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Literature Review: Effectiveness of a Combination of Neuromuscular Taping and Balance Exercises on Postural Function in Patients with Peripheral Neuropathic Diabetes

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Keywords: Diabetic Peripheral Neuropathy; Neuromuscular Taping; Balance Training; Postural Stability; Fall Risk;

Abstract
Introduction*: Diabetic Peripheral Neuropathy is a common complication of diabetes mellitus that leads to sensory and motor impairments, reduced proprioception, and postural instability, increasing the risk of falls and functional limitations. Neuromuscular taping and balance training have been proposed as non-pharmacological interventions to improve postural function in this population.* ***Objective****: This literature review aimed to evaluate the effectiveness of the combination of neuromuscular taping and balance training on postural function in patients with diabetic peripheral neuropathy.* ***Method:*** *A literature review was conducted using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses approach. Articles were identified from Publish or Perish and Google Scholar databases published between 2015 and 2025. Twelve eligible studies were selected based on predefined inclusion criteria and analyzed systematically.* ***Result and Discussion:*** *The reviewed studies demonstrated that balance training significantly improved static and dynamic balance, functional mobility, and reduced fall risk. Neuromuscular taping showed positive effects on balance, proprioception, and pain reduction. Studies combining neuromuscular taping with balance training reported more consistent and superior outcomes compared to single interventions, including improvements in postural stability and center of pressure parameters.* ***Conclusion:*** *The combination of neuromuscular taping and balance training is an effective and clinically applicable approach to improve postural function, reduce fall risk, and alleviate pain in patients with diabetic peripheral neuropathy.*

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Introduction

Diabetic Peripheral Neuropathy (DPN) is a clinical condition that causes disorders of the peripheral nervous system. Individuals with peripheral neuropathy experience symptoms of numbness, tingling, pain, burning sensation, and weakness in the limbs. (Myron.A *et al*., 2024). Diabetic Peripheral Neuropathy (DPN) is a chronic complication of Diabetes Mellitus characterized by damage to peripheral nerves, especially in the lower extremities, resulting in sensory and motor impairment and decreased proprioception ability. DPN patients have a tendency to experience balance disorders, decreased nerve conduction speed, and foot deformities that affect the distribution of plantar pressure. This condition increases the risk of falls as well as other foot complications. This shows how DPN is not only a sensory disorder but also has a major impact on motor function and postural control of the body (Thakur *et al.,* 2024).

DPN is a significant economic burden on the health system and patients. Cost data analysis showed that patients with diabetic neuropathy especially those with pain had significantly higher total annual care costs compared to diabetic patients without neuropathy, including the cost of inpatient care, outpatient visits, and medications. These annual costs can increase exponentially as the severity of neuropathy symptoms increase, reflecting a surge in the use of healthcare services and more intensive medical interventions. Additional financial impacts including indirect costs due to decreased productivity, job loss, and burdens on informal caregivers also exacerbate family and community economic pressures. Effective rehabilitative interventions such as a combination of neuromuscular taping and balance exercises not only offer the potential to improve functional outcomes but also the possibility of reducing the long-term cost burden by lowering the incidence of falls, improving functional abilities, and extending the patient's independence in carrying out daily activities (Bromberg *et al.,* 2024)

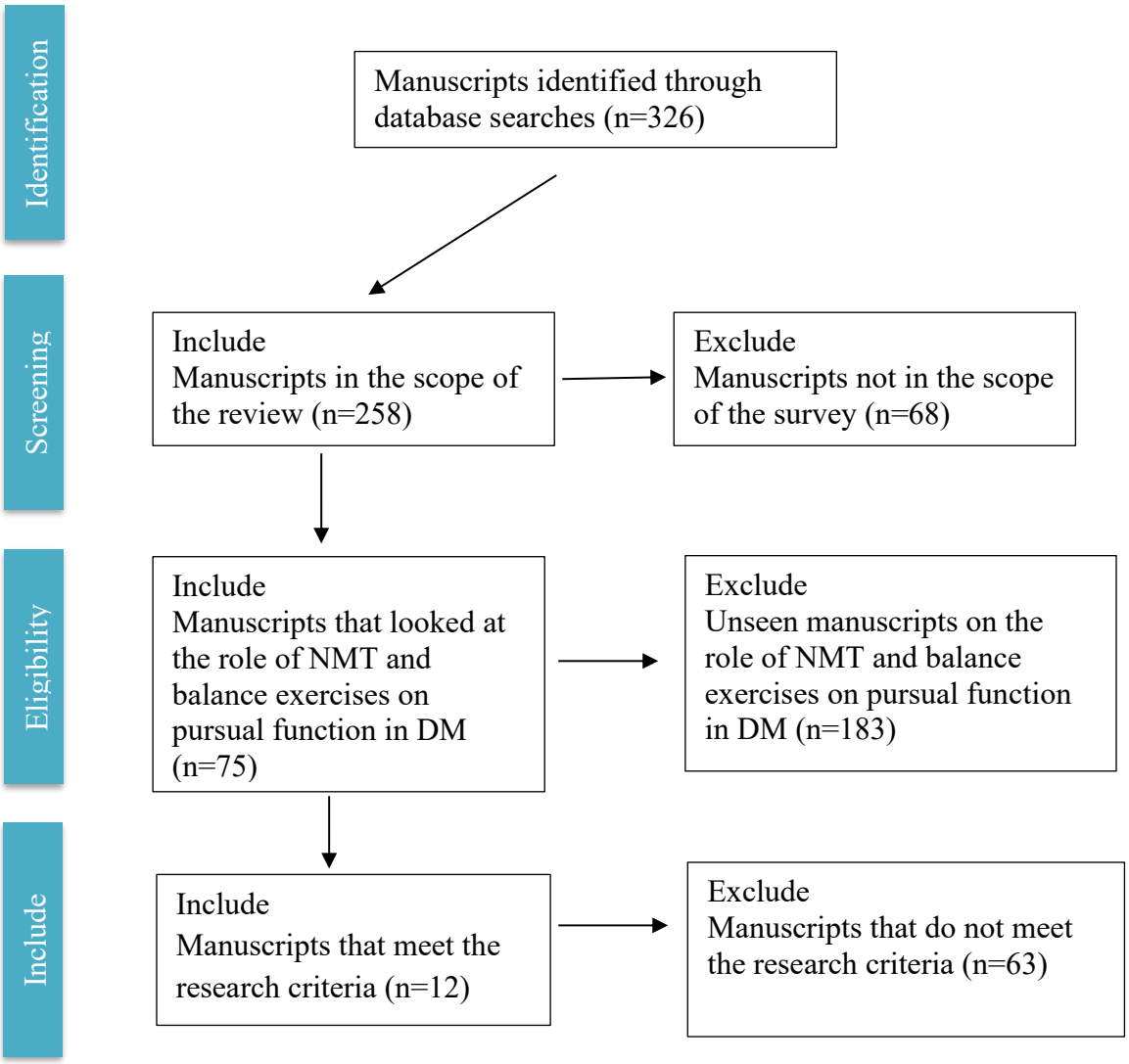
In the population group with neurological disorders, people with DPN rank third highest in terms of fall incidence rate (Rosenblatt *et al.,* 2021). Therefore, the identification and treatment of balance disorders in DPN patients is an important aspect of physiotherapy and rehabilitation management. NeuroMuscular Taping (NMT) is a nonpharmacological intervention that can be used in the treatment of DPN. NMT is believed to be able to improve peripheral circulation in patients with DPN disorder, this technique can be used for the development of alternative modality therapies (Kristianto *et al*., 2021). NMT is defined as a specific technique for applying elastic adhesive tapes to the skin using a decompression methodology that provides a local therapeutic effect directly at the treatment site to reduce pain, facilitate lymphatic drainage and improve vascularization due to wrinkles forming in the skin (Blow *et al*., 2018). In addition to NMT balance exercises have been shown to be effective in improving postural stability and reducing the risk of falls in DPN patients. A systematic review showed that physical interventions including balance exercises, gait training, proprioceptive exercises, and multimodal activities were able to improve static and dynamic balance, as well as increase balance confidence in people with DPN.

Although the combination of neuromuscular taping (NMT) and balance exercises has shown potential in improving postural function as well as quality of life in patients with diabetic peripheral neuropathy, barriers to its implementation in clinical practice and communities are still quite significant. Studies on diabetic neuropathy rehabilitation note that patients' adherence to exercise programs is often influenced by psychological factors such as low motivation, fear of injury, and the absence of immediate results that patients

perceive, which can reduce the consistency of participation in long-term exercise. In addition, access to adequate physiotherapy and rehabilitation services is still limited in many areas, so patients often have difficulty getting ongoing professional guidance, especially in primary health facilities or low-resource communities. These barriers include a lack of visit time, a tight schedule, and a limited number of facilities or tools needed for safe and effective balance exercises (Thakur *et al,* 2024).

Method

This study used a literature review method to gain a comprehensive understanding through the systematic mapping of relevant studies on the role of NMT and Balance Exercises in patients with DPN. The method of analysis of the literature selection uses the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) approach (Page *et al.,* 2021), which can be seen in Figure 1. Study data sources were identified from the Publish or Perish and Google Scholar databases with a publication range of 2018 to 2024. The search parameters include various keyword combinations such as "NMT and Balance Exercise," "Diabetes Peripheral Neuropathy", "Neuromuscular Taping", "Balance Training", "Postural Stability","Fall Risk"



The focus of this study is to explore the effectiveness of Neuromuscular Taping and Balance Exercise interventions in improving balance, reducing the risk of falls, reducing pain, and improving plantar distribution. To maintain measurable yet comprehensive coverage, the researchers analyzed 12 major publications that specifically addressed the effects of both interventions. This number is considered sufficient to provide a broad overview of current research trends relevant to the topic. The research process was carried out through stages of reading and gradual analysis to find the relationship between variables and their significance to the research theme. The initial analysis focused on how each article highlighted the mechanisms by which the DPN mechanism can affect balance, the distance risk and distribution of plantar pressure and how the NM mechanism and the lack of balance can affect the problem. Furthermore, the analysis process involves organizing and systematically categorizing the quality of the methodology and findings in each study. This approach makes it easier for researchers to identify research trends, the effectiveness of interventions, and the most influential variables such as the frequency of exercise, duration of interventions.

Relevant literature was obtained through combinatorial keyword searches “Neuromuscular Taping", "Balance Exercise", "Postural Function", "Peripheral Diabetes Neuropathy". The articles used came from internationally and nationally reputable journals in the fields of physiotherapy, sports medicine, and rehabilitation science. Each selected study was then evaluated using a systematic data matrix, which contained information about the author and year of publication, the purpose of the study, the method and sample of the study, the type of intervention. This approach allows for an in-depth and comparative analysis of the effectiveness of each exercise method in improving balance, decreasing the risk of stroke, reducing pain, and distributing pressure on the plantar. The results of this systematic study are expected to provide a theoretical and practical basis for health workers, physiotherapists, and researchers in choosing the most appropriate exercise approach for chronic low back pain therapy.

Result and Discussion

1. Result

Based on the results of the literature selection using the PRISMA method, 12 articles that met the inclusion criteria were obtained and analyzed further. The included articles were published in the last 10 years (2015–2025) with a research design dominated by randomized controlled trials (RCTs), quasi-experimental, and one systematic review. All studies included patients with peripheral neuropathic diabetes (DPN) with impaired postural function.

The interventions studied included neuromuscular taping (NMT), balance exercises, and a combination of both. The duration of the intervention varied between 2–8 weeks with a frequency of exercise 2–5 times per week. The main outcomes analyzed in these studies included balance, risk of falls, pain, and center of pressure (COP) parameters

Table 1
Items for Systematic Reviews and Meta-Analyses

No	Author (Year)	Article Title	Study Design	Sample	Intervention	Variables & Measuring Tools	Key Findings
1	Thakur & Goyal (2024)	Effectiveness of Neuromuscular Taping on Balance, Proprioception, Pain, and Nerve Conduction Parameters in Patients with Diabetic Peripheral Neuropathy	RCT	DPN Patients	Neuromuscular taping	Balance (BBS), pain (VAS), proprioception	NMT improves balance and lowers pain significantly
2	Allet et al. (2016)	Effect of balance and strength training on gait and balance in diabetic peripheral neuropathy	RCT	DPN Patients	Balance & strengthening exercises	BBS, TUG	Improved balance and mobility function
3	Morrison et al. (2018)	Balance training reduces falls risk in people with diabetic peripheral neuropathy	RCT	DPN Patients	Balance training	Fall risk, COP	Reduced risk of falls and postural sway
4	Grewal et al. (2015)	Postural instability in patients with diabetic peripheral neuropathy	Observational	DPN Patients	–	COP (Flat Force)	COP increases in DPN patients
5	Hasanpour-Dehkordi et al. (2020)	Effect of balance exercises on balance and fear of falling in diabetic neuropathy	RCT	DPN Patients	Balance exercises	BBS, FES-I	The risk of falling decreased significantly
6	Lee et al. (2018)	Effects of elastic taping combined with balance training on postural control	Quasi-experimental	Adults with Balance Disorders	Elastic taping + balance	Static-dynamic balance	A combination is more effective than just exercise.
7	Lim & Tay (2019)	Effects of ankle taping on postural stability	Experimental	Adult	Elastic/NMT ankle	Postural sway, COP	Taping improves postural stability
8	Petrofsky et al. (2020)	The effect of sensory loss on balance and plantar pressure in diabetic neuropathy	Experimental	DPN Patients	–	COP, plantar pressure	Sensory disorders affect COP
9	Pang et al. (2025).	Exercise interventions for improving postural control in older adults with DPN: A systematic review and meta-analysis	Systematic review	DPN Patients	Exercise programs	COP path, balance	Exercise lowers COP and fall risk
10	Cavanagh et al. (2017)	Falls risk in patients with diabetic peripheral neuropathy	Cohort	DPN Patients	–	Fall risk	DPN increases the risk of falling
11	Simon et al. (2017)	Effect of elastic taping on postural stability	Experimental	Adult	Elastic Taping	Postural sway	Taping lowers the postural sway

12	Journal of Diabetology (2024)	Effectiveness of neuromuscular taping on balance and pain in DPN	RCT	DPN Patients	Neuromuscular taping	Balance, pain	Significant balance and pain improvements

2. Discussion

Effectiveness of Interventions on Balance

Based on a synthesis of 12 articles analyzed, balance exercises consistently showed significant improvements in static and dynamic balance in patients with peripheral neuropathic diabetes (DPN). This increase is shown by an improvement in the Berg Balance Scale (BBS) score as well as a decrease in Timed Up and Go (TUG) time after a balance training program and muscle strengthening (Allet *et al.,* 2016; Hasanpour-Dehkordi *et al.,* 2020). These findings suggest that balance exercises play an important role in improving postural control and mobility function in DPN patients.

In addition to balance exercises, neuromuscular taping (NMT) has also been reported to have a positive effect on balance. A randomized controlled trial study (Thakur *et al.,* 2024) showed that NMT application significantly improved balance and proprioception in DPN patients. Similar findings were also reported in another RCT study that showed improvement in balance after neuromuscular taping interventions (Journal of Diabetology, 2024).

Furthermore, studies that combine elastic or neuromuscular taping with balance exercises show more consistent and superior results than balance exercises alone. Research by Lee *et al.* (2018) reported that the combination of taping and balance exercises provided greater improvement in static and dynamic postural control, indicating a synergistic effect in improving balance function.

Effectiveness against the Risk of Falls

DPN patients are known to have a higher risk of falls due to sensory impairment and postural control. Several studies report that balance exercises are able to significantly reduce the risk of falls, both measured through subjective instruments such as the Fall Efficacy Scale-International (FES-I) and through fall incident reports (Hasanpour-Dehkordi *et al.,* 2020; Morrison *et al., 2018).*

A cohort study by Cavanagh et al. (2017) confirmed that DPN is an independent risk factor for falls. However, balance training interventions have been shown to be able to lower the level of fear of falls and increase patients' confidence in functional activities. Recent systematic review and meta-analysis studies have also shown that physical exercise programs are generally effective in lowering the risk of falls in the DPN population (Pang *et al.,* 2025).

Effectiveness against Pain

The results of the synthesis showed that neuromuscular taping had a positive effect on the reduction of neuropathic pain in DPN patients. Pain reductions measured using the Visual Analog Scale (VAS) were reported to be significant after NMT application (Thakur *et al.,* 2024; Journal of Diabetology, 2024). This analgesic effect is thought to be related to the stimulation of skin mechanoreceptors that modulate nociceptive inputs and improve local circulation.

This decrease in pain is an important factor because neuropathic pain can limit the patient's participation in balance exercises. Therefore, the combination of NMT with balance exercises has the potential to provide additional benefits in improving overall functional outcomes.

Effectiveness against the Center of Pressure (COP)

Several studies using objective measurements showed that DPN patients experienced increased postural sway and Center of Pressure (COP) movements compared to healthy individuals (Grewal *et al.,* 2015; Petrofsky *et al.,* 2020). Peripheral sensory disturbance and decreased plantar sensation contribute to postural instability indicated by increased COP path length and COP velocity.

Balance training interventions have been shown to decrease COP movements, reflecting increased postural stability (Morrison *et al.,* 2018; Pang *et al.,* 2025). In addition, experimental studies on elastic and neuromuscular taping have shown a decrease in postural sway and improvement in postural stability, although not entirely in the DPN population (Lim & Tay, 2019; Simon *et al.,* 2017). These findings support the potential use of taping as an additional modality in objectively improving postural control.

Clinical Implications and Recommendations

Based on the synthesis of the 12 articles analyzed, the findings of this literature review have important clinical implications in the management of patients with peripheral neuropathy diabetes (DPN), especially related to postural function disorders. Evidence shows that balance exercises are an effective core intervention to improve static and dynamic balance, improve mobility function, and reduce the risk of falls in DPN patients (Allet *et al*., 2016; Morrison *et al*., 2018; Hasanpour-Dehkordi et al., 2020; Pang *et al*., 2025). Therefore, balance exercises should be a regular part of the rehabilitation program for DPN patients.

In addition, findings from several studies suggest that neuromuscular taping (NMT) can be used as a safe and non-invasive adjunct modality to improve balance, proprioception, and lower neuropathic pain in DPN patients (Thakur *et al*., 2024; Journal of Diabetology, 2024). The analgesic effect and increased sensory input generated by NMT have the potential to increase patient participation in balance exercises and daily functional activities.

Findings related to the Center of Pressure (COP) confirm that DPN patients experience significant objective postural instability due to peripheral sensory disturbances (Grewal *et al.,* 2015; Petrofsky *et al.*, 2020). Balance and taping training interventions have been shown to reduce postural sway and COP movements, which has shown an objective improvement in postural stability (Morrison *et al.,* 2018; Lim *et al.,* 2019; Simon *et al.,* 2017). This confirms the importance of using objective measuring tools such as force plates or COP parameters in the clinical evaluation of DPN patients.

Furthermore, studies combining taping and balance exercises showed more consistent results than single interventions (Lee *et al.,* 2018), indicating that a multimodal approach is more appropriate for addressing postural function impairment in multifactorial DPN patients. Thus, rehabilitation approaches that integrate active exercise and passive sensory stimulation can provide more optimal clinical benefits.

Research Limitations

Based on the synthesis of the 12 articles analyzed, there are several methodological and substantive limitations that need to be considered in interpreting the results of research related to the effectiveness of neuromuscular taping and balance exercises in patients with peripheral neuropathic diabetes (DPN).

First, most studies have relatively small sample sizes, especially in randomized controlled trial and quasi-experimental studies. This limited sample size has the potential to degrade the statistical power of the study and limit the generalization of results to a broader population of DPN (Allet *et al.,* 2016; Morrison *et al.,* 2018; Thakur *et al.,* 2024).

Second, there is a high heterogeneity in the design of the intervention, including variations in the duration, frequency, and intensity of balance exercises, as well as differences in techniques and locations of neuromuscular or elastic taping applications. These variations make it difficult to make direct comparisons between studies and hinder the determination of the most optimal intervention dose (Lee et al., 2018; Lim & Tay, 2019).

Third, not all studies specifically evaluated the combination of neuromuscular taping and balance exercises in the DPN population. Several taping studies have been conducted in adult populations with generalized balance disorders, so the results have not been fully generalized to DPN patients (Lee et al., 2018; Simon et al., 2017).

Fourth, the use of diverse and non-uniform measuring instruments is an important limitation. Although most studies use clinical measuring tools such as BBS, TUG, and FES-I, only a small number involve objective measurements such as Center of Pressure (COP) using force plates. This limits a comprehensive understanding of postural control changes objectively (Grewal et al., 2015; Petrofsky et al., 2020).

Fifth, some studies had relatively short follow-up durations, so the long-term effects of the intervention on balance, fall risk, and pain could not be adequately evaluated. As a result, the long-term sustainability of the intervention's benefits remains unclear (Hasanpour-Dehkordi et al., 2020; Pang et al., 2025).

Finally, there are limitations in reporting blinding and bias control, particularly in studies of non-pharmacological interventions such as taping and balance exercises. Lack of blinding in participants and therapists has the potential to increase the risk of performance bias and measurement bias, which can affect the internal validity of the research results (Morrison et al., 2018; Thakur & Goyal, 2024).

Conclusion

This literature review shows that patients with peripheral neuropathic diabetes (DPN) experience significant postural function impairments, which include decreased static and dynamic balance, increased risk of falls, the appearance of neuropathic pain, as well as changes in postural control indicated through Center of Pressure (COP) parameters. The disorder is related to damage to the sensory, proprioceptive, and motor systems due to diabetic neuropathy. Balance exercises have been shown to be effective in improving postural control and mobility function in DPN patients. This improvement is reflected in improved clinical balance scores, decreased functional mobility time, and reduced fear of falling. In addition, balance exercises also showed a positive impact on the objective parameters of COP, indicating improved postural stability. Neuromuscular taping provides additional benefits in improving balance and lowering neuropathic pain. The mechanism of working of taping is thought to be through increased stimulation of

skin Mecha receptors and proprioceptive inputs, which contributes to improved perception of body position and postural stability. The analgesic effects of neuromuscular taping also have the potential to increase patient participation in exercise programs.

The combination of neuromuscular taping and balance exercises showed superior and consistent results compared to a single intervention. This multimodal approach has been shown to be more effective in improving balance, lowering the risk of falling, reducing pain, and improving objective postural control in DPN patients.

Thus, the combination of neuromuscular taping and balance exercises can be recommended as an effective and clinically applicable rehabilitation strategy to improve postural function in patients with peripheral neuropathic diabetes. Further research with a more uniform experimental design, longer duration of interventions, and the use of standard objective measuring tools is still needed to strengthen the scientific evidence and optimize intervention protocols.

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