

To Study the Effect of Weight Bearing Exercises in Stroke Patient with Plantar Pressure Disturbance in Affected Limb

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Received: 25th Aug, 2026 | Revised: 1st Sep, 2026 | Accepted: 5th Sep, 2026 | Available Online: 11th Sep, 2026

ABSTRACT

Background: Stroke often causes hemiparesis, which can negatively affect postural stability, create uneven weight distribution, and alter plantar pressure patterns. Individuals frequently place less weight on the involved limb, leading to impaired balance, inefficient gait mechanics, and a greater likelihood of falls. Achieving equal weight distribution is therefore an important objective in neurorehabilitation. Weight-bearing interventions are commonly incorporated to stimulate proprioceptive feedback, promote muscle activation, and support functional improvement. Despite their widespread use, there is still limited objective evidence regarding their influence on plantar pressure distribution when assessed with tools such as a pedobarometer.

Aim of study: To evaluate the impact of weight-bearing exercises on plantar pressure distribution in the affected limb of individuals with Stroke.

Procedure: A pre-post experimental investigation was carried out among individuals with Stroke who demonstrated asymmetrical plantar pressure on the affected side. The participants completed a planned weight-bearing exercise regimen that emphasized gradual limb loading, balance-related tasks, and functional movement activities during the intervention period. Measurements of plantar pressure variables such as peak pressure, contact surface area, and overall weight distribution were recorded with a pedobarometer prior to and following the intervention.

Result: The average plantar pressure recorded on the affected limb rose from $12.88\% \pm 0.64\%$ before treatment to $16.79\% \pm 1.57\%$ after completion of the intervention, suggesting better weight-bearing ability. Although this improvement did not reach statistical significance ($p = 0.226$), the findings demonstrated a favorable tendency toward enhanced plantar pressure distribution after the weight-bearing exercise program.

Conclusion A well-planned weight-bearing exercise regimen enhances plantar pressure distribution and promotes improved weight symmetry in individuals with Stroke. Pedobarometric evaluation provides a dependable and objective method for measuring these alterations. Incorporating targeted weight-bearing interventions into stroke rehabilitation may enhance postural control, functional mobility, and overall recovery.

Key words: Stroke rehabilitation, Weight-bearing exercises, Plantar pressure distribution, Pedobarometer, Hemiparesis, Balance training.

How to cite this article: Miss. Manasi Narendra Shringare¹ Dr. Akanksha Bhat^{2*} Dr. Romita Shah³ Dr. Soniya Lohana⁴. To Study the Effect of Weight Bearing Exercises in Stroke Patient with Plantar Pressure Disturbance in Affected Limb. Int J Drug Deliv Technol. 2026;16(82s):1124-1129. DOI: 10.25258/ijddt.16.82s.124.

INTRODUCTION

Stroke (cerebrovascular accident) is an sudden loss of neurological function caused by an interruption of the blood flow to the brain. Stroke is a diverse condition marked by a neurological impairment of cerebrovascular origin that lasts longer than twenty-four hours. (1)

Strokes are the third most common cause of disability and they can induce a variety of disabilities that impact different bodily systems (1).

Hemiplegia, or the paralysis of muscles on one side of the body opposite the side of the brain where the CVA

occurred, is one way that a stroke might present itself (2)

Stroke-related damage may go away on its own with neurological healing (reversible ischemic neurological deficit), usually in three weeks. Longer than three weeks, residual neurological deficits have the potential to cause reliance and permanent incapacity (2).

NEURO REHABILITATION OF POST STROKE PATIENT

Main goals of stroke patients' rehabilitation. The main objectives of physical therapy care in 70–80% of cases are to retain and recover lost functions while halting further decline in those that still exist¹. (3)

The feet are one of the most important components involved in maintaining bodily equilibrium when standing. The initial and typically only point of contact between the body and the outside world is the foot. The motor system and sensory receptors, which are widely distributed on the foot's plantar surface, are responsible for maintaining proper foot function (3).

The planning of subsequent motor actions follows the transfer of pertinent information to higher cognitive centers via feed-back mechanisms. Walking, changing body positions, and keeping or regaining balance are examples of more complicated motor actions that need the capacity to maintain a free-standing posture with a uniform distribution of weight on both feet (3).

PLANTAR PRESSURE DISTURBANCES IN STROKE PATIENTS:

People who have had a stroke frequently have trouble controlling their posture and balance, and some of them never get back to standing. When people are able to stand again, their balance is usually characterized by unequal lower limb weight distribution and greater sway during calm stance. (4). In stroke survivors, a common finding is a decrease in weight bearing on the paretic side, which has been found to have a negative correlation with both motor function and the ability to regain independence in daily living activities (4).

Following a stroke, postural abnormalities are a major handicap, and many patients never fully regain the capacity to stand erect without interruption. Hemiparetic patients' standing posture is characterized by three primary patterns: a rise in center of gravity displacement, which is indicative of postural instability and orthopedic, sensorimotor, and cognitive impairments; a narrow range of stability beyond which the patient loses equilibrium (either due to a compromised ability to regulate a stressed equilibrium system or to a lack of coordination between posture and movement); and weight bearing asymmetry, where the non-paretic leg bears a greater weight. (5) Complex neuromusculoskeletal factors that can significantly affect balance, mobility, and physical function include muscle weakness, decreased joint range of motion, altered muscle tone, altered foot biomechanics sensory and proprioceptive deficits, movement stiffness and foot issues (6)

One of the top priorities is getting back to being able to walk safely and independently many stroke survivors and is regarded as the main objective of stroke recovery (7). Since the foot determines the interaction between the lower limb and ground, its function is fundamental to how walking is achieved (7). Both supinated (16%) and pronated (13%) foot types were noted in recent attempts to characterize the foot in stroke survivors, indicating asymmetrical foot types (7). On the afflicted side, they also exhibit impairments in foot movement and structure,

including decreased range of motion in most segments and planes, greater pronation, and decreased supination (7).

Weight Bearing: Weight bearing is a frequently used term in physical therapy to characterize the extent to which a lower limb can bear body weight during standing and during the stance phase of walking. Weight bearing in human subjects is dynamic and entails ongoing changes in force and its distribution over the foot.1–6 In healthy individuals, weight bearing on either lower limb during regular standing and walking is similar. Yet, in pathologic conditions affecting one limb, the ability to load the affected lower limb in the same way as the unaffected one is frequently compromised, making stance and gait asymmetrical (8)

Weight bearing exercises: Exercises involving weight bearing enhance general health, balance, coordination, and endurance. At least four times a week, spend at least 30 to 45 minutes weight-bearing to increase bone mass (9)

Because weight-bearing activities stimulate the muscles surrounding the joint to co-contract and increase pressure on the joint to stabilize the articular fovea proprioceptive inputs, they are well recognized to be beneficial for joint stability (10)

People who have had a stroke frequently have trouble controlling their posture and balance, and some of them never get back to standing. When people are able to stand again, their balance is usually characterized by unequal lower limb weight distribution and greater sway during calm stance. (11)

A reduction in weight bearing on the paretic side is a common finding in stroke survivors and it has been negatively related to both motor function and recovery of independence in activities of daily living (11)

One of the main objectives of stroke rehabilitation is to transfer weight from one lower limb to the other and to bear weight on the paretic lower extremity. It has been demonstrated that enhanced performance of numerous functional tasks is correlated with improvements in these limb loading and weight transfer skills. (11).

A contemporary technique called pedobarography makes it possible to evaluate the locomotor system using the distribution of plantar pressure. The technique is helpful in the rehabilitation of many kinds of movement disorders. (12)

To measure foot contact patterns, pedobarography software computes the center-of-pressure trajectory with respect to the foot. (13)

According to the literature, pedobarography is a safe, non-invasive technique that can be used to examine foot biomechanics in relation to the overall musculoskeletal system. understanding a motion abnormality, its likely connection to a systemic illness,

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and tracking the progress of treatment and rehabilitation are all made possible by a pedobarographic examination purpose (12).

METHODOLOGY

An Interventional Quasi experimental study conducted at D.Y. Patil Hospital Kolhapur using Simple random sampling/convenient method on Stroke patients for a duration of 6 months The **Sample size** was 81. Study subjects were selected fulfilling inclusion and exclusion criteria.

Inclusion Criteria

Age 40-75years, patients brunnstrom grade 3 and above, chronic stage stroke (>6months post op) ability to stand independently or with minimal resistance.

Exclusion criteria

Other neurological conditions (parkinson's, multiple sclerosis), severe lower limb Orthopedic conditions (fracture or deformity)

PROCEDURE

Ethical clearance will be obtained from the institution ethical committee.

According to inclusion and exclusion criteria participants will be screened.

The procedure will be explained to the subject.

Prior written consent form from the participants will be obtained.

Pre assessment value will be recorded before study is started.

Considering the inclusion and exclusion criteria subjects will be requested to participate in study. The nature of study will be explained. A brief demographic data including name, age, gender, occupational status as per data collection sheet will be recorded.

The intervention consists of a structured weight-bearing exercise program aimed at improving postural stability and correcting pressure distribution abnormalities in stroke patients. All sessions will be conducted by a trained physiotherapist.

Program Duration and Frequency

Total Duration: 6 weeks

Frequency: 3 sessions per week

Session Duration: 30 to 45 minutes

Session Structure

Each session will be divided into:

Warm-up (5–10 minutes)

Main weight-bearing exercises (25–30 minutes)

Cool-down/stretching (5 minutes)

Warm-up (Examples):

Ankle pumps

Marching in place

Trunk rotations (seated or standing with support)

Gentle arm swings

- Performing weight transfer exercises guided by visual target tracking
- Maintaining stance on unstable surfaces such as a balance disc or wobble board, as tolerated
- Practicing functional walking activities, including carrying light objects during ambulation
- Incorporating obstacle crossing tasks into gait training sessions

➤ Progression Criteria

Advancement of the program will be tailored according to individual patient factor such as :

Ability to maintain midline during tasks

Reduction in compensatory movements

Improved tolerance to unstable surfaces Feedback from pressure mapping systems (if available)

➤ Monitoring and Safety

- All exercises will be performed under supervision.
- Monitoring of vital parameters will be carried out, particularly during the initial sessions.
- Rest periods will be provided whenever required by the participants.
- Appropriate safety measures, including belts or supportive assistance, will be used to minimize the risk of falls.

Weight-Bearing Exercises

The main intervention includes exercises targeting symmetrical pressure distribution, postural alignment, and weight shifting.

Phase 1: Week 1–2 (Basic Control and Static Weight-Bearing)

Supported standing with equal weight-bearing (mirror or therapist feedback)

Weight shifting in standing: Anterior-posterior and lateral shifts

Mini squats (hands supported if needed)

Wall-assisted standing: Maintaining midline posture

Stepping in place while holding parallel bars or wall

Phase 2: Week 3–4 (Dynamic Control and Functional Weight-Bearing)

Side stepping along a wall or parallel bars

Step-ups on a 4–6 inch platform

Sit-to-stand repetitions focusing on equal foot pressure

Standing on foam surface (with supervision)

Tandem standing or narrow base standing

Phase 3: Week 5–6 (Advanced Control and Balance Challenge)

Dual-task standing (e.g., catching a ball while standing)

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Weight shifting with visual target tracking
 Standing on balance disc or wobble board (if tolerated)
 Functional ambulation tasks: Carrying lightweight objects while walking
 Obstacle negotiation during gait training

Progression Criteria

Progression will be individualized based on:
 Ability to maintain midline during tasks
 Reduction in compensatory movements
 Improved tolerance to unstable surfaces
 Feedback from pressure mapping systems (if available)

Monitoring and Safety

All exercises will be performed under supervision.
 Vital signs will be monitored (especially in early sessions).
 Participants will be allowed to rest as needed.

Safety belts or supports will be used as necessary to prevent falls.

RESULTS

AGE OF THE STROKE PATIENTS HAVING PLANTAR PRESSURE DISTURBANCE IN AFFECTED LIMB

	Minimum	Maximum	Mean	Std. Deviation
Age	45.00	88.00	63.70	10.96

A) Table: Age of the stroke patients having plantar pressure disturbance in affected limb

Stroke Participants age with plantar pressure disturbance in affected limb: Descriptive Statistics: . The descriptive statistics of the study participants are displayed in the table. The age of stroke patients with plantar pressure disturbance in the affected limb ranged from **45 to 88 years**, indicating that the study included both middle-aged and elderly individuals. The average age of participants was 63.70 years, indicating that most individuals in the study were older adults, which is consistent with the increased prevalence of Stroke in this age group. The standard deviation of 10.96 years shows a moderate variation in age, suggesting that although many participants were near the mean, there was still a noticeable spread across different age categories. This reflects that the sample was not uniform and included individuals spanning a wide age range.

The age range of 43 years between the minimum and maximum values further highlights this variability. However, since the mean is positioned near the midpoint of the range, the distribution appears

relatively balanced without significant skewness. Overall, the findings show that the study mainly involved older adults, which is clinically important as advancing age is a well-established risk factor for stroke and related issues such as altered plantar pressure distribution

B) THE TABLE SHOWS THAT WEIGHT BEARING EXERCISES SIGNIFICANTLY IMPROVED THE PLANTAR PRESSURE DISTURBANCE IN STROKE PATIENTS .

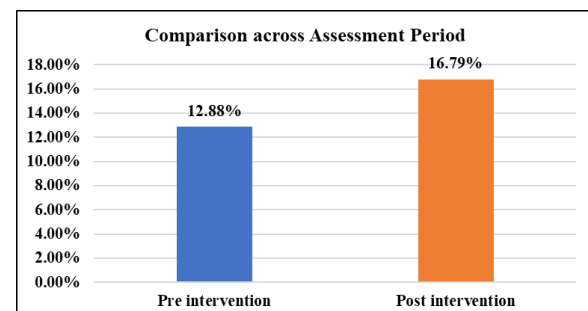
Assessment Period	Mean	Std. Deviation	p-value
Pre intervention	12.88 %	0.64%	0.226
Post intervention	16.79 %	1.57%	

TABLE: The table shows that weight bearing exercises significantly improved the plantar pressure disturbance in stroke patients

The average plantar pressure rose from 12.88% prior to the intervention to 16.79% following it, reflecting an improvement in weight-bearing ability on the affected limb. This indicates that after completing the exercise program, participants were able to place greater load on the involved side.

The **standard deviation** increased from **0.64% in the pre-intervention phase** to **1.57% in the post-intervention phase**, reflecting greater variability in participants' responses after the intervention.

However, the **p-value obtained was 0.226**, which is greater than the conventional level of significance ($p < 0.05$).



GRAPH: PRE AND POST OF PEDOBAROMETER

Graph shows graphical representation of pre and post values of pedobarometer. Pre value of pedobarometer across Assessment Period is 12.88% and After weight

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bearing exercises i.e- Post Value of pedobarometer across Assessment is 16.79%.

DISCUSSION

The study was carried out to examine the impact of weight-bearing exercises on plantar pressure distribution in the affected limb of individuals with stroke. The results demonstrated an increase in mean plantar pressure from the pre-intervention to the post-intervention phase, suggesting improved weight-bearing ability; however, this change was not statistically significant ($p > 0.05$). (14)

Individuals with stroke commonly exhibit uneven weight distribution, decreased weight-bearing on the affected limb, and deficits in balance and gait, leading to altered plantar pressure patterns and reduced functional mobility. (15).

The improvement noted in this study may be due to the effectiveness of weight-bearing exercises in increasing muscle activation, enhancing proprioceptive feedback, and improving neuromuscular control. These exercises promote greater loading of the affected limb, which is important for regaining symmetry and enhancing functional activities such as standing and walking. (16)

Earlier research has shown that closed kinetic chain exercises can markedly enhance plantar pressure distribution by improving weight-bearing on the affected limb and facilitating better postural stability. (14)

In addition, performing repeated weight-bearing exercises provides continuous sensory feedback from the affected limb to the central nervous system. This ongoing afferent input aids cortical reorganization and promotes motor relearning, both of which are essential for recovering balance, improving coordination, and enhancing gait function after Stroke (23).

Although post-intervention improvements were noted, the findings did not achieve statistical significance. This may be due to several contributing factors, such as a small sample size leading to reduced statistical power, a short intervention period that may not have allowed sufficient time for measurable changes to occur, and differences in stroke severity and functional ability among participants.

Such heterogeneity can influence individual responses to treatment. Similar inconsistencies in outcomes have also been documented in earlier studies, where differences in patient characteristics and intervention protocols led to varied responses to rehabilitation. (16) From a clinical perspective, even though the results did not reach statistical significance, the observed improvement in plantar pressure distribution indicates a positive therapeutic trend. This suggests that weight-

bearing exercises may still be valuable in promoting increased loading on the affected limb, which is essential for improving symmetry, balance, and overall functional performance. Therefore, these exercises can play a meaningful role in supporting functional recovery and rehabilitation outcomes in individuals with stroke. (14)

CONCLUSION

Despite these constraints, the findings suggest that including weight-bearing exercises in rehabilitation protocols for individuals with Stroke who present with plantar pressure abnormalities may be beneficial. Such training may help improve neuromuscular control, strengthen proprioceptive input, and facilitate motor relearning, ultimately supporting better functional recovery.

In summary, weight-bearing exercises seem to produce favorable clinical changes in plantar pressure distribution of the affected limb in stroke patients, although statistical significance was not demonstrated. Future studies involving larger participant groups, extended intervention durations, and more rigorous controlled designs are needed to provide stronger evidence and confirm these outcomes.

REFERENCES

1. Rogers A, Morrison SC, Gorst T, Paton J, Freeman J, Marsden J, Cramp MC. Repeatability of plantar pressure assessment during barefoot walking in people with stroke. *Journal of Foot and Ankle Research*. 2020 Dec;13:1-7..
2. Vediappan V, Vadel J, Ram PS, Prashitha VS. Comparison of weight bearing exercises and non-weight bearing exercises versus weight bearing exercises alone to improve the lower limb motor function in stroke patients.
3. De Nunzio A, Zucchella C, Spicciato F, Tortola P, Vecchione C, Pierelli F, Bartolo M. Biofeedback rehabilitation of posture and weightbearing distribution in stroke: a center of foot pressure analysis. *Funct Neurol*. 2014 Apr-Jun;29(2):127-34. PMID: 25306123; PMCID: PMC4198161.
4. Goliwas M, Kocur P, Furmaniuk L, Majchrzycki M, Wiernicka M, Lewandowski J. Effects of sensorimotor foot training on the symmetry of weight distribution on the lower extremities of patients in the chronic phase after stroke. *Journal of Physical Therapy Science*. 2015;27(9):2925-30.
5. Malarvizhi G, Balakrishnan R, Deepika AU, Preetha RK, Monica S, Supriya S. Perception

- of Weight Bearing Distribution during Standing and Its Association with Proprioception in Post Stroke Patients-A Cross Sectional Study.
6. Rogers A, Morrison SC, Gorst T, Paton J, Freeman J, Marsden J, Cramp MC. Repeatability of plantar pressure assessment during barefoot walking in people with stroke. *Journal of Foot and Ankle Research*. 2020 Dec;13:1-7..
 7. Forghany S, Nester C, Tyson S, Preece S, Jones R. Plantar pressure distribution in people with stroke and association with functional mobility. *Journal of Rehabilitation Sciences & Research*. 2019 Jun 1;6(2):80-5
 8. Bohannon RW, Larkin PA. Lower extremity weight bearing under various standing conditions in independently ambulatory patients with hemiparesis. *Phys Ther*. 1985 Sep 1;65(9):1323-5.
 9. Anderson TB, Duong H. Weight Bearing. [Updated 2023 May 1]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-.
 10. Lee, SungEun & Cho, SungHyouun & Kim, Kyoungh. (2013).
 11. The Effects of Weight-Bearing Exercise on Upper Extremity Activities Performance in the Female Stroke Patients. *International Journal of Contents*. 9. 0.5392/JoC.2013.9.1.065.
 12. Lorkowski J, Gawronska K. Pedobarography in Physiotherapy: A Narrative Review on Current Knowledge. *Adv Exp Med Biol*. 2022;1375:13-22. doi: 10.1007/5584_2021_636.
 13. Mudge AJ, Sangeux M, Wojciechowski EA, Louey MG, McKay MJ, Baldwin JN, Dwan LN, Axt MW, Burns J. Can pedobarography predict the occurrence of heel rocker in children with lower limb spasticity? *Clin Biomech (Bristol)*. [Bristol](#)
 14. Lee NK, Son SM, Nam SH. Changes of plantar pressure distributions following open and closed kinetic chain exercise in patients with stroke. *NeuroRehabilitation*. 2013;32(2):385–390.
 15. De Nunzio AM, Nardone A, Picco D, Nilsson J, Schieppati M. Biofeedback rehabilitation of posture and weight-bearing distribution in stroke patients. *Funct Neurol*. 2014;29(2):127–134.
 16. Zhao R, et al. Effects of rehabilitation exercises on gait, balance, and plantar pressure in post-stroke patients. *Brain Sci*. 2022;12(12):1694.