



A Comparative Study Of The Effectiveness Of Task Oriented Training On Activity Specific Balance , Lower Limb Function Between Male And Female Patients With Diabetic Neuropathy

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ABSTRACT :

Introduction - Chronic hyperglycaemia arising from faulty insulin secretion, defective insulin action, or a combination of the two defines diabetes mellitus as a metabolic disease. Underlying mechanisms range from autoimmune loss of pancreatic beta-cells and the resulting insulin shortage to physiological changes that leave the body resistant to insulin's effects.

Method- Fifty-two patients underwent a four-week program of thrice-weekly training sessions. Balance confidence (ABC Scale) and lower-limb function (LEFS) were both recorded before the program began and again once it ended.

Results - Post-intervention scores showed a highly significant gain ($t(25) = -17.18$, $p < 0.001$), demonstrating a meaningful training-related improvement in activity-specific balance.

Conclusion - Significant improvement occurred in both sexes, though female participants gained comparatively more than their male counterparts.

Keywords : Diabetic Neuropathy, Task-Oriented Training, Lower Limb Function, Activity Specific Balance

Main text

Persistently elevated blood glucose is the hallmark of diabetes mellitus, a chronic metabolic condition that develops when insulin secretion fails, insulin action is impaired, or both mechanisms operate together.⁽¹⁾ Its underlying causes range from an autoimmune attack that destroys pancreatic beta-cells and leaves the body short of insulin, to a separate set of physiological changes that make tissues resistant to insulin's effects.⁽¹⁾ Whichever mechanism is at play, the outcome is the same: insulin can no longer act properly on its target tissues, throwing carbohydrate, fat, and protein metabolism out of balance.⁽¹⁾ Clinically, pronounced hyperglycaemia announces itself through excessive urination and thirst, unexplained weight loss, occasional overeating, and blurred vision. (1) Clinicians recognize two broad categories: an insulin-dependent form (Type 1, IDDM) and a non-insulin-dependent form (Type 2, NIDDM). The former, T1DM or autoimmune diabetes, sets in once loss of pancreatic β cells leaves the body unable to produce sufficient insulin, driving blood glucose upward.⁽²⁾ It most often surfaces in childhood or adolescence, though a later onset is not unheard of.⁽²⁾ T2DM, by contrast, develops when tissue resistance to insulin combines with a pancreas that cannot secrete enough insulin to compensate.⁽¹⁾ Insulin insensitivity, a steady decline in insulin output, and eventual beta-cell exhaustion together choke off glucose uptake by the liver, muscles, and fat tissue while accelerating fat breakdown. More recent work has also implicated faulty alpha-cell activity in the disease process.⁽³⁾ Left unchecked over time, diabetes exacts a heavy toll on multiple organ systems: retinopathy threatens eyesight, nephropathy can progress to kidney failure, peripheral neuropathy raises the odds of foot ulcers, amputation, and Charcot joint deformity, and autonomic neuropathy disrupts gastrointestinal, cardiovascular, genitourinary, and sexual function.⁽¹⁾ Neither insulin-dependent (IDDM) nor non-insulin-dependent (NIDDM) diabetes offers protection once the disease has run long enough — both leave patients open to these complications and the morbidity they bring.⁽⁴⁾ At its core, type 2 diabetes reflects tissue that no longer responds adequately to insulin, paired with a pancreas unable to secrete enough of it to compensate (Davidson's Principles and Practice of Medicine, 23rd edition, 2018). Worldwide, this chronic disorder has been growing steadily more common,⁽³⁾ with projections pointing to developing nations — where

most cases cluster among people aged 45 to 64 — as the next frontier of the epidemic.⁽³⁾ Genetics and lifestyle jointly drive this trend,⁽³⁾ with inactivity, sedentary routines, smoking, and heavy drinking singled out as key modifiable risks.⁽³⁾ Management, correspondingly, leans on patient education, dietary and lifestyle change, weight control, exercise, glucose self-monitoring, and pharmacological treatment where needed (Davidson's Principles and Practice of Medicine, 23rd edition, 2018). A prolonged high-glucose state also damages peripheral nerves directly, giving rise to diabetic peripheral neuropathy (DPN) — a microvascular complication of type 2 diabetes diagnosed once other causes of nerve dysfunction have been ruled out.⁽⁵⁾ Of all diabetes-related complications, those stemming from peripheral and autonomic nerve damage are the single most common.⁽⁶⁾ Clinically, this neuropathy falls into somatic forms (polyneuropathy, whether symmetrical or not, and mononeuropathy) and visceral or autonomic forms, the most typical being distal symmetric polyneuropathy,⁽⁶⁾ which classically follows a 'stocking and glove' pattern across the hands and feet.⁽⁶⁾ Its toll is considerable: muscle weakness, numbness, pain, unsteady balance, and diminished lower-limb function chip away at daily function and life satisfaction over time.⁽⁷⁾ Balance itself suffers markedly, with postural sway growing more pronounced once vision is taken out of the equation.⁽⁸⁾ Numbed feet leave patients less able to judge and correct their balance moment to moment, largely because proprioceptive input is compromised.⁽⁸⁾ Faulty movement strategies, structural biomechanical changes, and disorientation compound this instability further.⁽⁸⁾ Beyond these shared mechanisms, sex appears to shape both how severely neuropathy manifests and how well patients respond to treatment. Men typically hold on to more muscle mass and strength, yet more often suffer severe sensory and motor nerve damage and higher rates of foot ulceration; women, conversely, tend to report more intense neuropathic pain, weaker muscles, and poorer function overall, an imbalance that can deepen after menopause as hormonal changes take their own toll on neuromuscular health and balance. Body composition, hormonal profile, pain sensitivity, gait, and activity level likely all play a part in why male and female outcomes diverge during rehabilitation. Task-oriented training has a solid evidence base for improving balance, proprioception, and lower-limb function in this population, yet head-to-head comparisons of how well it works for men versus women remain scarce. Establishing whether sex changes the calculus could steer clinicians toward more individualized, evidence-based programming — and, in turn, toward better functional outcomes, fewer falls, and a better quality of life for patients. Underlying this approach is a view of movement itself as something that emerges from many interacting neural systems, organized toward a goal and constrained by the surrounding environment (Shumway Cook & Woollacott 2001). Task-related training (TRT) puts that view into practice: patients rehearse goal-directed, functional movements in natural settings, gradually building the motor control strategies needed to overcome movement disorders,⁽⁹⁾ with each activity chosen because it is task-specific, self-directed, or goal-driven in nature.⁽⁹⁾ Work in stroke rehabilitation illustrates the payoff — programs pairing task-oriented practice with targeted strengthening of weakened muscles have improved locomotion and weight-bearing through the lower limbs during sitting and standing,⁽⁹⁾ largely by rehearsing gait and gait-related tasks in a functional context.⁽⁹⁾ In practice, such programs draw on treadmill and overground walking, cycling, endurance and circuit work, sit-to-stand drills, and reaching exercises, all aimed at sharpening balance.⁽⁹⁾ Given how much the gait disturbances of diabetic neuropathy (DN) raise the odds of a fall or injury,⁽¹⁰⁾ building this kind of training into rehabilitation could restore the confidence patients need to move through daily life without fearing a fall. Against this backdrop, the present study set out to compare male and female patients with diabetic neuropathy on how much task-oriented training improved their activity-specific balance and lower-limb function, with the aim of clarifying whether sex-specific rehabilitation responses exist and using that evidence to shape more individualized physiotherapy care for diabetic peripheral neuropathy.

MATERIALS & METHODS

Fifty-two patients meeting predefined inclusion and exclusion criteria took part in this four-week trial, attending training sessions three times weekly. Each patient had the study explained to them beforehand and gave written informed consent before enrolment. To track change over time, balance confidence (via the ABC Scale) and lower-limb function (via the LEFS) were both scored once at baseline and again after the four weeks of training had run their course.

Inclusion criteria:

- 1) Aged between 40 and 70 years (Davidson's Principles and Practice of Medicine, 23rd edition, 2018)
- 2) Male or female
- 3) A baseline activity-specific balance score above 60%
- 4) A baseline LEFS score of 50 or higher

Exclusion criteria:

- 1) Any coexisting neurological disorder.
- 2) Any coexisting cardiovascular condition
- 3) A musculoskeletal injury such as a fracture or ligament tear.
- 4) Diabetes that was poorly controlled.
- 5) Motor or sensory deficits traceable to a cause unrelated to diabetes.

6) Enrolment in any other concurrent rehabilitation or exercise program

Task oriented Training Protocol:

Task-oriented activities model on everyday functional tasks formed the backbone of the protocol, delivered in one daily session per patient. Each session ran roughly an hour in total: 10–15 minutes to warm up, 25–30 minutes of active training, and a further 10–15 minutes to cool down. Warming up meant working every major joint through its range of motion first, then stretching the key muscle groups for the remaining 10 to 15 minutes.

Cool Down Exercises - Two minutes of controlled diaphragmatic breathing opened the cool-down, after which patients held gentle static stretches — without bouncing — across the lower-limb muscles most taxed by training: gastrocnemius-soleus, hamstrings, quadriceps, and hip flexors, each for roughly 20–30 seconds. A few minutes of easy active movement followed (ankle pumps and circles, knee bending and straightening, hip motions), and the session wound down with one to two minutes of seated rest and unhurried breathing.

EXERCISES TO IMPROVE BALANCE: Patients began each exercise with support available and progressed toward performing it unsupported as ability allowed.

- a) Lifting the leg and holding it steady
- b) Rising onto the heels
- c) Clearing a foot stool with the leg and returning it to the start position; d) bending the hip and knee to 90° and setting the foot down on a stool
- e) Stepping up onto, and down from, a low step
- f) Kicking a ball back and forth
- g) Narrowing the stance from wide-based to feet-together and finally to tandem.
- h) Walking heel-to-toe in a straight line

Difficulty, complexity, and repetition count were all adjusted on a rolling basis to keep pace with each patient's improving ability, with performance data guiding how many repetitions and how much intensity were prescribed. Intensity was ramped up through one or more of the following changes:

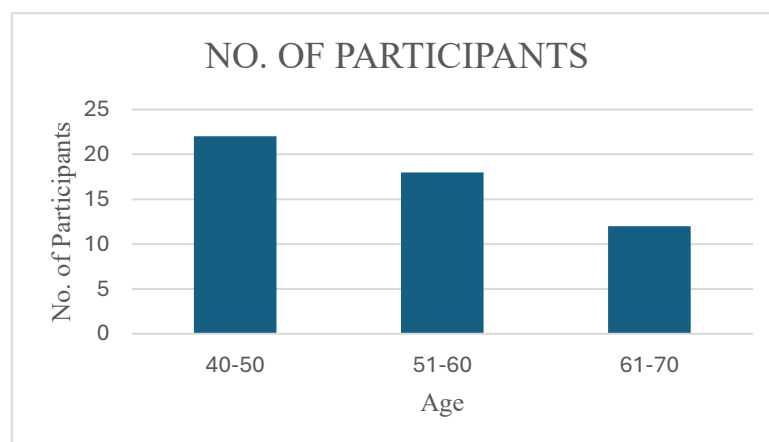
- Tightening the base of support
- Adding repetitions
- Lengthening hold times
- Altering the base of support
- Withdrawing visual feedback

At the end of training, balance was re-scored on the Activities-specific Balance Confidence scale and lower-limb function was re-scored on the Lower Extremity Functional Scale.

RESULT

Diabetic neuropathy was present in all 52 study participants. By age, the 40–50 bracket made up the biggest share (30.6%), with the 51–60 (25.0%) and 61–70 (16.7%) brackets trailing behind.

Graph 1: Representation of Number of participants

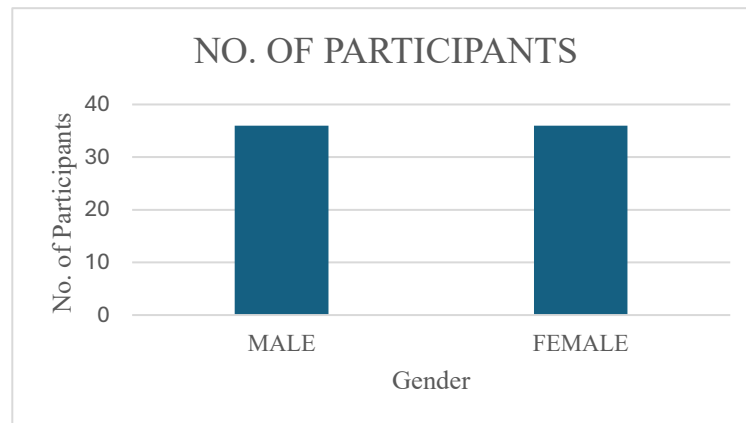


GENDER	NO. OF PARTICIPANTS
MALE	36
FEMALE	36

Table 1 : No. Of Participants

Men and women were represented in equal numbers, 36 apiece (50% each). Within Group A specifically, the 26 male participants with diabetic neuropathy spanned ages 40 to 62, averaging 52.15 ± 6.79 years.

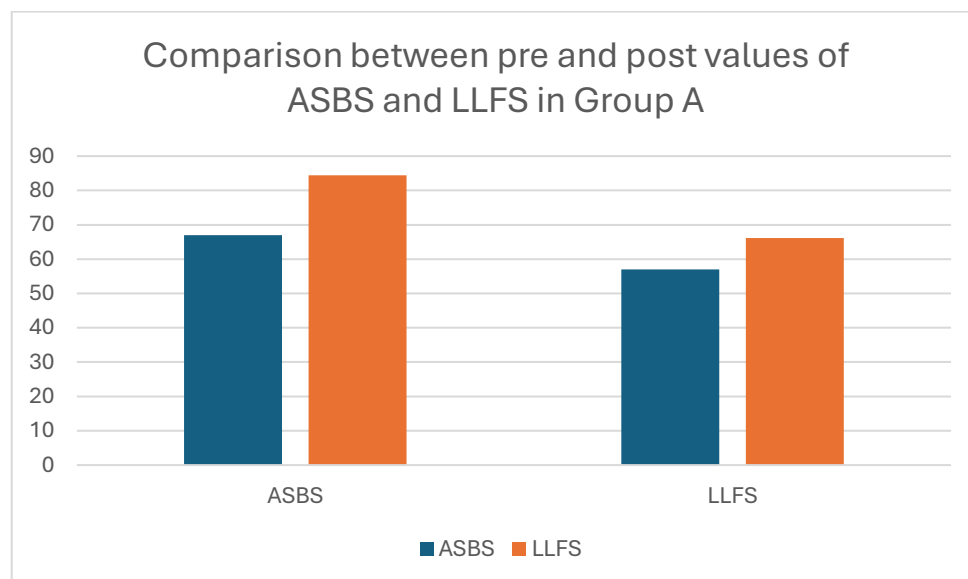
Graph 2: Representation of Gender participated



ASBS scores in Group A climbed markedly over the intervention period, from a pre-treatment average of 66.96 ± 3.80 to 84.38 ± 3.14 afterward — a gain of roughly 17.42 points. Individual post-treatment scores clustered between 78 and 90, suggesting the improvement in activity-specific balance was consistent across the group.

A comparable trend emerged for Lower Limb Functional Scale Scores (LLFSS) in Group A: the pre-treatment average of 56.96 ± 2.93 rose to 66.12 ± 2.34 afterward, a gain of roughly 9.15 points, with post-treatment scores falling between 61 and 70 — a sign that lower-limb function had genuinely improved.

Graph 3: Comparison of Pre and post values of Activity Specific balance scale and Lower limb Functional Scale in Group A

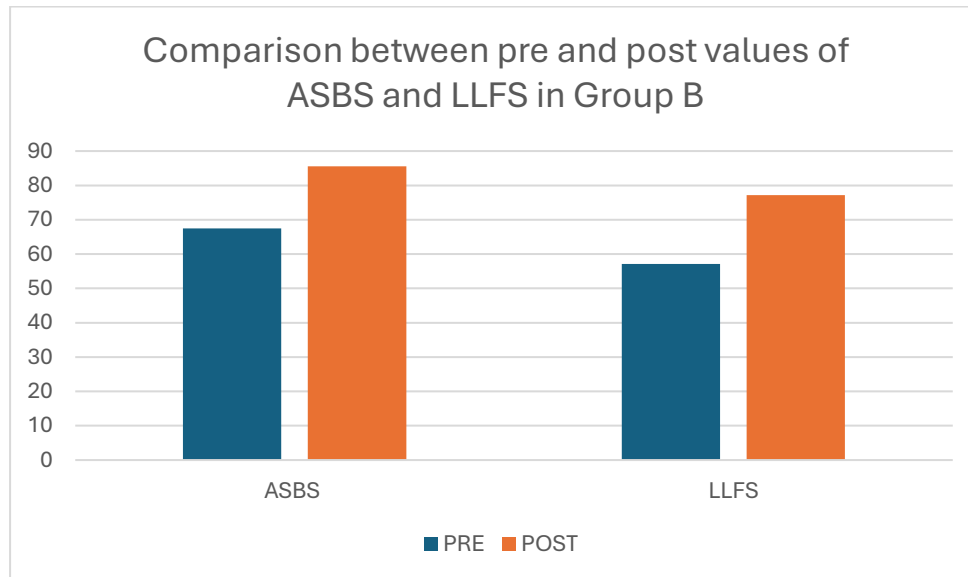


For Group B, pre- versus post-treatment ASBS scores were compared with a paired-samples t-test, which returned a highly significant result ($t(25) = -17.18, p < 0.001$) — clear confirmation of a meaningful gain in activity-specific balance.

LLFSS scores, however, did not follow a normal distribution, so the Wilcoxon signed-rank test took the place of a paired t-test; it, too, pointed to a

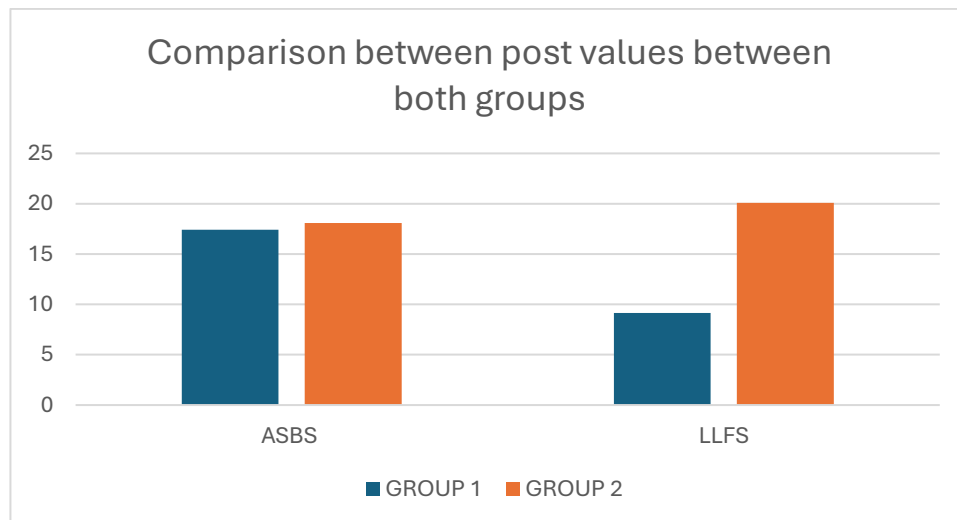
statistically significant post-intervention gain in lower-limb function ($W = 0$, $z = -4.457$, $p < 0.001$). A Hodges–Lehmann estimate placed the median difference at -20 (95% CI: -22.5 to -18) — a substantial pre-to-post improvement in LLFSS.

Graph 4: Comparison of Pre and post values of Activity Specific balance scale and Lower limb Functional Scale in Group B



Independent-samples t-tests were then used to line Group A up against Group B on baseline, post-treatment, and change scores. Neither ASBS ($t(50) = -0.444$, $p = 0.659$) nor LLFSS ($t(50) = -0.160$, $p = 0.873$) differed between groups at baseline, so the two cohorts entered the intervention on comparable footing. That parity largely held after treatment too: post-treatment ASBS scores still showed no significant gap between groups ($t(50) = -0.943$, $p = 0.350$), pointing to similarly effective balance outcomes either way. LLFSS told a different story, though — post-treatment scores diverged significantly ($t(50) = -13.07$, $p < 0.001$), with Group B coming out ahead of Group A on lower-limb function.

Graph 5: Comparison of post values between both groups



DISCUSSION

How well does task-oriented training work for men compared with women coping with diabetic neuropathy? That was the question driving this study, and the four-week intervention gave a fairly clear answer: both sexes improved significantly on balance and lower-limb function, backing task-oriented training as a workable rehabilitation option for diabetic peripheral neuropathy. The two groups tracked closely on the Activity-Specific Balance Scale (ASBS), but not on the Lower Limb Functional Scale (LLFSS) — there, women pulled ahead of men by a significant margin, hinting at a sex-linked difference in how functional recovery unfolds. None of this is surprising given what is already known about task-oriented practice: repeating goal-directed movements is thought to drive motor learning, sharpen neuromuscular coordination, and build the confidence patients need for daily activities, which would explain the mobility gains recorded here. Other work on this population points the same way. Allet and colleagues (2010) linked task-

oriented gait and balance training to better walking, postural control, and balance confidence in diabetic peripheral neuropathy, and Sartor and colleagues (2012) reported that functional exercise focused on balance cut postural sway and lifted functional balance by sharpening proprioceptive input and lower-limb coordination. Repetition is the likely common thread — practicing tasks like stepping, tandem walking, weight shifts, and sit-to-stand transitions hones sensorimotor integration and postural control alike. As for why women in this sample gained more lower-limb function than men, several explanations are plausible: differing baseline neuromuscular status, how closely each sex sticks to a rehabilitation program, and differences in movement strategy or motor adaptation could all play a role. Women, by several accounts, lean more on precise movement and postural control tactics during rehab, while men with diabetic neuropathy more often carry heavier burdens of muscle weakness, proprioceptive loss, and severe sensory deficits — factors that can cap how much function they recover. Few studies have pitted male and female outcomes against each other directly, but this dataset argues that sex deserves a seat at the table when physiotherapy programs are individualized, given the apparent stake it holds in how much function a patient ultimately regains. Balance, unlike lower-limb function, showed no such sex gap — a result that fits with training benefiting balance confidence about equally in men and women. The likely reason is that balance recovery hinges mainly on repeated exposure to postural challenges, which drives sensory reweighting, motor planning, and adaptive postural responses in much the same way for both sexes; that would explain why ASBS scores converged even as LLFSS scores pulled apart. Mechanistically, the field generally credits task-oriented training with promoting cortical reorganization and motor relearning through repeated, meaningful functional practice. Shumway-Cook and Woollacott's account holds that motor performance gains the most when practice is task-specific, goal-directed, and staged to resemble real-life demands; repeating such practice sharpens proprioceptive feedback, muscle activation patterns, dynamic balance, and coordination, which together improve gait efficiency and cut fall risk. Diabetic neuropathy is exactly the setting where these mechanisms matter most, since impaired sensory feedback there is a leading cause of both balance dysfunction and diminished lower-limb performance.

CONCLUSION

Taken together, these results indicate that task-oriented training works as a physiotherapy approach for building activity-specific balance and lower-limb function in people with diabetic neuropathy, with both sexes improving significantly and women edging out men in the size of that improvement.

Declaration by Authors

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