JHWCR JOURNAL OF HEALTH, WELLNESS AND COMMUNITY RESEARCH 3007-0570

DOI: https://doi.org/10.61919/qfdsdd84

Original Article

Role of Plantar Sensory Training in Reducing Balance Impairment Among Adults with Diabetic Neuropathy

Aaron Anthony John[1], Dr Muhammad Inam[2], Dr Tayyeba Saeed[3], Areesha Khan[4], Lareb Sindhu Ghanghro[5], Fahad Hassan[6], Leenah Irfan[7]

[1] Occupational Therapist, Dar Ul Sukun, Karachi, Pakistan
[2] Professor, MTI Lady Reading Hospital, Peshawar, Pakistan
[3] Assistant Professor, Jinnah University for Women, Karachi, Pakistan
[4] Doctor of Physiotherapy, JPMC, College of Physiotherapy, Karachi, Pakistan
[5] Fourth-Year MBBS Student, Hamdard Medical University, Karachi, Pakistan
[6] Doctor of Physiotherapy, Master of Public Health, Dear Life Rehabilitation Center, Lahore, Pakistan
[7] Doctor of Physical Therapy, Elite College of Management Sciences, Gujranwala, Pakistan

Corresponding author: Aaron Anthony John, ajohn342@gmail.com; Dr Muhammad Inam, dr_mohammadinam@yahoo.co.uk

"Cite this Article" **Received**: 13 November 2025; **Accepted**: 12 February 2026; **Published**: 27 February 2026
Author Contributions: Concept: AAJ, MI; Design: AAJ, MI, TS, AK; Data Collection: AAJ, LSG, FH, LI; Analysis: AAJ, MI, TS, AK; Drafting: AAJ, MI, TS, AK, LSG, FH, LI.
Ethical Approval: Liaquat National Hospital, Karachi, Pakistan. **Informed Consent**: Written informed consent was obtained from all participants; **Conflict of Interest**: The authors declare no conflict of interest. **Funding**: No external funding; **Data Availability**: Available from the corresponding author on reasonable request; **Acknowledgments**: NA

ABSTRACT

Background: Diabetic peripheral neuropathy reduces plantar sensation and contributes to impaired postural control and functional mobility. Sensory-oriented exercises may complement conventional balance rehabilitation by increasing sensory input from the plantar surface. Objective: To compare the effects of targeted plantar sensory training and conventional balance training on balance, postural sway, and functional mobility in adults with diabetic peripheral neuropathy. Methods: This two-group pretest–post-test experimental study included 50 adults recruited from rehabilitation settings in Karachi, Pakistan. Participants received either plantar sensory training or conventional balance training three times weekly for eight weeks. Outcomes were assessed using the Berg Balance Scale, sway area, and Timed Up and Go test. Results: Each group included 25 participants. Berg Balance Scale scores increased from 39.8 ± 4.5 to 49.6 ± 3.8 with plantar sensory training and from 40.1 ± 4.7 to 45.2 ± 4.1 with conventional training. Sway area decreased from 14.7 ± 3.6 to 8.2 ± 2.7 cm^2 and from 14.4 ± 3.8 to 10.9 ± 3.1 cm^2, respectively. Timed Up and Go time decreased from 15.8 ± 2.9 to 11.4 ± 2.2 seconds and from 15.6 ± 3.1 to 13.2 ± 2.5 seconds, respectively. Post-intervention differences favoured plantar sensory training for all outcomes. Conclusion: Plantar sensory training was associated with greater improvements in balance, postural stability, and functional mobility than conventional balance training.
Keywords: Diabetic peripheral neuropathy; Plantar sensory training; Postural balance; Postural sway; Functional mobility; Rehabilitation.

INTRODUCTION

Diabetic peripheral neuropathy is a common chronic complication of diabetes mellitus and is characterized by progressive sensory and motor dysfunction, particularly in the distal lower extremities. Affected individuals frequently experience numbness, paraesthesia, reduced plantar sensation, muscle weakness, and impaired proprioception, all of which can compromise gait and postural control (1–4). These impairments restrict functional mobility and may increase susceptibility to instability and falls during standing, walking, and other activities of daily living.

Sensory information from the plantar surface of the foot contributes substantially to the maintenance of postural stability. Plantar cutaneous receptors continuously detect changes in pressure distribution, surface characteristics, and body position, allowing the central nervous system to generate appropriate postural adjustments. In diabetic peripheral neuropathy, reduced transmission of this sensory information limits the ability to detect changes at the foot–surface interface and may delay compensatory balance responses. Individuals with diabetic peripheral neuropathy consequently demonstrate greater postural sway, reduced walking stability, and poorer balance performance than individuals without neuropathy (5–7).

Conventional rehabilitation for diabetic peripheral neuropathy commonly includes lower-limb strengthening, gait practice, and static and dynamic balance exercises. Such interventions can improve mobility and balance-related performance; however, they may not specifically address the reduction in plantar somatosensory input underlying postural instability (8,9). Sensory-oriented rehabilitation approaches seek to increase the amount and quality of information received from the plantar surface through textured surfaces, pressure-awareness exercises, controlled weight shifting, proprioceptive activities, and targeted plantar stimulation. Previous studies have suggested that balance and sensorimotor training can improve postural control and functional mobility among individuals with diabetic peripheral neuropathy, while plantar stimulation may provide additional sensory cues that assist balance regulation (10–12).

Despite this physiological rationale, evidence remains limited regarding whether a structured plantar sensory training programme provides greater improvement than conventional balance training when the interventions are delivered at a similar frequency and duration. The effectiveness of such training also requires evaluation in routine rehabilitation settings where technologically advanced balance and sensory-retraining equipment may not be readily available. Examining a structured programme based on supervised sensory-awareness and balance activities may therefore provide clinically relevant evidence for the management of balance impairment among adults with diabetic peripheral neuropathy in Pakistan.

This study aimed to compare the effects of targeted plantar sensory training and conventional balance training on balance performance, postural sway, and functional mobility among adults with diabetic peripheral neuropathy in Karachi, Pakistan. It was hypothesized that participants receiving plantar sensory training would demonstrate greater improvements in Berg Balance Scale scores, postural sway area, and Timed Up and Go performance following the eight-week intervention.

MATERIALS AND METHODS

This two-group, pretest–post-test experimental study was conducted in selected physiotherapy and rehabilitation centres in Karachi, Pakistan. The study compared the effects of a targeted plantar sensory training programme with those of conventional balance training among adults with diabetic peripheral neuropathy. Both groups received supervised rehabilitation for eight weeks, with outcome assessments completed before initiation of the intervention and after completion of the training period. The study was conducted in accordance with the ethical principles governing research involving human participants. Approval was obtained from the relevant institutional ethics committee before participant recruitment. Each participant received an explanation of the study purpose, procedures, potential benefits, and possible risks, and provided written informed consent before enrolment.

Male and female adults aged 40–70 years with type 2 diabetes mellitus and a confirmed diagnosis of peripheral neuropathy were recruited from rehabilitation clinics and diabetic care units through purposive sampling. Eligible participants had symptoms consistent with impaired plantar sensory function, including numbness, tingling, reduced foot sensitivity, or diminished awareness of plantar pressure. Participants were also required to be able to stand independently and understand and follow instructions required for the assessments and exercise programme. Individuals were excluded if they had undergone lower-limb surgery; had an active diabetic foot ulcer, severe musculoskeletal impairment, a major cardiovascular condition, severe visual impairment, or a neurological disorder other than diabetic peripheral neuropathy; or had another condition that could independently compromise balance or prevent safe participation in the intervention.

Following eligibility screening, consent, and baseline assessment, participants were allocated to either the plantar sensory training group or the conventional balance training group. The plantar sensory training group attended three supervised sessions per week for eight consecutive weeks. Each session lasted approximately 40–45 minutes and incorporated activities intended to increase plantar sensory input and improve postural control. The programme included stimulation using surfaces with different textures, controlled foot movements, plantar pressure-awareness exercises, multidirectional weight-shifting activities, and balance tasks performed on surfaces of varying sensory and stability characteristics. Exercises were progressively advanced according to each participant's functional ability and tolerance. Emphasis was placed on awareness of foot position and pressure distribution, controlled transfer of body weight, and integration of plantar sensory information during standing and balance-related activities.

Participants in the conventional balance training group received supervised rehabilitation at a frequency and duration comparable to those of the plantar sensory training group. The conventional programme consisted of routine static and dynamic balance exercises, walking practice, and lower-limb strengthening activities commonly used in physiotherapy management. Exercise difficulty was progressed according to participant ability while maintaining safety and correct performance. Both interventions were delivered under physiotherapist supervision, and attendance at the scheduled sessions was recorded throughout the intervention period.

Participant characteristics were documented at baseline using a structured data-collection form. The information collected included age, sex, body mass index, duration of diabetes mellitus, and duration of peripheral neuropathy. Outcome assessments were conducted at baseline and after completion of the eight-week intervention. Functional balance was evaluated using the Berg Balance Scale, with higher scores representing better balance performance. Postural stability was assessed by recording sway area in square centimetres during quiet standing on a stable surface under standardized assessment conditions. Greater sway area represented poorer postural control.

Functional mobility and fall-risk-related performance were assessed using the Timed Up and Go test. Participants were instructed to rise from a chair, walk the marked test distance, turn, return to the chair, and sit down, while the total completion time was recorded in seconds. Longer completion times indicated poorer functional mobility. Plantar sensory function was additionally examined through clinical assessment of foot sensation and awareness of changes in plantar pressure.

All assessments were conducted in a controlled environment by trained researchers using standardized procedures. Participants were provided with adequate rest before and, where necessary, between assessments to minimize the influence of fatigue. Measurements were repeated when required to ensure that the recorded values reflected correct task performance. Attendance, exercise-related difficulties, and adverse events occurring during the intervention sessions were documented.

Data were analysed using statistical software. Continuous variables were summarized as means and standard deviations, while categorical variables were reported as frequencies and percentages. Baseline demographic and clinical characteristics were compared between the intervention groups to describe their initial comparability. Changes in Berg Balance Scale scores, postural sway area, and Timed Up and Go completion times were evaluated from baseline to the end of the eight-week intervention, and differences in outcomes were compared between the plantar sensory training and conventional balance training groups. The reported analysis was based on participants with complete baseline and post-intervention assessments. Statistical tests were two-sided, and a p-value of less than 0.05 was considered statistically significant.

RESULTS

Of the 60 adults assessed for eligibility, 50 completed the baseline and post-intervention assessments and were included in the analysis. The plantar sensory training and conventional balance training groups each comprised 25 participants. The remaining 10 individuals were not included because they did not meet the eligibility criteria or did not complete follow-up.

The baseline demographic and clinical characteristics of the groups are presented in Table 1. The mean age was 58.2 ± 6.4 years in the plantar sensory training group and 57.6 ± 6.8 years in the conventional balance training group. The groups had similar distributions of sex, duration of diabetes, duration of neuropathy, and body mass index at baseline, with no statistically significant differences in the reported comparisons.

Table 1. Baseline Demographic and Clinical Characteristics of the Participants

Characteristic	Plantar Sensory Training Group (n = 25)	Conventional Balance Training Group (n = 25)	p-Value
Age, years	58.2 ± 6.4	57.6 ± 6.8	0.74
Male, n (%)	14 (56.0)	13 (52.0)	0.78
Female, n (%)	11 (44.0)	12 (48.0)	—
Duration of diabetes, years	10.6 ± 3.2	10.1 ± 3.5	0.61
Duration of neuropathy, years	4.8 ± 1.7	4.6 ± 1.9	0.69
Body mass index, kg/m²	27.8 ± 3.1	28.2 ± 3.4	0.65

Data are presented as mean ± standard deviation unless otherwise indicated. The p-values are those reported in the source manuscript. The p-value for sex represents the overall comparison of the binary distribution.

Both groups demonstrated improved balance and functional mobility after eight weeks; however, the magnitude of improvement was consistently greater in the plantar sensory training group. The mean Berg Balance Scale score increased by 9.8 points, from 39.8 ± 4.5 to 49.6 ± 3.8, in the plantar sensory training group. The conventional balance training group demonstrated a 5.1-point increase, from 40.1 ± 4.7 to 45.2 ± 4.1. The resulting between-group difference in mean change was 4.7 points in favour of plantar sensory training.

Postural sway area decreased from 14.7 ± 3.6 cm² to 8.2 ± 2.7 cm² in the plantar sensory training group, representing an absolute reduction of 6.5 cm² and a relative reduction of 44.2%. In the conventional balance training group, sway area decreased from 14.4 ± 3.8 cm² to 10.9 ± 3.1 cm², corresponding to an absolute reduction of 3.5 cm² and a relative reduction of 24.3%. The difference between the group-level changes was −3.0 cm² in favour of plantar sensory training.

Timed Up and Go performance also improved in both groups. Completion time decreased by 4.4 seconds, from 15.8 ± 2.9 seconds to 11.4 ± 2.2 seconds, in the plantar sensory training group. The conventional balance training group demonstrated a 2.4-second reduction, from 15.6 ± 3.1 seconds to 13.2 ± 2.5 seconds. The corresponding between-group difference in mean change was −2.0 seconds.

Table 2. Changes in Balance, Postural Stability, and Functional Mobility After Eight Weeks

Outcome	Plantar Sensory Training Baseline	Plantar Sensory Training Post-Intervention	Change, n (%)	Conventional Training Baseline	Conventional Training Post-Intervention	Change, n (%)	Difference in Change
Berg Balance Scale, points	39.8 ± 4.5	49.6 ± 3.8	+9.8 (+24.6%)	40.1 ± 4.7	45.2 ± 4.1	+5.1 (+12.7%)	+4.7
Sway area, cm²	14.7 ± 3.6	8.2 ± 2.7	−6.5 (−44.2%)	14.4 ± 3.8	10.9 ± 3.1	−3.5 (−24.3%)	−3.0
Timed Up and Go, seconds	15.8 ± 2.9	11.4 ± 2.2	−4.4 (−27.8%)	15.6 ± 3.1	13.2 ± 2.5	−2.4 (−15.4%)	−2.0

Baseline and post-intervention values are presented as mean ± standard deviation. Percentage changes were calculated from the reported group means. Positive change indicates improvement for the Berg Balance Scale, whereas negative change indicates improvement for sway area and Timed Up and Go completion time. Variability estimates for individual change scores were unavailable.

At the post-intervention assessment, the mean Berg Balance Scale score was 4.4 points higher in the plantar sensory training group than in the conventional balance training group. The estimated 95% confidence interval for this difference was 2.15–6.65 points, with a large standardized between-group effect of Hedges g = 1.10. The reported between-group comparison was statistically significant at $p < 0.001$.

The plantar sensory training group also had a mean post-intervention sway area that was 2.7 cm^2 lower than that of the conventional balance training group. The estimated 95% confidence interval ranged from −4.35 to −1.05 cm^2, with Hedges g = −0.91. The reported between-group p-value was 0.002.

Post-intervention Timed Up and Go completion time was 1.8 seconds shorter in the plantar sensory training group. The estimated 95% confidence interval ranged from −3.14 to −0.46 seconds, with Hedges g = −0.75 and a reported p-value of 0.01. Collectively, these results indicate that the plantar sensory training group achieved greater improvements across functional balance, static postural stability, and functional mobility outcomes.

Table 3. Post-Intervention Between-Group Effect Estimates

Outcome	Mean Difference (95% CI)	Hedges g	Reported p-Value
Berg Balance Scale, points	4.40 (2.15 to 6.65)	1.10	<0.001
Sway area, cm^2	−2.70 (−4.35 to −1.05)	−0.91	0.002
Timed Up and Go, seconds	−1.80 (−3.14 to −0.46)	−0.75	0.01

CI, confidence interval. Mean differences, confidence intervals, and Hedges g values were calculated from the reported post-intervention means, standard deviations, and group sizes using independent-group aggregate estimates. Positive values favour plantar sensory training for the Berg Balance Scale; negative values favour plantar sensory training for sway area and Timed Up and Go completion time.

DISCUSSION

This study compared targeted plantar sensory training with conventional balance training among adults with diabetic peripheral neuropathy. Both interventions were associated with improved balance and functional mobility after eight weeks, but the plantar sensory training group demonstrated consistently greater gains. Compared with conventional training, plantar sensory training produced a 4.7-point greater improvement in Berg Balance Scale score, a 3.0 cm^2 greater reduction in sway area, and a 2.0-second greater reduction in Timed Up and Go completion time. The post-intervention comparisons also produced moderate-to-large standardized effects across all three outcomes.

The greater improvement in Berg Balance Scale scores is consistent with evidence that structured balance and sensorimotor exercises can improve functional balance in people with diabetes and peripheral neuropathy. Allet et al. reported improvements in gait, balance, strength, and mobility following a physiotherapy programme combining balance, gait, and function-oriented strengthening exercises (8). Ahmad et al. similarly found that eight weeks of sensorimotor and gait training improved proprioception, nerve function, and lower-limb muscle activation in adults with diabetic peripheral neuropathy (10). A related trial demonstrated improvements in static balance, dynamic balance, centre-of-pressure measures, proprioception, and Timed Up and Go performance following sensorimotor training (13). The present findings extend this evidence by indicating that incorporating focused plantar sensory activities into a supervised balance programme may provide additional benefit over conventional balance exercises alone.

The reduction in postural sway is also clinically relevant because diabetic peripheral neuropathy compromises the somatosensory information required to maintain the centre of mass within the base of support. Individuals with diabetic peripheral neuropathy have demonstrated greater postural instability and altered balance responses compared with individuals without neuropathy (5,7). Plantar electrical stimulation has previously been associated with improved postural balance, plantar sensation, and gait performance, supporting the principle that increasing sensory input from the sole of the foot may influence postural regulation (11). Textured-insole research has also been developed around the premise that manipulation of the plantar sensory environment may modify balance, gait, and foot-sensation outcomes in diabetic peripheral neuropathy (12). The present reduction in sway area is therefore directionally consistent with the proposed role of plantar afferent information in postural control.

Several mechanisms may explain the observed findings. Plantar cutaneous receptors provide information regarding pressure distribution, surface characteristics, and changes in the position of the body relative to the supporting surface. Peripheral neuropathy reduces the reliability of this information and may impair the timing and accuracy of corrective postural responses (3,4). Repeated exposure to textured surfaces, pressure-awareness tasks, controlled foot movements, and multidirectional weight shifting may increase attention to the remaining plantar signals and improve their integration with visual, vestibular, and proprioceptive inputs. Such sensory reweighting is a plausible explanation rather than a directly measured mechanism in the present study, because neural processing, sensory thresholds, and central integration were not objectively evaluated.

The improvement in Timed Up and Go performance suggests that the benefits were not limited to quiet standing. The test integrates sit-to-stand transfer, walking, turning, and controlled sitting and therefore reflects multiple components of functional mobility. The greater reduction in completion time in the plantar sensory training group may have resulted from improved awareness of foot placement, more efficient weight transfer, and increased confidence in transitional movement. Nevertheless, the study did not prospectively measure fall incidence. The Timed Up and Go findings should therefore be interpreted as evidence of improved functional mobility and fall-risk-related performance rather than direct proof that the intervention prevented falls.

The conventional balance training group also showed meaningful improvement. This finding was expected because routine static and dynamic balance exercises, lower-limb strengthening, and walking practice address several motor contributors to instability. Reviews of rehabilitation for peripheral neuropathy have concluded that strength and balance training can improve balance-related outcomes, although intervention content and methodological quality vary substantially among studies (9,14,15). The additional improvement observed in the plantar sensory training group suggests that programmes addressing both motor performance and sensory input may offer greater benefit than programmes directed predominantly towards conventional motor components.

The intervention may have practical clinical value because it used supervised exercises involving textures, plantar pressure awareness, controlled foot movement, and weight shifting rather than a technologically intensive sensory-feedback system. These activities may be incorporated into physiotherapy programmes for adults with diabetic peripheral neuropathy who present with impaired balance. The findings do not, however, establish cost-effectiveness, long-term sustainability, or effectiveness in unsupervised and community settings. Clinical implementation should therefore be accompanied by appropriate foot inspection, safety monitoring, and individual progression according to neuropathy severity and functional capacity.

The study has several strengths, including the use of an active comparison group, comparable intervention duration and frequency, and assessment of complementary functional and postural outcomes. Important limitations must also be considered. The analysis was based on a small sample of 50 participants recruited purposively from rehabilitation settings in one city. The methods available in the manuscript did not adequately document sequence generation, allocation concealment, assessor blinding, or the original group-specific losses to follow-up. Consequently, selection, performance, detection, and attrition biases cannot be excluded. The analysis was limited to participants with complete baseline and follow-up data, and no long-term assessment was performed.

The intervention was multicomponent and included weight shifting and balance tasks in addition to plantar stimulation. Its effects therefore cannot be attributed exclusively to stimulation of plantar receptors. The exact measurement protocol and equipment used to calculate sway area were also insufficiently described. Furthermore, although plantar sensory function, attendance, and adverse events were identified as data-collection elements, corresponding numerical findings were not available for analysis. The absence of an actual falls outcome, an untreated comparison group, and longer-term follow-up further limits conclusions concerning fall prevention and persistence of benefit.

CONCLUSION

An eight-week programme incorporating targeted plantar sensory activities was associated with greater improvements in functional balance, postural sway, and Timed Up and Go performance than conventional balance training among adults with diabetic peripheral neuropathy. These findings support the inclusion of sensory-oriented foot activities as a potential adjunct to conventional rehabilitation; however, larger rigorously designed trials with clearly documented allocation procedures, standardized sensory and postural measurements, prospective fall monitoring, and longer follow-up are required before firm conclusions can be made regarding long-term effectiveness or fall prevention.

REFERENCES

1. Boulton AJM, Vinik AI, Arezzo JC, Bril V, Feldman EL, Freeman R, et al. Diabetic neuropathies: a statement by the American Diabetes Association. Diabetes Care. 2005;28(4):956–962. doi:10.2337/diacare.28.4.956.

2. Tesfaye S, Boulton AJM, Dyck PJ, Freeman R, Horowitz M, Kempler P, et al. Diabetic neuropathies: update on definitions, diagnostic criteria, estimation of severity, and treatments. Diabetes Care. 2010;33(10):2285–2293. doi:10.2337/dc10-1303.

3. Pop-Busui R, Boulton AJM, Feldman EL, Bril V, Freeman R, Malik RA, et al. Diabetic neuropathy: a position statement by the American Diabetes Association. Diabetes Care. 2017;40(1):136–154. doi:10.2337/dc16-2042.

4. Feldman EL, Callaghan BC, Pop-Busui R, Zochodne DW, Wright DE, Bennett DLH, et al. Diabetic neuropathy. Nat Rev Dis Primers. 2019;5(1):41. doi:10.1038/s41572-019-0092-1.

5. Turcot K, Allet L, Golay A, Hoffmeyer P, Armand S. Investigation of standing balance in diabetic patients with and without peripheral neuropathy using accelerometers. Clin Biomech. 2009;24(9):716–721. doi:10.1016/j.clinbiomech.2009.07.003.

6. Richardson JK, Hurvitz EA. Peripheral neuropathy: a true risk factor for falls. J Gerontol A Biol Sci Med Sci. 1995;50A(4):M211–M215. doi:10.1093/gerona/50A.4.M211.

7. Menz HB, Lord SR, St George R, Fitzpatrick RC. Walking stability and sensorimotor function in older people with diabetic peripheral neuropathy. Arch Phys Med Rehabil. 2004;85(2):245–252. doi:10.1016/j.apmr.2003.06.015.

8. Allet L, Armand S, de Bie RA, Golay A, Monnin D, Aminian K, et al. The gait and balance of patients with diabetes can be improved: a randomised controlled trial. Diabetologia. 2010;53(3):458–466. doi:10.1007/s00125-009-1592-4.

9. Tofthagen C, Visovsky C, Berry DL. Strength and balance training for adults with peripheral neuropathy and high risk of fall: current evidence and implications for future research. Oncol Nurs Forum. 2012;39(5):E416–E424. doi:10.1188/12.ONF.E416-E424.

10. Ahmad I, Verma S, Noohu MM, Shareef MY, Hussain ME. Sensorimotor and gait training improves proprioception, nerve function, and muscular activation in patients with diabetic peripheral neuropathy: a randomized control trial. J Musculoskelet Neuronal Interact. 2020;20(2):234–248.

11. 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;11(4):693–701. doi:10.1177/1932296817695338.

12. Hatton AL, Gane EM, Maharaj JN, Burns J, Paton J, Kerr G, et al. Textured shoe insoles to improve balance performance in adults with diabetic peripheral neuropathy: study protocol for a randomised controlled trial. BMJ Open. 2019;9(7):e026240. doi:10.1136/bmjopen-2018-026240.

13. Ahmad I, Noohu MM, Verma S, Singla D, Hussain ME. Effect of sensorimotor training on balance measures and proprioception among middle and older age adults with diabetic peripheral neuropathy. Gait Posture. 2019;74:114–120. doi:10.1016/j.gaitpost.2019.08.018.

14. Mustapa A, Justine M, Mohd Mustafah N, Jamil N, Manaf H. Postural control and gait performance in diabetic peripheral neuropathy: a systematic review. Biomed Res Int. 2016;2016:9305025. doi:10.1155/2016/9305025.

15. Pan X, Bai JJ. Balance training in the intervention of fall risk in elderly with diabetic peripheral neuropathy: a review. Int J Nurs Sci. 2014;1(4):441–445. doi:10.1016/j.ijnss.2014.09.001.