3	Ghazal et al[9]	Randomized controlled trail	40-75 years participants	Berg Balance Scale, Functional Reach Test, Fall Risk Assessment.	Task- oriented balance training involving tandem gait, obstacle avoidance, multidirectional stepping, walking while carrying objects, dynamic reaching exercises.	Task-oriented training was superior to traditional balance exercises in improving balance and reducing fall risk.
4	Whaval et al[10]	Randomized control trail	40-70 years 30 patients,	Activity specific balance confidence (ABC) scale, distal proprioceptive test, and lower limb functional scale (LLFS)	Task-specific balance and mobility program involving perturbation training, obstacle crossing, tandem walking, reaching activities, and functional gait exercises performed for 8 weeks.	There was a significant difference in the dynamic balance between the SMST and control groups (=28(t 2η 0.000, =P -6.74,) = (groups program SMST the that showed variance of analysis of results The.)0.61= 2η 0.001, =P 14.16,) =1,28(F (direction X the in-balance static the improved direction Y the in and) 0.33=2η 0.028, =P 5.38,) =1,28(F (. DPN with women older in) 0.16= Older women with Diabetic Peripheral Neuropathy.
5	Stolarczyk et al[11]	Experimental study	45-50 years 77 participants.	Functional Reach Test, Dynamic Gait Index.	Task- Oriented mobility involving sit – to stand transitions, Stair Climbing, object carrying while walking, obstacle crossing, directional waling and community ambulation activities for 10 weeks.	There were statistically significant differences between patients with diabetes compared to healthy subjects in GSI (2.79 vs 1.1), FPI (1.66 vs 0.7), MLI (0.88 vs 0.52) and risk of falling (5.18 vs 2.72) $p < 0.05$. There were also statistically significant changes before and after training in all stability indices (GSI: 2.79 vs 1.26,

Continued.

S. no	Author/ year	Study design	Age group (years)	Outcome measures	Intervention	Result
						FPI: 1.66 vs 0.77, MLI: 0.88 vs 0.54 accordingly) p<0.05 and risk of falling (5.18 vs 3.87) p<0.05 in the study group who had undergone training with biofeedback.
6	Venkataraman et al[12]	Randomized controlled trail	143 participants	Outcome measures were used: SF-36 PCS and EQ-5D-5L scores. Secondary outcomes: TUG, FTSTS, functional reach, static balance, ankle strength, knee ROM, and balance confidence.	Exercises include range of motion activies, resistance, strengthening with theraband, static and dynamic balance, endurance training.	No significant improvement was observed in HRQoL scores. However, significant improvements were found in Timed Up-and-Go (TUG), Five Times Sit-to-Stand (FTSTS), ankle muscle strength, knee range of motion, and balance confidence compared with controls.
7	Xhardo et al[13]	Quasi experimental study	50-72 years 15 patients.	Berg Balance Scale, Timed Up and Go Test.	Functional balance training consisting of tandem Standing, Single leg stance, walking, stepping on different surfaces, reaching tasks, and dynamic postural control exercises for 8 weeks.	These findings support integrating the Berg Balance Scale into structured diabetic care program reduce fall risk and improve functional stability.
8	Ahmad et al[14]	Randomized controlled trail.	38 participants.	Outcome measures included proprioception, nerve conduction studies of the peroneal and tibial nerves, and electromyographic activity of lower-limb muscles and multifidus during standing (eyes open and closed) and treadmill walking.	Training included warm-up exercises, balance and proprioceptive exercises, gait training, lower-limb strengthening, and cool-down exercises. The control group received only diabetes and foot-care education.	Significant improvements were observed in proprioception in all directions, peroneal nerve conduction velocity, and activation of the medial gastrocnemius and multifidus muscles during standing and walking. The intervention group demonstrated better postural control and neuromuscular function than the control group (p<0.05).
9	Patil et al[15]	Comparative study	18 patients.	Berg balance scale, Michigan Neuropathy disability symptoms scale, Fear of Falling Avoidance Behavior Questionnaire.	The conventional therapy session for group A was given for 30 minutes and the conventional therapy along with task-oriented session for group B was given for 50 minutes.	Result of this study showed that there is significant difference in pre and post values for both FFABQ and BBS scales except for BBS the scores of group A no significant changes. On comparison between Group A and Group B, the group B showed more improvement in FFABQ and BBS score than group A.
10	Asadi et al[16]	Quasi experimental study	30 patients.	Dynamic balance was assessed using Timed Up and Go (TUG), and static balance was evaluated before and after 12 weeks of training	Multisensory training was conducted for 40 minutes, twice weekly for 12 weeks. Exercises targeted somatosensory, visual, and vestibular systems through walking on different surfaces, head movements, visual tracking, and balance activities with eyes open and closed.	Significant improvements were observed in dynamic balance (p<0.001) and static balance in both X-axis (p=0.001) and Y-axis (p=0.028) following multisensory training.
11	Thenmozhi et al[17]	Comparative study	40-65 years 30 patients.	Mini-BEST Test, Balance Error Scoring System, Paired t -test.	Activities included stepping strategies, reaching beyond, limits of stability, tandem walking, obstacle walking and balance board training for 6 weeks.	In between group analysis using independent t-test, except anticipatory postural control all the other three components of balance showed statistically significant improvement.

DISCUSSION

The present review examined the effectiveness of various rehabilitation interventions in improving balance, coordination, gait performance, and functional mobility among individuals with DPN. A total of 11 studies were reviewed, encompassing interventions such as task-oriented training, balance and stability training, Biodex balance system training, biofeedback-based interventions, multisensory training, augmented feedback training, and sensorimotor gait training. The overall findings consistently demonstrated that structured rehabilitation programs are effective in enhancing postural stability and reducing fall risk in individuals with DPN.

Balance impairment is one of the most common functional deficits associated with diabetic peripheral neuropathy due to sensory loss, impaired proprioception, and reduced neuromuscular control. The majority of the reviewed studies reported significant improvements in balance following rehabilitation interventions. Significant improvements in balance and reduction in fall risk were reported following rehabilitation interventions.[16] Similarly, substantial improvements in static and dynamic balance through structured balance-training programs were demonstrated in several studies.[8,14,17] These findings suggest that repetitive balance exercises stimulate sensory integration and improve postural control mechanisms, thereby enhancing stability during daily activities.

Task-oriented training emerged as an effective intervention for improving functional outcomes in patients with DPN. Significant improvements in balance, gait performance, proprioception, and confidence during functional activities were reported in multiple studies.[9-11] Task-oriented exercises closely replicate real-life movements and encourage active problem-solving during motor tasks, thereby promoting motor learning and improving functional performance. The consistent positive outcomes observed across these studies support the incorporation of task-specific training into rehabilitation programs for individuals with diabetic neuropathy.

Technology-assisted interventions such as Biodex balance system training, stability trainer exercises, and biofeedback-based rehabilitation also demonstrated superior outcomes compared to conventional physiotherapy alone. Significant improvements in coordination, postural stability, and fall-risk indices following Biodex-based training were reported.[14,12] Greater improvements in functional balance were also observed among participants who received Stability Trainer exercises in addition to conventional physiotherapy.[8] These findings indicate that technology-assisted rehabilitation provides enhanced sensory feedback, allowing patients to make real-time postural adjustments and achieve greater improvements in balance performance.

The role of sensory integration in maintaining balance was further highlighted by studies investigating multisensory and augmented feedback interventions. Significant improvements in both static and dynamic balance following multisensory training have been reported.[17] While superior outcomes with visual and auditory feedback-based training compared with conventional exercises were also observed.[18] These findings emphasize the importance of stimulating visual, vestibular, and somatosensory systems simultaneously to compensate for sensory deficits associated with diabetic neuropathy.

Improvements in gait performance and functional mobility were also evident in studies evaluating task-oriented gait training and sensorimotor interventions. Significant gains in proprioception, nerve conduction velocity, muscle activation, and walking performance following sensorimotor and gait training were reported.[15] Improvements in gait biomechanics, coordination, and confidence during walking activities were also observed.[9] These findings suggest that interventions targeting proprioceptive and neuromuscular deficits can effectively enhance locomotor function and reduce mobility limitations in patients with DPN.

Although most studies reported positive outcomes in physical performance measures, improvements in balance and functional mobility were not always accompanied by significant changes in health-related quality of life.[13] This finding suggests that quality of life is influenced by multiple factors beyond physical function, including psychological, social, and disease-related variables. Therefore, future rehabilitation programs may benefit from incorporating comprehensive approaches that address both physical and psychosocial aspects of diabetic neuropathy.

Overall, the reviewed literature provides strong evidence supporting the effectiveness of rehabilitation interventions in improving balance, coordination, gait performance, proprioception, and functional mobility among individuals with diabetic peripheral neuropathy. The findings indicate that interventions incorporating task-oriented activities, sensory feedback, biofeedback technology, and progressive balance challenges produce the most favorable outcomes. These approaches may play a crucial role in reducing fall risk, enhancing independence, and improving overall functional performance in this population. The majority of studies reviewed support the efficacy of task-oriented training in improving balance, gait, functional mobility, lower limb strength, and quality of life in individuals with diabetic peripheral neuropathy. Nevertheless, some studies reported limited effectiveness, particularly in patients with advanced neuropathy or when intervention duration was insufficient. Therefore, although task-oriented training appears to be a promising rehabilitation strategy, further high-quality randomized controlled trials with larger sample sizes and long-term follow-up are required to establish definitive clinical recommendations.

CONCLUSION

This review study concludes that based on the reviewed existing evidences, it can be concluded that rehabilitation interventions play a significant role in improving balance, coordination, gait performance, proprioception, and functional mobility among individuals with diabetic peripheral neuropathy. The evidence from the 11 reviewed studies indicates that interventions such as task-oriented training, balance and stability training, Biodex Balance System training, biofeedback-based rehabilitation, multisensory training, augmented feedback training, and sensorimotor gait training are effective in reducing balance deficits and fall risk associated with diabetic neuropathy. Among the various interventions, task-oriented and technology-assisted training approaches demonstrated particularly favorable outcomes in enhancing postural stability, motor control, and functional performance. Studies utilizing sensory feedback, biofeedback systems, and progressive balance challenges reported greater improvements compared with conventional exercise programs. Furthermore, interventions targeting proprioceptive and neuromuscular impairments contributed to significant gains in gait performance, coordination, and balance confidence.

Overall, the findings suggest that structured and individualized rehabilitation programs should be considered an essential component in the management of diabetic peripheral neuropathy. Incorporating balance-focused, task-specific, and sensorimotor training strategies may help improve functional independence, reduce fall risk, and enhance the overall physical well-being of individuals with diabetic peripheral neuropathy. Future research with larger sample sizes and longer follow-up periods is recommended to further establish the long-term effectiveness of these interventions and optimize rehabilitation protocols for this population.

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