

Literature Review

Non-Pharmacological Balance Therapy on Diabetic Peripheral Neuropathy Patients with Balance Disorders

Jeremy Nicolas Sibarani^{1*} , Kristanti WanitoWigati² , Lilik Herawati² , Imam Subadi³ 

1Faculty of Medicine, Universitas Airlangga, Surabaya, East Java, Indonesia

2Departement of Physiology, Faculty of Medicine, Universitas Airlangga, Surabaya, East Java, Indonesia

3Departement of Physical Medicine and Rehabilitation, Faculty of Medicine, Universitas Airlangga, Surabaya, East Java, Indonesia

*Corresponding Author:

Jeremy Nicolas, Faculty of Medicine, Universitas Airlangga, Jl. Mayjen Prof. Dr. Moestopo No.47, Surabaya, East Java, Indonesia

Email: jeremy.nicolas.sibarani-2017@fk.unair.ac.id

Article info:

Received: January
24th, 2021;

Received in revised:
October 28st, 2021;

Accepted: October
29th, 2021

Published: February
25th, 2022

This is an open access
article under the CC-
BY license

[\(https://creativecommons.org/licenses/by/4.0/\)](https://creativecommons.org/licenses/by/4.0/)



Cite this as:

Sibarani JN, Wigati K,
Herawati L, Subadi I.
Non-pharmacological
balance therapy on
diabetic peripheral
neuropathy patients with
balance disorders
SPMRJ. 2022;4(1):26-
31.

ABSTRACT

Background: Patients with diabetic peripheral neuropathy (DPN) suffers from proprioception and mobility disturbance which can potentially affects balance. There are various balance therapy options for DPN patients. The purpose of this study was to determine the effectiveness of various non-pharmacological therapies (surgery, traditional medicine, exercise and assistive devices) in DPN patients with balance disorders.

Aim: To determine the effectiveness of non-pharmacological balance therapy in people with diabetic peripheral neuropathy.

Material and Methods: A systematic review was conducted using randomized controlled trial study articles found using PICO characteristics in ScienceDirect and PubMed in the last 10 years. All articles were selected based on PRISMA and descriptive analysis was carried out on the selected articles.

Results: Significant balance improvement was found in traditional Thai massage, physical exercise therapy, assistive device therapy with whole-body vibration, and assistive device therapy with electrical stimulation. Surgical therapy with unilateral nerve decompression did not provide a significant measurable balance improvement.

Conclusion: Physical exercise therapy, traditional Thai foot massage, WBV and electrical stimulation therapy (with the exception of TENS on the knee) significantly improve balance. Meanwhile, unilateral nerve decompression surgical therapy did not improve the balance significantly.

Keywords: *balance, diabetes, peripheral neuropathy, therapy*

Introduction

Based on data compiled by WHO, the number of people with diabetes in the world in 2014 was 422 million people. Indonesia has a diabetes prevalence of the total adult population of 6.2% which means there are more than 10 million total cases of diabetes in adults. Meanwhile, diabetic peripheral neuropathy is the most common neuropathy and one of the most common diabetes-related diseases in the world. It was found that approximately 50% of people with diabetes mellitus had diabetic peripheral neuropathy throughout their life with varying degrees of severity based on age, duration of diabetes, type of diabetes and blood glucose control. Therefore, diabetic peripheral neuropathy is a case that affects many people in the world according to the large number of diabetes cases.¹ DPN can worsen the decrease in the quality of life (QoL) of diabetic patients and worsen the prognosis of diabetes. Therapy used in balance management in diabetic peripheral neuropathy patients is a therapy that works by reducing neural dysfunction especially determine the effectiveness of various non-pharmacological balance therapies in people with DPN.

Material and Methods

This study used a retrospective observational research design with a systematic review approach, in which all variable data were collected from previous studies. The data is collected from previous research articles published in ScienceDirect and PubMed databases. The article search method uses PICO

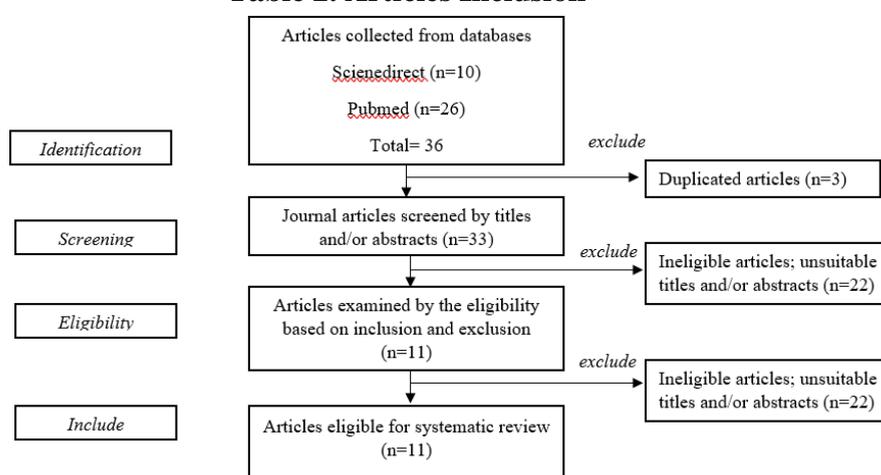
(Population, Intervention, Comparison, Outcome) characteristics as shown in the Table 1.

Table 1. PICO

PICO	In form of
Population	Patients with DPN
Intervention	Non-pharmacological balance therapy
Comparison	-
Outcome	Balance

The materials used in this study are secondary data in the form of study results and analysis from published studies regarding the effectiveness of non-pharmacological balance therapy in people with DPN. Data in the form of articles that have been collected are managed by using the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) method. The analysis was carried out by comparing the results of each secondary data in the form of journal articles. A randomized controlled trial study is ensued to meet the criteria for the inclusion criteria by using non-pharmacological balance intervention with diabetic peripheral neuropathy as the subject in questioned. it will produce a balance outcome and as resulted, it will produce a balance outcome by using studies being published in this ten years.

Table 2. Articles Inclusion



Results

Table 3. Result from studied articles

Author and year of publication	Population	Intervention	Control	Outcome	Findings	
Ahmad et al, 2019	Patients with DPN (n: 37)	Sensorimotor exercise	-	TUG, OLS, CoP range and CoP sway	Improvement in OLS EO dan EC, TUG, CoP range dan CoP sway	
Chatchawan et al, 2015	Patients with DPN (n: 60)	Traditional Thai foot massage	Leg exercise	TUG, OLS	Improvement in TUG and OLS in both groups, but in the intervention group, improvement in TUG pad was more significant than control	
Dixit et al, 2016	Patients with DPN (n: 64)	Moderate aerobic exercise	-	CoP sway and sway velocity	Improvement of sway velocity on the x-axis and mediolateral displacement in closed eyes on the foam surface	
Grewal et al, 2015	Patients with DPN (n: 39)	Sensor-based interactivebalance training with visual movement feedback	with joint movement	-	CoM sway, ankle and hip sway	Improvement of the CoM sway, ankle and hip sway for open eye conditions Improvement of the ankle sway when the eyes are closed
Lee et al, 2013	Patients with DPN (n: 55)	WBV with balance and exercise	with balance exercise	-	CoP sway, OLS, BBS, FRT, TUG	Improvements in CoP sway, OLS, FRT, BBS and TUG in the WBV and BE Groups, and improvements in WBV were more significant compared to BE
Maurik et al, 2015	Patients with DPN (n: 39)	Unilateral nerve decompression surgery	Contra-lateral leg	CoP sway	There was no significant difference between the intervention and control legs	
Najafi et al, 2013	Patients with DPN (n: 13)	Plantar simulation	Placebo	CoM sway area	There was significant improvement in the CoM sway area at the second week of therapy, and there was an additional improvement at the sixth week, although not significant	
Najafi et al, 2017	Patients with DPN (n: 28)	TENS in the plantar area	Placebo	Ankle, hip, CoM sway	Repair of the ankle sway and CoM sway of the area with the eyes opened in the intervention group	
Rojhanji-	Patients	Swiss ball		OLS, BBS,	Difference in all balance parameters between intervention and control groups except for OLS with	
Shirazi et al, 2016	with DPN (n: 60)	And Frenkel exercise	-	SEBT	open and closed eyes and BBS and SEBT in 3 directions The output of the Swiss ball is better than the Frenkel test	
Saadat et al, 2017	Female Patients with DPN (n: 28)	TENS in the knee area	Placebo	Sway velocity, CoP displacement	There was no difference between the intervention and control groups	
Song et al, 2011	Patients with DPN (n: 38)	Balance exercise	-	CoP sway, OLS, BBS, FRT, TUG 10MWD	Improvement in CoP sway, OLS, BBS, FRT, TUG, 10MWD	

Details: 10MWD: 10-m walking distance; ABC Scale: activities-specific balance confidence scale; BBS: Berg Balance Scale; CoM: center of mass; CoP: center of pressure; DPN: diabetic peripheral neuropathy; FRT: unctional reach test; OLS: one leg stance test; SEBT: star excursion balance test; TENS: transcutaneous electricalnerve stimulation; TUG: timed up and go test; WBV: whole-body vibration

Literature searches were conducted on two different databases, namely ScienceDirect and PubMed. From these two databases, 36 studies were found with search terms on the title, abstract, and keywords as follows: "diabetes AND peripheral neuropathy AND balance AND (therapy OR management OR intervention)". Of the 36 studies, there were 33 studies after eliminating duplication. The studies were then screened by reading the titles and abstracts. It was found that 22 studies did not meet PICO and sample criteria. After going through the screening process, 11 suitable and potential studies were found to be studied in this review. After eliminating the studies based on the sample criteria, it was found that 11 studies met the criteria for inclusion in this systematic review.

Discussion

In these 11 articles, non-pharmacological balance therapy can be classified into several therapeutic groups, namely: physical exercise, traditional Thai foot massage, whole-body vibration (WBV), nerve decompression surgery, and electrical stimulation, respectively. Physical exercise is a type of therapy that is widely used to train balance in the elderly and has been shown to be effective according to several studies.³ There were 6 articles that discussed the use of physical exercise as a balance therapy: Ahmad et al (2018), Dixit et al (2016), Grewal et al (2015), Lee et al (2013), Rojhani Shirazi et al (2016) and Song et al. (2011). Research by Ahmad et al (2018) that used sensorimotor exercises showed improvements in balance which were marked by improvements in the results of TUG, OLS, center of pressure range and sway. Research by Dixit et al (2016) found that by using moderate intensity aerobic exercise, there is an improvement in balance as measured by the center of pressure sway and sway velocity. Research by Grewal et al (2015) that used sensor-based interactive balance exercises with visual joint movement feedback showed an improvement in balance as well, marked by improvements in the center of pressure sway, OLS, BBS, FRT and TUG. Research by Rojhani-Shirazi et al (2016) examined two types of therapy: Swiss ball and Frenkel

exercises. This study showed an improvement in balance marked by improvements in OLS, BBS and SEBT in 3 directions, and more significant improvements in Swiss ball training. A study by Song et al (2011) examined tapering exercises and found improvements in balance marked by improvements in center of pressure sway, OLS, BBS, FRT, TUG and 10MWD.

Research by Chatchawan et al (2015) showed that traditional Thai footmassage therapy for 2 weeks could improve balance in patients with DPN that is characterized by improvements in TUG and OLS. The therapeutic mechanism of deep massage type may involve improvement of blood flow to certain areas of the body. The existence of joint mobilization can also stimulate the nervous system directly.^{4,5} This can improve neuropathy by changing the distribution of pressure on the feet, as well as stimulation of the proprioceptive system. The presence of joint mobilization also increases flexibility and can improve postural stability.⁶

The use of Whole body vibration (WBV) therapy produces a good balance repair effect. According to Lee et al (2013), the use of WBV therapy in conjunction with balance training results in better balance improvement outcomes than balance training alone. WBV is a type of therapy that uses a platform capable of producing oscillatory movements and delivering vibrations throughout the body. The mechanism of action of WBV involves tonic vibration stretch reflex. It is a condition in which there is a rapid change in muscle and tendon length. In the elderly, short-term WBV therapy has been shown to be effective in improving lower limb muscle strength, bone density, mobility and can also effectively reduce the incidence of falls in the elderly,⁷ where the decrease in the incidence of falls is due to improvements of equilibrium.⁸ However, it should be noted that in long-term WBV therapy and with a high frequency of vibration side effects may occur, including: degeneration of the lumbar vertebrae, low back pain, fatigue of musculus erector spinae, as well as negative effects on the digestive system, female reproductive organs and peripheral veins.

Therefore, a special protocol is needed for WBV therapy.⁹

Maurik et al (2015) showed that there is no evidence that surgical treatment of unilateral nerve decompression in the lower extremities can improve balance in patients with DPN. It is shown by the absence of significant improvements in the CoP sway. Theoretically, in people with diabetes mellitus, there is an increase of glucose in cells so that there is an increase in the production of polyols such as sorbitol. Polyol will be concentrated in cells, causing water osmosis and cell expansion, so that a double crush phenomenon will occur which causes chronic nerve compression.^{10,11} According to the study by Maurik et al (2015), the absence of an improvement in balance is probably because there was a bias in the selection in that study. The most unbalanced patients were not included in the criteria for the population to be tested, so that the improvement in the sway parameter was smaller and insignificant.

In this systematic review, there are 3 studies that discuss electrical stimulation therapy, namely by Najafi et al (2013), Najafi et al (2017), and Saadat et al (2017). Research by Najafi et al used electrical stimulation in the plantar area using a waterbath. It obtained improvements in balance as measured by the center of mass sway area and the most significant improvement occurred in the first 2 weeks of therapy. In a study by Najafi et al (2017), stimulation was also carried out in the plantar area for 6 weeks by using TENS. An improvement in balance was obtained as measured by using an ankle sway and center of mass sway area (open eye conditions). Meanwhile, in a study by Saadat et al (2017) which used TENS in the knee area, the improvement in balance was not really significant.

From the results of several previous studies mentioned, it can be seen that only research by Saadat et al (2017) has resulted an insignificant outcome of balance improvement. Two causes might influence the results of the study. The study used stimulation in the knee area while the other two studies used stimulation in the plantar area. This is probably because the plantar area is an important area in somatosensory

input and disturbances in plantar sensations can affect body balance.¹² Another thing that might cause a difference in balance outcome is that Saadat et al (2017) only measured the short-term effects of the intervention, so that the long-term effect of TENS in the knee area is unknown.

Electrical stimulation therapy is an alternative therapy for DPN sufferers who are unable to carry out physical exercise therapy because of fear of falling, so that it can improve balance, reduce fear of falling and encourage patients to be more physically active.¹³ Several studies have shown that low-level mechanical or electrical stimulation to sensory neurons can significantly increase their ability to detect weak signals. Therefore, it is plausible that electrical stimulation of the feet can improve balance due to increased sensitivity to somatosensory signals from the feet. Thus, it reduces the occasional fall rate caused by decreased touch sensitivity and awareness of foot orientation and position. One study showed that mechanical noise stimulation increased vibration and tactile perception in diabetic patients with moderate to severe neuropathy when tremors occurred.¹⁴

Conclusion

Based on the results obtained from the data, it was found that there was a significant balance improvement in traditional medicine therapy in the form of traditional Thai massage, physical exercise therapy, assistive device therapy with whole-body vibration, and assistive device therapy with electrical stimulation. Meanwhile, surgical therapy with unilateral nerve decompression did not provide a significant measurable balance improvement.

References

1. Hicks CW, Selvin E. Epidemiology of Peripheral Neuropathy and Lower Extremity Disease in Diabetes. *Curr Diab Rep.* 2019 Aug;19(10):86.
2. Ites KI, Anderson EJ, Cahill ML, Kearney JA, Post EC, Gilchrist LS. Balance interventions for Diabetic Peripheral Neuropathy: A systematic review. *J Geriatr Phys Ther.* 2011;34(3):109–16.
3. Najafi B, Talal TK, Grewal GS, Menzies R, Armstrong DG, Lavery LA. Using Plantar Electrical Stimulation to Improve Postural Balance and Plantar Sensation among Patients with Diabetic Peripheral Neuropathy: A Randomized Double Blinded Study. *J Diabetes Sci Technol.* 2017 Jul;11(4):693–701.

4. Mori H, Ohsawa H, Tanaka TH, Taniwaki E, Leisman G, Nishijo K. Effect of massage on blood flow and muscle fatigue following isometric lumbar exercise. *Med Sci Monit*. 2004 May;10(5):CR173--8.
5. Watson SV V. *Practical reflexology: Interpretation and techniques*. Boston: McGraw-Hill; 2009.
6. Chatchawan U, Eungpinichpong W, Plandee P, Yamauchi J. Effects of thai foot massage on balance performance in diabetic patients with peripheral neuropathy: a randomized parallel-controlled trial. *Med Sci Monit Basic Res*. 2015 Apr;21:68–75.
7. Sitjà-Rabert M, Rigau D, Fort Vanmeerghaeghe A, Romero-Rodríguez D, Bonastre Subirana M, Bonfill X. Efficacy of whole body vibration exercise in older people: A systematic review. *Disabil Rehabil*. 2012;34(11):883–93.
8. Pollock RD, Martin FC, Newham DJ. Whole-body vibration in addition to strength and balance exercise for falls-related functional mobility of frail older adults: A single-blind randomized controlled trial. *Clin Rehabil*. 2012 Oct;26(10):915–23.
9. Lee K, Lee S, Song C. Whole-body vibration training improves balance, muscle strength and glycosylated hemoglobin in elderly patients with diabetic neuropathy. *Tohoku J Exp Med*. 2013 Dec;231(4):305–14.
10. Jayaram S, Khobragade A, Langade D. Methylcobalamin , Pyridoxine and Nicotinamide in Diabetic Neuropathy : A Review. *Indian J Clin Pract*. 2009 Jun;20(1):17–21.
11. Valdivia JMV, Weinand M, Maloney CT, Blount AL, Dellon AL. Surgical treatment of superimposed, lower extremity, peripheral nerve entrapments with diabetic and idiopathic neuropathy. *Ann Plast Surg*. 2013 Jun;70(6):675–9.
12. Parsons SL, Mansfield A, Inness EL, Patterson KK. The relationship of plantar cutaneous sensation and standing balance post-stroke. *Top Stroke Rehabil*. 2016 Oct;23(5):326–32.
13. Najafi B, Crews RT, Wrobel JS. A novel plantar stimulation technology for improving protective sensation and postural control in patients with diabetic peripheral neuropathy: A double-blinded, randomized study. *Gerontology*. 2013;59(5):473–80.
14. Khaodhiar L, Niemi JB, Earnest R, Lima C, Harry JD, Veves A. Enhancing Sensation in Diabetic Neuropathic Foot with Mechanical Noise. *Diabetes Care*. 2003 Dec;26(12):3280–3.