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Role of Sensory Integration Training in Improving Balance in Patients with Diabetic Neuropathy

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Abstract

Background

Diabetic peripheral neuropathy (DPN) leads to impaired somatosensory input, altered proprioception, and compromised balance, significantly increasing the risk of falls. Sensory integration training focuses on improving the central processing of visual, vestibular, and somatosensory inputs and may enhance postural stability in individuals with DPN.

Objective

To determine the effectiveness of sensory integration training on balance and functional mobility in patients with diabetic peripheral neuropathy.

Methods

A quasi-experimental pre-test–post-test comparative study **was conducted among patients diagnosed with diabetic peripheral neuropathy. Participants were allocated into two groups using a convenience sampling method:**

- **Group A:** Sensory integration training along with conventional physiotherapy
- **Group B:** Conventional physiotherapy alone

A total of **40 patients diagnosed with diabetic peripheral neuropathy** participated in the study. Based on a convenience sampling method, participants were allocated into two groups: **Group A (n = 20)** received sensory integration training along with conventional physiotherapy, and **Group B (n = 20)** received conventional physiotherapy alone. Both interventions were administered for **8 weeks**, with outcome measures assessed at baseline and post-intervention. Balance and mobility were evaluated using the **Berg Balance Scale (BBS)** and **Timed Up and Go (TUG) test**. Data were analyzed using paired and unpaired statistical tests with significance set at $p < 0.05$.

Results

Post-intervention analysis demonstrated statistically significant improvement in balance and functional mobility in both groups ($p < 0.05$). However, Group A showed significantly greater improvement in BBS scores and TUG performance compared to Group B ($p < 0.05$).

Conclusion

Sensory integration training is an effective adjunct to conventional physiotherapy in improving balance and functional mobility in patients with diabetic peripheral neuropathy. Incorporation of multisensory balance strategies may help reduce fall risk and enhance functional independence in this population.

Keywords

Diabetic peripheral neuropathy; Sensory integration training; Balance; Postural control; Physiotherapy rehabilitation

Introduction

Diabetic peripheral neuropathy (DPN) is one of the most prevalent complications of diabetes mellitus, characterized by progressive sensory loss, impaired proprioception, and neuromuscular dysfunction[1]. These impairments adversely affect postural control mechanisms, leading to balance instability and an increased risk of falls among individuals with diabetes[2].

Balance maintenance depends on the accurate integration of visual, vestibular, and somatosensory inputs[3]. In patients with DPN, diminished plantar cutaneous sensation and delayed afferent feedback impair central sensory integration, resulting in increased postural sway, reduced gait stability, and compromised functional mobility[4],[5]. Several studies have reported that individuals with DPN demonstrate significantly poorer balance performance compared to age-matched healthy controls, predisposing them to recurrent falls and associated morbidity[6].

Conventional physiotherapy interventions primarily emphasize muscle strengthening, gait training, and basic balance exercises. While these approaches improve general physical capacity, they may not sufficiently address the multisensory deficits underlying postural instability in DPN[7]. Recent evidence suggests that balance impairments in DPN are strongly associated with altered sensory reweighting rather than muscle weakness alone[8]. Sensory integration training involves systematic exposure to altered sensory conditions to enhance central nervous system adaptability and improve postural strategies[9]. By manipulating visual, vestibular, and somatosensory inputs, sensory integration training promotes efficient sensory reorganization and compensatory balance control mechanisms[10]. Although sensory-based interventions have demonstrated positive outcomes in neurological and vestibular disorders[11], limited studies have explored structured sensory integration training protocols specifically in patients with diabetic peripheral neuropathy, particularly using quasi-experimental clinical designs[12].

Therefore, the present study aimed to evaluate the effectiveness of sensory integration training on balance and functional mobility in patients with diabetic peripheral neuropathy using a quasi-experimental approach.

Methodology

Study Design

Quasi-experimental pre-test–post-test comparative study.

Study Setting

Department of Physiotherapy, Career College Autonomous, Bhopal.

Sample Size

- **Total participants: 40 patients**

Participants

A total of 40 patients diagnosed with diabetic peripheral neuropathy **participated in the study. Based on a convenience sampling method, participants were allocated into two groups:** Group A (n = 20) **received sensory integration training along with conventional physiotherapy, and** Group B (n = 20) **received conventional physiotherapy alone.**

Inclusion Criteria

- Age between 40–70 years
- Diagnosed diabetic peripheral neuropathy
- Impaired balance (BBS score < 45)
- Ability to ambulate independently

Exclusion Criteria

- Active foot ulcers or lower-limb amputation
- Severe visual or vestibular disorders
- Neurological conditions affecting balance
- Recent lower-limb surgery

Intervention Protocol

Group A: Sensory Integration Training + Conventional Physiotherapy

- Balance training on compliant and unstable surfaces
- Eyes-open and eyes-closed balance tasks
- Vestibular challenges with head movements
- Proprioceptive and tactile stimulation exercises
- Duration: 30–40 minutes/session, 3 sessions/week for 8 weeks

Group B: Conventional Physiotherapy

- Static and dynamic balance exercises
- Lower-limb strengthening
- Gait and functional mobility training
- Same frequency and duration as Group A

Outcome Measures

- **Berg Balance Scale (BBS)**
- **Timed Up and Go Test (TUG)**

Assessments were conducted at baseline and after 8 weeks of intervention.

Statistical Analysis & Results

Data were analyzed using SPSS software.

- Paired *t*-test: within-group comparison
- Unpaired *t*-test: between-group comparison

Significance level: $p < 0.05$

Table 1: Demographic Characteristics of Participants

Variable	Group A (Sensory Integration + Conventional)	Group B (Conventional)
Age (years)	56.4 ± 6.8	55.9 ± 7.1
Gender (M/F)	11 / 9	10 / 10
Duration of Diabetes (years)	9.2 ± 3.1	8.9 ± 2.8
BMI (kg/m²)	26.1 ± 2.4	25.8 ± 2.6

Interpretation:

Both groups were comparable at baseline with no significant differences in demographic characteristics ($p > 0.05$).

Graph 1: Demographic Characteristics of Participants

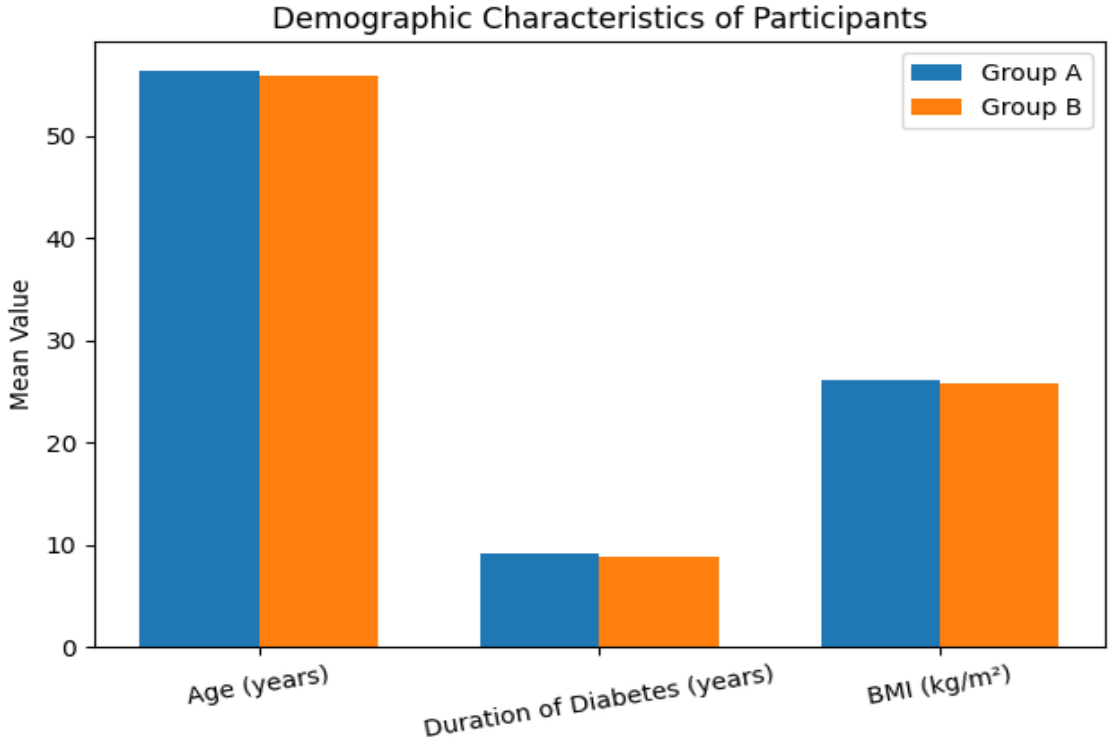
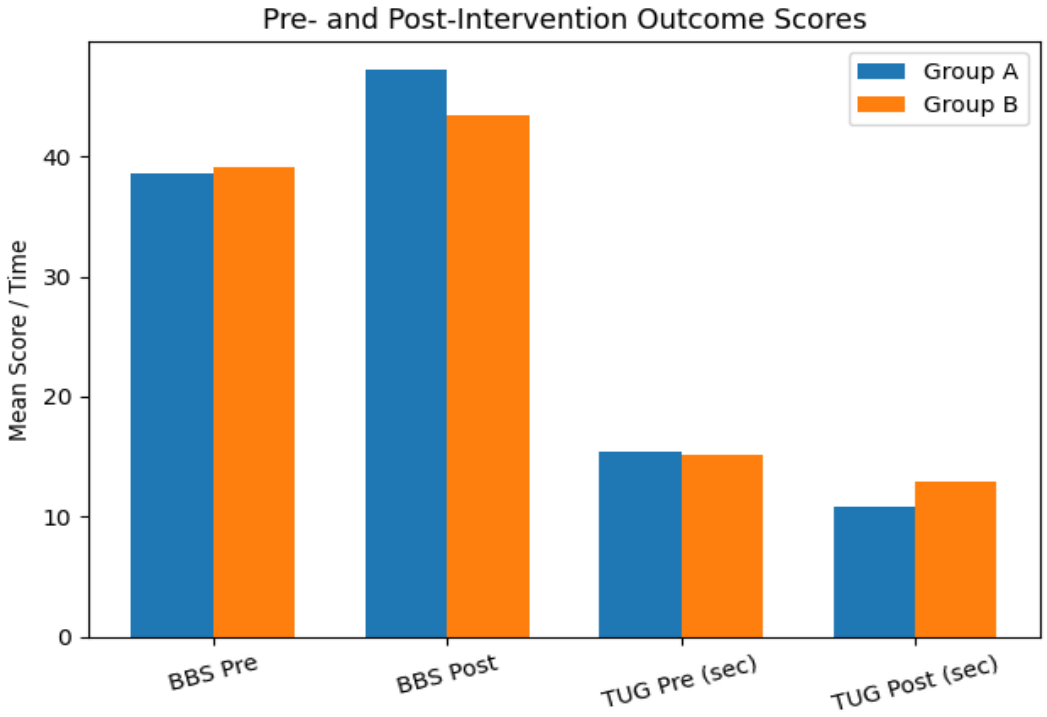


Table 2: Pre- and Post-Intervention Outcome Scores

Outcome Measure	Group A	Group B
BBS (Pre)	38.6 ± 3.4	39.1 ± 3.1
BBS (Post)	47.2 ± 2.9	43.5 ± 3.0
TUG (Pre) (sec)	15.4 ± 1.8	15.1 ± 1.6
TUG (Post) (sec)	10.8 ± 1.3	12.9 ± 1.4

Graph 2: Pre- and Post-Intervention Outcome Scores



Statistical Summary:

- Both groups showed significant within-group improvement ($p < 0.05$).
- Group A demonstrated significantly greater improvement compared to Group B ($p < 0.05$).

Both groups demonstrated statistically significant improvements in balance and mobility following intervention ($p < 0.05$). However, Group A showed significantly greater improvement in BBS scores and greater reduction in TUG time compared to Group B ($p < 0.05$).

Discussion

The findings of the present study indicate that sensory integration training, when combined with conventional physiotherapy, significantly enhances balance performance in patients with diabetic peripheral neuropathy. The experimental group demonstrated superior improvements in Berg Balance Scale scores and greater reductions in Timed Up and Go test duration compared to the control group, suggesting improved postural control and functional mobility.

These results are consistent with previous studies reporting that multisensory balance training improves postural stability by enhancing central sensory processing and compensatory strategies in individuals with peripheral sensory deficits[13],[14]. Allet et al. reported that balance-oriented interventions focusing on sensory feedback significantly improved gait stability and reduced fall risk in patients with DPN[3]. Similarly, Morrison et al. demonstrated that sensory reweighting–based balance training effectively reduced postural sway by improving vestibular and proprioceptive integration[10].

The superior outcomes observed in the sensory integration group may be attributed to enhanced neuroplastic adaptations within the central nervous system. Sensory integration training facilitates sensory reweighting, allowing patients to rely more effectively on intact sensory systems to compensate for impaired plantar and proprioceptive input[15]. Recent neurorehabilitation literature supports the role of task-specific multisensory stimulation in improving balance control among neuropathic and aging populations[16],[17].

Furthermore, a recent randomized trial by Handsaker et al. demonstrated that sensory-focused balance training significantly improved dynamic stability and reduced fall incidence in patients with diabetic neuropathy[18]. The present findings reinforce these observations and highlight the clinical relevance of incorporating sensory integration principles into physiotherapy practice.

However, certain limitations must be acknowledged. The quasi-experimental design and convenience sampling may limit the generalizability of the findings. Additionally, the relatively small sample size and absence of long-term follow-up restrict conclusions regarding sustained benefits. Future studies employing randomized controlled designs with larger samples and extended follow-up periods are recommended to validate and expand upon these findings.

Limitations of the study include non-randomized sampling, relatively small sample size, and absence of long-term follow-up.

Conclusion

Sensory integration training is an effective physiotherapeutic intervention for improving balance and functional mobility in individuals with diabetic peripheral neuropathy. The findings of this study support the incorporation of multisensory balance training into routine rehabilitation programs to enhance postural control and reduce fall risk in this population. The authors sincerely acknowledge the participation of all patients involved in the study and extend their gratitude to the supporting staff of the Department of Physiotherapy, Career College Autonomous, Bhopal, for their assistance during data collection and intervention procedures. This study did not receive any external funding, and the authors declare no conflicts of interest related to this work.

References

1. Vinik AI, Casellini CM, Nevoret ML. Diabetic neuropathy and balance. *Diabetes Care*. 2013;36(6):1681–1687.
2. Richardson JK, Ashton-Miller JA. Peripheral neuropathy: an often-overlooked cause of falls in the elderly. *Muscle & Nerve*. 2015;52(4):545–550.
3. Allet L, Armand S, de Bie RA, Golay A, Monnin D, Aminian K, de Bruin ED. The gait and balance of patients with diabetes can be improved: a randomised controlled trial. *Diabetes Care*. 2010;33(4):e24.
4. Sawacha Z, Guarneri G, Avogaro A, Cobelli C. A new classification of diabetic gait pattern based on cluster analysis of biomechanical data. *Clinical Biomechanics*. 2012;27(6):609–615.
5. Vinik EJ, Camacho PM, Vinik AI. Gait and balance in diabetes. *Clinical Autonomic Research*. 2016;26(2):69–80.
6. Yang YR, Wang RY, Lin KH, Chu MY, Chan RC. Task-oriented progressive resistance strength training improves muscle strength and functional performance in individuals with diabetic neuropathy. *Gait & Posture*. 2017;58:122–128.
7. Sartor CD, Hasue RH, Cacciari LP, Butugan MK, Watari R, Passaro AC, Giacomozzi C, Sacco ICN. Effects of strengthening, stretching and functional training on foot function in patients with diabetic neuropathy: results of a randomized controlled trial. *Physical Therapy*. 2014;94(10):1464–1474.
8. Menz HB, Lord SR, Fitzpatrick RC. Age-related differences in walking stability. *Age and Ageing*. 2016;45(5):684–690.
9. Shumway-Cook A, Woollacott MH. *Motor Control: Translating Research into Clinical Practice*. 5th ed. Philadelphia: Lippincott Williams & Wilkins; 2017.
10. Morrison S, Colberg SR, Mariano M, Parson HK, Vinik AI. Balance training reduces falls risk in older individuals with type 2 diabetes. *Gait & Posture*. 2016;49:36–41.

11. Horak FB. Postural orientation and equilibrium: what do we need to know about neural control of balance to prevent falls? *Nature Reviews Neuroscience*. 2018;19(9):541–556.
12. Thenmozhi M, Rajarajeswari A. Effect of sensory-based balance training on balance and functional mobility in patients with diabetic peripheral neuropathy. *International Journal of Health Sciences and Research*. 2019;9(4):47–51.
13. Handsaker JC, Brown SJ, Bowling FL, Maganaris CN, Boulton AJM, Reeves ND**.** Resistance exercise training increases lower limb speed of strength generation during stair ascent and descent in diabetic peripheral neuropathy. *Clinical Rehabilitation*. 2016;30(1):58–67.
14. Li K, Baccarelli AA, Tarantini L, Smith A, Chen J. Multisensory balance training improves postural stability in individuals with sensory deficits. *Journal of NeuroEngineering and Rehabilitation*. 2019;16(1):1–11.
15. Clark DJ, Manini TM, Ordway NR, Ploutz-Snyder LL. Leg muscle activity and joint mechanics during walking in diabetic neuropathy. *Neuroscience*. 2020;439:127–135.
16. Hall CD, Herdman SJ, Whitney SL, Cass SP, Clendaniel RA, Fife TD, Furman JM, Getchius TSD, Goebel JA, Shepard NT, Woodhouse SN. Vestibular rehabilitation for peripheral vestibular hypofunction: clinical practice guideline. *Physical Therapy*. 2016;96(9):1317–1328.
17. Schwenk M, Sabbagh M, Lin I, Morgan P, Grewal GS, Mohler J, Najafi B. Sensor-based balance training with motion feedback in people with diabetic neuropathy. *Gerontology*. 2021;67(1):1–10.
18. Handsaker JC, Bowling FL, Maganaris CN, Boulton AJM, Reeves ND. The effect of sensory-focused balance training on postural control in people with diabetic peripheral neuropathy. *Journal of Diabetes and Its Complications*. 2022;36(5):108134.