

Effectiveness of Multisensory Exercises Versus Focused Exercise Regimen on Dynamic Balance and Balance Confidence in Patients with Type 2 Diabetic Neuropathy- An Experimental Study

Shiwani Nitin Redij (PT)¹, Dr. Radha Bhattad (PT)²

¹Final year MPT, P.E.S. Modern College of Physiotherapy, Pune, 411005

²Professor and Head of department, Neurophysiotherapy, Sancheti College of Physiotherapy, Pune, 411005

Corresponding Author: Dr. Radha Bhattad (PT)

DOI: <https://doi.org/10.52403/ijhsr.20240554>

ABSTRACT

Background & purpose: Progressive deterioration of balance occurs in persons with type 2 diabetic peripheral neuropathy; which affects quality of life. Thus the purpose of this study was to compare the effectiveness of two balance trainings, multisensory training and focused exercise regimen on balance and balance confidence in persons with diabetic neuropathies.

Materials and Methodology: 54 subjects were included as per inclusion, exclusion criteria and randomly allocated in two groups. Group A (n=27) received Multisensory and resistance exercises. Group B (n=27) received focused exercises and resistance exercises. Both the groups received 3sessions/week for 6 weeks. Dynamic balance and confidence was assessed using Berg Balance Scale (BBS), Activity Specific Balance and Confidence scale (ABC). The data was analyzed by using Wilcoxon signed rank test and Mann-Whitney rank sum test were used wherever necessary, to determine significant differences in data among groups and between pre-test and post-test scores ($p<0.05$).

Results: All outcome measures were homogenous at baseline ($p>0.05$). Intragroup & intergroup analysis revealed significant changes in outcome parameters ($p>0.05$) and Group A was better than Group B.

Conclusion: Both the training groups showed clinically significant effect in improving dynamic balance and balance confidence in type 2 diabetic neuropathy participants. But on comparing, Multisensory Exercises are more effective than Focused Exercise Regimen in improving Dynamic Balance and Balance Confidence in patients with Type 2 Diabetic Peripheral Neuropathy.

KEYWORDS: Diabetic peripheral neuropathy, Multisensory Exercises, focused exercise regimen, dynamic balance and balance confidence.

INTRODUCTION

Diabetes mellitus (DM) is a group of metabolic disease characterized by an elevated blood glucose concentration as a result of defects in insulin secretion and/or inability to use insulin. ⁽¹⁾ Long term effects

of DM can cause specific complications like diabetic peripheral neuropathy (DPN), retinopathy, nephropathy and autonomic dysfunctions. ⁽²⁾ DPN, affects a large population an internationally agreed definition of (DPN) is “the presence of

symptoms and/or signs of peripheral nerve dysfunction in people with diabetes after the exclusion of other causes.”^(3,4)

Young MJ et al (1993) in a multicentre study of the prevalence of DPN, found that prevalence of neuropathy increases with increase in age and duration of diabetes.⁽⁴⁾

Clinical signs of DPN include bilateral lower extremity loss of touch, pressure, vibratory, position, and temperature sensory perception and decreased ankle reflexes. These impairments can cause balance affection, instability while walking or standing and lead to falls and functional limitations and loss of independence because activities like walking are critical for the maintenance of independence in a community.⁽⁵⁾

The muscular symptoms include muscle weakness, atrophy, balance problems, abnormal gait.⁽⁶⁾ One possible explanation for these results come from the work of Richardson JK et al (2001) in study of balance in peripheral neuropathy identified that older women with diabetes and peripheral neuropathy have impaired ability to rapidly develop torque at the ankle, which has an impact on balance.⁽⁷⁾

Balance is a complex phenomenon which uses inputs from the proprioceptive systems, visual, vestibular, and exterosensibility, to produce a motor response that allow the transition between dynamic and static activities.⁽⁸⁾ Balance training is utilization and integration of these systems. Hence balance training in diabetics may result in better out comes and improved function.⁽⁹⁾

Multisensory training provides sensory stimulation of the visual, vestibular, and somatosensory systems through exercises that are performed on different types of surfaces, textures and densities.⁽¹⁰⁾ Another balance training, Focused exercise regimen which includes bipedal and unipedal toes and heel raises, inversion, eversion can be used in patients with DPN.⁽¹¹⁾

However, while numerous studies have looked at the effect of “Multisensory Exercises” and “Focused Exercise Regimen” on balance and walking abilities, in elderly and in diabetic neuropathy population, but to

date no work has specifically looked at the effect of which exercise is more beneficial on balance when given with resistance training in patients with type 2 diabetic neuropathy. This provided the focus for the present research.

METHODOLOGY

Study design: This study was primary and prospective, pre test-post test experiment intervention with 2 independent variables, multisensory exercises and focused exercise regimen. The dependent variables were Berg Balance scale (BBS) and Activity Specific Balance and Confidence scale (ABC).

Study settings: Outpatient department of PES Modern College of physiotherapy, Pune; Physiotherapy settings in hospitals and; Old age homes in and around Pune.

Sample size and Study duration: In this study, 54 participants with DPN were recruited by convenience sampling. The study duration period was for 18 months.

Inclusion criteria:

- Participants Diagnosed as Type 2 DPN by physician in the age group of 60-70 years.⁽⁴⁾
- Both males and females.
- Participants with type 2 Diabetes for more than 5 years⁽⁴⁾
- Participants with Neuropathy disability score 3-8.⁽⁴⁾
- Participants with Berg Balance Score between 35-45⁽¹²⁾
- Ability to walk with or without assistance.

Exclusion criterion:

- Participants having musculoskeletal or surgical problems of lower extremity which affect mobility. Eg. fractures, foot ulcers
- Participants with Uncontrolled cardiovascular, respiratory conditions.
- Visual impairment without correction.
- Participants with Cardiac arrhythmias, cardiac pacemakers, Systemic infections and ankle deformities or injuries.

During the study period, both groups continued to receive the usual recommended medical care, which included pharmacological treatment and self-care instructions.

PROCEDURE:

Permission was taken to carry out the research work was obtained from the institutional ethical committee. Participation of subjects was confirmed by obtaining written informed consent from each subject. A Total of 54 participants were recruited based on inclusion and exclusion criteria and were divided into 2 groups. 27 participants were allocated in group A and 27 participants were allocated in group B. All outcome measures were assessed at baseline and after 6 weeks. The therapist stood beside the participant to guarantee physical safety in case of loss of balance.

Group A received multisensory balance exercises⁽¹⁶⁾ and resistance training for 60 minutes, 3 sessions each week for 6 weeks. Warm up (5 min) - Short walks, games with balls using hand and feet.

1. Walking forward, backward, sideways for 10ft on regular floor, soft mattress and foam mattress with eyes opened and eye closed at different speeds. (2 rounds each and increasing 2 rounds every 2 weeks)
2. Obstacle walking
3. Bipedal stance with feet close together (10s)
4. Unipedal stance- Eye open and eyes closed firm surface, Eye open and eyes closed soft surface.
5. Tandem stance (10s), tandem walking for 1 round.
6. Getting up from chair with or without using arm for 10 reps.

Group B received Focused Exercise Regimen⁽¹¹⁾ and resistance training for 60 minutes, 3 sessions each week for 6 weeks. Warm up (5 min)- (open chain active ankle ROM exercises).

1. Bipedal toe raises and heel raises- Participants did these as quickly as

possible, using support as necessary. 1 set of 10 and increased by 1 set every 2 weeks.

2. Bipedal inversion and eversion- In this exercise, participants' center of mass was shifted laterally as participants strengthened ankle invertors and evertors via closed chain exercises. Subjects started with 1 set of 10 and increased by 1 set every 2 weeks.
3. Unipedal toe raises and heel raises- Subjects started with 1 set of 10 and increased by 1 set after every 2 weeks.
4. Unipedal inversion and eversion- Participants inverted and everted the foot while standing on it to challenge balance. Subjects started with 1 set of 10 and increased by 1 set after every 2 weeks.
5. Wall slides- Subjects started with bipedal slides with knee flexion maximum of about 45°. They performed 3 sets of 10. After 6 exercise sessions the first set was performed on each foot.
6. Unipedal balance for time- Three tries on each foot.

Resistance training

7. Lower extremity resistance training was given using weight cuffs to both the groups. Standardized De Lorme and Watkins technique of progressive resistance exercises was used for ankle dorsiflexors and plantar flexors. Knee flexors and extensors.
8. 1 RM was predicted by Brzycki's formula = $\text{weight} \div (1.0278 - (0.0278 \times \text{number of repetitions}))$ ⁽¹⁷⁾

DATA ANALYSIS AND RESULT:

Data analysis was done using Microsoft Excel, WinPepi (Version 11.65) and Primer (Version 7). Normality of the data was checked and appropriate statistical test was applied.

Statistical analysis was done using non parametric tests to compare the descriptive characteristics (age, duration of diabetes, neuropathy disability score and no statistically significant difference was found. The significance level was set at 0.05. The

results of Mann whitney U test with mean showed the homogeneity of two groups (Table1).

Table 1: Analysis of Baseline Characteristics

Variable	Group A (Multisensory exercise)	Group B (Focuses exercise regimen)	Significance (p value)
Age	67.7 ± 3.729	68.3 ± 2.163	0.869
Duration of Diabetes	12.74 ± 5.50	14.04 ± 6.08	0.628
NDS	6.44 ± 1.28	6.96 ± 1.19	0.151

Table 2: Berg Balance scale scores in Group A and Group B before and after the treatment

Outcome measure	Group	Mean	Std. deviation	P value
BBS_Pre	Group A	40.85	2.783	<0.05
	Group B	41.52	2.293	
BBS_Post	Group A	45.3	3.571	<0.05
	Group B	44.78	3.13	

Table 3: ABC scale scores in Group A and Group B before and after the treatment

Outcome measure	Group	Mean	Std. deviation	P value
ABC_Pre	Group A	56.37	6.878	<0.05
	Group B	63.72	7.886	
ABC_Post	Group A	55.03	6.514	<0.05
	Group B	60.09	8.175	

DISCUSSION

Present study has given us the conclusion that Multisensory Exercise with Resistance Training is effective in improving dynamic balance and balance confidence (p value <0.05) in type 2 diabetic neuropathic participants. This can be explained as: there is a close interaction between sensory and motor processes in postural control. Postural movement used depends on availability of sensory information. The three major sensory systems are somatosensory, visual and vestibular.⁽¹⁸⁾ During multisensory exercises the proprioceptive information from the joint receptors pass through the spinocerebellar tracts and reach cerebellum which is a chief controlling organ for balance⁽¹⁹⁾ and the somatosensory input (walking on soft mattress, foam mattress) given will increase the sensitivity of the receptors there by improving the balance. Further by adding alteration in visual and vestibular inputs (eyes open and eyes closed) will make the individual to depend on the somatosensory inputs to control balance. Therefore combining all these will certainly help the individual to improve balance and balance confidence.⁽²⁾

The results of above studies are in accordance with M Kutty et al (2013) who

studied the effect of multisensory exercises on balance and gait and found improvement in balance.⁽²⁰⁾ The results of the study are also in accordance with Misha.P.M et al (2017) who studied the effects of multisensory exercises on physical function and number of falls in subjects with diabetic neuropathy. They found that multisensory exercises showed greater improvement in physical function assessed using lower extremity functional scale and reduction in number of falls assessed using fall efficacy scale.⁽²⁾

Also in current study; the focused exercise regimen was found to be effective in improving dynamic balance and balance confidence (p value <0.05) in type 2 DPN participants. Focused exercise regimen rapidly increases distal muscle strength, ankle torque, recruitment of motor units and improvement in ankle proprioception threshold. Thus Focused exercise regimen may have improved balance and balance confidence.^(22, 23, 24)

Our study is in agreement with Richardson JK et al (2001) who studied the effect of focused exercise regimen on unipedal stance time, functional reach, tandem stance time and activity specific balance and confidence (ABC) scale.⁽²⁵⁾ Our study is also in

conjugation with Raghav D et al (2013) who studied the effect of Focused exercise regimen over strengthening exercises on walking ability, stride length and cadence in patients with diabetic neuropathy.⁽²⁶⁾

Further on comparing multisensory exercises with resistance training and focused exercise regimen with resistance training we found that multisensory exercise is more effective ($p < 0.05$) in improving dynamic balance ($z = 3.38$) and balance confidence ($t = 3.560$) in type 2 DPN patients. Jyoti; Karol et al (2016) have also emphasized the positive effects of balance training exercises on stability trainer, they proposed that, sensory inputs were manipulated by altering the support surface additionally proprioceptive training also augment firing from the cutaneous receptors of the feet and from mechanoreceptors of the muscle during cocontraction produced by the swaying movement. When we stand on unstable surface the stimulus applied to the cutaneous receptors of the sole is keep on changing. This will stop adaptation of the receptors leads to continuous firing and transmission of impulses to higher centres.⁽²⁷⁾

The better improvement in the multisensory group compared to focused exercise regimen group might be due to the fact that, practicing balance training in progressive challenging levels such as foam surface, soft surface described in the study, can enhance somatosensory integration.⁽²⁸⁾⁽²⁹⁾ Foam surface and soft surface increases the external swing which more effectively encourages postural orientation by forcing faster modifications of the sensory system and motor system. Furthermore, it assists in the postural strategy of self-postural control.⁽³⁰⁾ In addition, during the exercise intervention, sensory inputs were manipulated by altering the support surface. These manipulations forced participants to effectively reweigh remaining inputs within the Central Nervous System.⁽²⁹⁾ Thus there was increase in balance and balance confidence.

Further studies are needed which include the effect of intervention on different types of

diabetic neuropathy. Balance and balance confidence can affect the Quality Of Life (QOL) which was not considered during the study. Long term effect of exercises can be taken into account. Effect of intervention on different variables of gait can be assessed.

CONCLUSION

We came to conclusion that both Multisensory Exercises and focused exercise regimen effective in improving balance but on comparing multisensory exercises are more effective than Focused Exercise Regimen in improving Dynamic Balance and Balance Confidence in patients with Type 2 Diabetic Peripheral Neuropathy.

Declaration by Authors

Acknowledgement: The author would like to thank the people who took part in this study. Author wishes to thank the colleagues at the PES Modern college of physiotherapy, Pune for their support and cooperation. Author is enormously indebted to the project guide who generously gave her time to read and guide. Author also wants to thank chief members of old age homes who gave permission to carry out the project. No financial support was received for this study.

REFERENCES

1. Kluwer W. *ACSM's Guidelines for Exercise Testing and Prescription*, 10 ed.: Lippincott Williams and Wilkins; 2017.
2. Pm, M. And Velmurugan, G., Effects Of Multisensory Exercises On Improving Physical Function And Reducing Number Of Falls In Subjects With Diabetic Neuropathy.
3. Boulton, A.J., 2005. Management of diabetic peripheral neuropathy. *Clinical diabetes*, 23(1), pp.9-15.
4. Young, M.J., Boulton, A.J.M., MacLeod, A.F., Williams, D.R.R. and Sonksen, P.H., 1993. A multicentre study of the prevalence of diabetic peripheral neuropathy in the United Kingdom hospital clinic population. *Diabetologia*, 36(2), pp.150-154.
5. Skamagas, M., Breen, T.L. and LeRoith, D., 2008. Update on diabetes mellitus: prevention, treatment, and association with

- oral diseases. *Oral diseases*, 14(2), pp.105-114.
6. Vinik AI, Mehrabyan A. Diabetic neuropathies. *Medical Clinics of North America*. 2004 Jul 1;88(4):947-99.
 7. Richardson JK, Sandman D, Vela S. A focused exercise regimen improves clinical measures of balance in patients with peripheral neuropathy. *Archives of physical medicine and rehabilitation*. 2001 Feb 1;82(2):205-9
 8. Woollacott M, Shumway-Cook A. Attention and the control of posture and gait: a review of an emerging area of research. *Gait & posture*. 2002 Aug 1;16(1):1-4.
 9. Shah C. Research Article Effects Of Sensory Training Over Two Different Surfaces On Balance And Gait In Persons With Diabetic Neuropathy. *International Journal of Recent Scientific Research*. Vol. 7, Issue, 3, pp. 9285-9290, March, 2016
 10. Alfieri FM, Riberto M, Gatz LS, Ribeiro CP, Lopes JA, Battistella LR. Comparison of multisensory and strength training for postural control in the elderly. *Clinical interventions in aging*. 2012;7:119.
 11. Richardson JK, Sandman D, Vela S. A focused exercise regimen improves clinical measures of balance in patients with peripheral neuropathy. *Archives of physical medicine and rehabilitation*. 2001 Feb 1;82(2):205-9
 12. Timar B, Timar R, Gaiță L, Oancea C, Levai C, Lungeanu D. The impact of diabetic neuropathy on balance and on the risk of falls in patients with type 2 diabetes mellitus: a cross-sectional study. *PLoS One*. 2016 Apr 27;11(4):e0154654.
 13. Berg KO, Maki BE, Williams JI, Holliday PJ, Wood-Dauphinee SL. Clinical and laboratory measures of postural balance in an elderly population. *Archives of physical medicine and rehabilitation*. 1992 Nov 1;73(11):1073-80.
 14. Downs S, Marquez J, Chiarelli P. The Berg Balance Scale has high intra-and inter-rater reliability but absolute reliability varies across the scale: a systematic review. *Journal of physiotherapy*. 2013 Jun 1;59(2):93-9.
 15. Powell LE, Myers AM. The activities-specific balance confidence (ABC) scale. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences*. 1995 Jan 1;50(1):M28-34.
 16. Pm M, Velmurugan G. Effects Of Multisensory Exercises On Improving Physical Function And Reducing Number Of Falls In Subjects With Diabetic Neuropathy. September 2017 *International Journal of Medical and Exercise Science* 2017, Vol 3 (3), 367-378.
 17. Abdul-Hameed U, Rangra P, Shareef MY, Hussain ME. Reliability of Irepetition maximum estimation for upper and lower body muscular strength measurement in untrained middle aged type 2 diabetic patients. *Asian journal of sports medicine*. 2012 Dec;3(4):267.
 18. Nashner LM, Shupert CL, Horak FB (1988). Head-trunk movement coordination in the standing posture. *Progress in Brain Research*; 76: 243-251.
 19. Z. Sativani, B. Purwanto, D. N. Utomo, "Effects of balance exercise and somatosensory stimulation on somatosensory response in diabetic peripheral neuropathy." *Proceeding of Surabaya International Health Conference*, 2017, 13-14, 367-374.
 20. Kutty NA, Majida NA. Effects of multisensory training on balance and gait in persons with type 2 diabetes: a randomised controlled trial. *Disability, CBR & Inclusive Development*. 2013 Jul 28;24(2):79-91.
 21. Bishop DL, Milton RL. The effects of denervation location on fiber type mix in self-reinnervated mouse soleus muscles. *Exp Neurol* 1997; 147:151-8.
 22. Behm DG, Sale DG. Intended rather than actual movement velocity determines velocity specific training response. *J Appl Physiol* 1993; 74:359-68.
 23. Vandervoort AA, Sale DG, Moroz J. Comparison of motor unit activation during unilateral and bilateral leg extension. *J Appl Physiol* 1984; 56:46-51.
 24. Brown AB, McCartney N, Sale DG. Positive adaptations to weight-lifting training in the elderly. *J Appl Physiol* 1990;69: 1725-33.
 25. Nashner LM, Shupert CL, Horak FB (1988). Head-trunk movement coordination in the standing posture. *Progress in Brain Research*; 76: 243-251.
 26. Raghav D (2013) 'Efficacy Of Schematic Exercises Overstrengthening Exercises On Walking Abilities, Stride Length And Cadence In Diabetic Neuropathy', *Indian Journal Of Physical Therapy*, 1(2), pp. 24-28.

27. K. Jyoti, J. Gauri, Vinay, "A study of the effect of stability trainer on dynamic balance in distal sensory diabetic neuropathy" JESP vol. 12, no. 1, pp. 94-98, Jan 2016.
28. Gazbare P, Pawan Suraj Prakash Arora, Tushar Palekar. Effect of Tai Chi Exercises on Balance of Type 2 Diabetic Peripheral Neuropathy Patients. *international Journal Of Scientific Research And Education*. May 2017; 5(5): .
29. El-Wishy A, Elsayed E. Effect of proprioceptive training program on balance in patients with diabetic neuropathy: A controlled randomized study. *Bulletin of Faculty of Physical Therapy*. 2012;17(2).
30. Dingwell JB, Cavanagh PR (2001). Increased variability of continuous over ground walking in neuropathic people is only indirectly related to sensory loss. *ScienceDirect, Gait & Posture*, Volume 14, Issue 1, Pages 1-10.

How to cite this article: Shiwani Nitin Redij, Radha Bhattad. Effectiveness of multisensory exercises versus focused exercise regimen on dynamic balance and balance confidence in patients with type 2 diabetic neuropathy- an experimental study. *Int J Health Sci Res*. 2024; 14(5):414-420. DOI: [10.52403/ijhsr.20240554](https://doi.org/10.52403/ijhsr.20240554)
