International Journal of Science and Research Archive
eISSN: 2582-8185
Cross Ref DOI: 10.30574/ijsra
Journal homepage: https://ijsra.net/

(REVIEW ARTICLE)

A literature review on effectiveness of treadmill training on gait performance for Parkinson's patients

RATHINA.A [1], NATASHA VERMA [2,*] and AYYAPPAN VALLIKKANNU [3]

[1] *Post Graduate Student, Master of Neurological Physiotherapy, Garden City University, Bengaluru, Karnataka, India.*
[2] *Assistant Professor, Department of Physiotherapy, Garden City University, Bengaluru, Karnataka, India.*
[3] *Family and Support.*

International Journal of Science and Research Archive, 2025, 15(02), 611-619

Publication history: Received on 03 April 2025; revised on 11 May 2025; accepted on 13 May 2025

Article DOI: https://doi.org/10.30574/ijsra.2025.15.2.1423

Abstract

Background: Parkinson's Disease (PD) is characterized by progressive motor impairments, notably gait disturbances. Treadmill training (TT) is a widely discussed rehabilitation strategy for gait enhancement in PD patients, but results across studies vary.

Objective: This review evaluates the efficacy of treadmill training on gait parameters—such as speed, stride length, and postural stability—in PD patients, using a systematic approach.

Methods: A comprehensive search was conducted in databases including PubMed, Scopus, Web of Science, and Google Scholar. Studies included focused on treadmill-based interventions in individuals diagnosed with PD, with outcomes on gait performance. Quality assessments and data extraction followed PRISMA standards.

Results: Ten studies involving sample sizes ranging from 1 to 36 participants were analyzed. The studies demonstrated consistent improvements in gait metrics such as walking speed, stride length, postural stability, and reduction in freezing episodes. Perturbation treadmill training and robot-assisted gait training yielded more substantial improvements for patients with severe impairments or freezing of gait (FOG+).

Conclusion: Treadmill training, especially when integrated with supportive strategies (e.g., BWSTT, rTMS, VR, perturbation), is effective in improving gait in PD patients. High-frequency and progressive-intensity programs offer optimal benefits, and tailored interventions further enhance outcomes.

Keywords: Gait; Postural Stability; Gait Performance; Stride Length; Rehabilitation; Treadmill Training; Parkinson's Disease & Freezing of Gait

1. Introduction

Parkinson's disease, a degenerative brain ailment that impairs mobility and other activities, is becoming more prevalent worldwide. A tiny percentage of cases are genetically based, but other risk factors include family history, constipation, and, surprisingly, not smoking. The diagnosis is based on the presence of either stiffness (rigidity) or tremor, as well as slowness of movement (bradykinesia). The condition manifests a variety of non-motor symptoms in addition to motor problems. The early stages of Parkinson's disease are long and may include mild symptoms. Individualized treatment is necessary, and if a person is disabled, symptom management actions shouldn't be postponed. While there is currently

* Corresponding author: NATASHA VERMA

no cure, there is encouraging research into medicines that reduce or stop the disease's course. Programs for personalized physical therapy can be an effective way to manage Parkinson's disease. (1)

Rehabilitating people with Parkinson's disease involves addressing their gait issues. During the early phases, patients frequently suffer abnormalities in gait rhythm, increased step frequency, longer periods of time in double support, and decreased walking speed and step length. During the course of Parkinson's disease, incapacitating axial symptoms such postural instability and freezing of gait (FOG) appear.

Drugs that target dopamine pathways might often not alleviate these symptoms, which emphasizes the significance of finding alternative approaches to enhance walking. (2)

Characterized by Increasing stiffness, tremors, bradykinesia, and postural instability are the hallmarks of Parkinson's disease, a neurological condition that worsens over time and eventually causes impairment. One of Parkinson's disease's (PD) main and constraining symptoms is impaired gait, which usually includes decreased walking speed, smaller steps, and difficulty walking while performing another task. (3,4)

Research indicates that people who suffer from freezing of gait (FOG+) usually respond to rehabilitation just as people without FOG (FOG−) when exercise is solely focused on improving gait. This is particularly true when using interventions like dual-task gait training and gait training with cues. (5)

In the last ten years, physiotherapy has increasingly focused on treadmill training (TT) as a possible way to improve balance and walking in Parkinson's disease. Although exactly how it works is still being studied, many studies, including a large review of 18 trials, have demonstrated that TT can lead to better walking speed and step length for people with PD. Additionally, research indicates that TT also improves balance while moving and makes walking more consistent. However, because regular treadmill training doesn't always challenge balance in the same way that everyday activities do, adding unexpected perturbations to the training to make it more challenging for posture is seen as a promising way to further enhance walking stability and lower the risk of falls in older adults. (6,7)

Recent large-scale reviews confirm that various exercises help with walking difficulties in Parkinson's, and treadmill training appears especially beneficial. Practicing on a treadmill for several weeks has been shown to increase step length and make steps more uniform, both when walking normally and on the treadmill itself. (8)

This study primarily aims to find out if using a treadmill with 20% body-weight support helps people with Parkinson's walk better compared to using 10% support or no support at all. Secondly, it expects that the 20% body-weight support will also lead to significant improvements in their balance, how much their condition limits their daily activities, their general sense of well-being, and their level of tiredness. To check these ideas, the study will compare the effects of 20%, 10%, and 0% body-weight support during treadmill training on walking ability, balance, quality of life, and fatigue in individuals with Parkinson's disease. (9)

1.1. Need of the study

Gait problems severely affect daily life for Parkinson's patients. Treadmill training is a potential solution, but its effectiveness needs clarity due to varied research findings. This review will synthesize existing studies on treadmill training's impact on gait in PD, providing a clearer understanding for clinicians and future research.

1.2. Objective of the study

This review analyzes current research on how treadmill training improves gait in Parkinson's patients. Specific goals include examining effects on walking speed and stride, understanding how different training approaches work, identifying who benefits most, evaluating study quality, and suggesting future research directions.

2. Materials and methods

- **Search Strategy:** A systematic search will be conducted across relevant electronic databases (e.g., PubMed, Scopus, Web of Science, Google Scholar) using keywords related to "Parkinson's Disease," "gait," "treadmill training," and potentially to identify relevant studies. The search will also consider variations in terminology and indexing.
- **Inclusion Criteria:** Studies will be included if they: (1) involve participants diagnosed with Parkinson's Disease, (2) investigate the effects of treadmill training as a primary or significant intervention, (3) report on

gait performance outcomes (e.g., speed, stride length, balance), and (4) are published in peer-reviewed journals. Studies conducted in South Asian populations or those reporting on cultural or context-specific adaptations of treadmill training will be of particular interest.

- **Exclusion Criteria:** Studies will be excluded if they: (1) focus on other interventions primarily, (2) do not report on gait outcomes, (3) involve participants with atypical parkinsonism, or (4) are not published in English (unless translation resources are available and feasible).
- **Study Selection:** Two independent reviewers will screen titles and abstracts of identified articles based on the inclusion and exclusion criteria. Full-text articles of potentially eligible studies will be retrieved and assessed for final inclusion. Disagreements between reviewers will be resolved through discussion or consultation with a third reviewer.
- **Data Extraction:** A standardized data extraction form will be used to collect relevant information from the included studies, such as study design, participant characteristics (including geographical location if reported), treadmill training protocols (frequency, intensity, duration), control interventions, outcome measures, and key findings related to gait performance.
- **Quality Assessment:** The methodological quality of the included studies will be assessed using a relevant critical appraisal tool (e.g., the Cochrane Risk of Bias tool for RCTs, the Downs and Black checklist for non-randomized studies). This will help evaluate the strength of the evidence base.
- **Data Synthesis:** The extracted data will be synthesized narratively, describing the characteristics of the included studies and their findings regarding the effectiveness of treadmill training on various gait parameters in Parkinson's patients. If sufficient homogenous data are available, a meta-analysis may be considered to provide a quantitative summary of the effects. The synthesis will pay attention to any studies conducted in the target geographical regions or those with culturally adapted interventions.

3. Prisma chart for inclusion of review

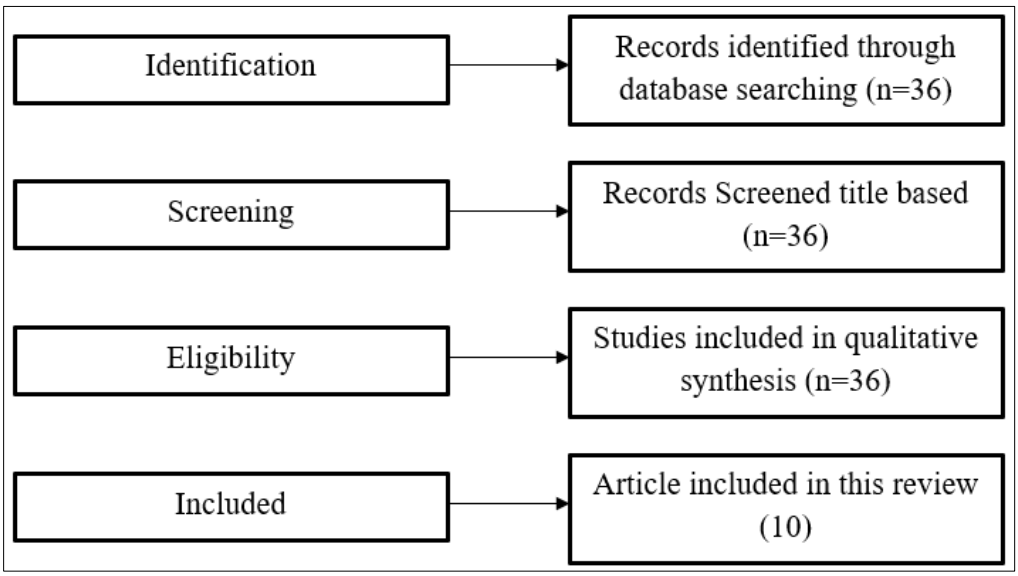

Figure 1 Flow Chart

4. Review of literature

Table 1 Characteristics of articles researched on Supplementation with exercise training among middle age adults with obesity.

Author, Year	Total No. of Samples	Duration of the study	Exercise + Supplementation Intervention	Outcome measures	Significant Findings
Marianna Capecci, Sanaz Pournajaf et.al 2019 (2)	96	4 weeks	Using the end-effector robotic device G-EO system, 20 sessions of RAGT were conducted five days a week for four weeks. The sessions began with 30% to 40% BWS at 1.5 km/h. BWS was gradually reduced up to 20% + 20 sessions (5 days a week for 4 weeks) of TT (Runner EE 720 MTR) while the speed was gradually increased to a maximum of 2.2 to 2.5 km/h. The participants were told to spend forty-five minutes walking on a treadmill. The walking pace was set at 0.8 to 1 km/h at the start of each session and progressively increased to 2.0 km/h.	Unified Parkinson's Disease Rating Scales, Parkinson's Disease Quality of Life Questionnaire, Timed Up and Go test, Freezing of Gait Questionnaire, and 6-minute walk test	Repetitive intensive gait training is an effective treatment for people with Parkinson disease and can increase endurance and gait velocity, especially for those with severe walking disability. Advantages are greater with robot-assisted gait training with treadmill training for individuals with freezing of gait–related disability.
Chloe Lau-Ha Chung et.al,2020 (3)	51	12 weeks	Either low-frequency (1Hz-TT) or high-frequency (25Hz-TT) repetitive transcranial magnetic stimulation (rTMS) was administered to both sides of the brain's motor cortex (M1) region, which regulates the lower leg muscle known as the tibialis anterior. Using a particular kind of magnetic coil (90mm double-cone coil) attached to a magnetic stimulator, this stimulation was given to the participants while they were seated. The rTMS treatment was immediately followed by a half-hour treadmill training session.	Dual-task, Timed up-and-go test (DT-TUG), Motor part of the Movement Disorder Society–Unified Parkinson's Disease Rating Scale	This study explored how stimulating the brain with repetitive Transcranial Magnetic Stimulation (rTMS) before treadmill training could enhance the benefits of the training for individuals with Parkinson's Disease (PD). The findings suggest that both low-frequency (1Hz) and high-frequency (25Hz) rTMS were more effective than a fake treatment (sham) in strengthening the brain's ability to adapt and learn through activity. This resulted in lasting improvements in both their fastest walking speed and their performance on more challenging walking tasks. Therefore, the research highlights the potential of rTMS to boost the effectiveness of treadmill training and provides insights into the brain

					processes that contribute to these improvements.
Margaret sc henchman, charity G.moore et.al,2017 (4)	128	26 weeks	Over the course of 26 weeks, participants were expected to follow the exercise regimen, which included four treadmill workouts per week, with a 5- to 10-minute warm-up, 30 minutes of treadmill exercise at a target heart rate, and a 5- to 10-minute cool-down.	Unified Parkinson's disease rating scale motor score	This study looked at whether it's possible and safe for individuals newly diagnosed with Parkinson's disease to do high-intensity treadmill exercise. The researchers concluded that a larger study is needed to figure out if exercising at a high heart rate (80% to 85% of their maximum) actually leads to significant clinical improvements in this patient group.
Esther M. J. Bekkers, Anat Mirelman et.al,2020 (5)	130	26 weeks	Over a 6-week period, participants exercised three times per week for approximately 45 minutes per session. Eighteen participants engaged in treadmill walking exercises where both gait speed and walking duration were progressively increased. In the first week, the treadmill speed was set at 80% of their over-ground gait velocity, increasing to 90% in the second week, with a planned 10% increase each subsequent week. Walking duration also increased from 20 to 45 minutes throughout the 6 weeks. All participants trained both arms.	Postural stability was assessed with the Mini-BEST test, and the NFOG-Q and TMT-B were also administered.	Despite their increased fall risk, individuals with freezing of gait (FOG) experienced similar improvements in balance and fall risk reduction from treadmill training (with or without virtual reality) as those without FOG. Overall, this preliminary study suggests that both groups have a comparable capacity to benefit from this type of training, and that the benefits tend to diminish similarly after training cessation.
Heiko Gabnera, Simon Steibb et.al,2019 (6)	60	26 weeks	The training protocol involved two 30-minute sessions per week for 8 weeks. Participants walked on a treadmill at a speed ranging from 12 to 15 (unit unspecified). The target perceived exertion during these sessions was ≤5 on a Likert scale of 1 (not difficult) to 7 (extremely difficult).	The Unified Parkinson Disease Rating Scale part-III (UPDRS-III) and the Postural Instability and Gait Difficulty score (PIGD) were used.	An 8-week program of Progressive Treadmill Training (PTT) resulted in greater improvements in motor symptoms, especially gait and postural stability. The lasting effects suggest that PTT could be a valuable additional treatment for gait and balance issues in Parkinson's disease (PD).
Elisa, Laura et.al, 2017 (7)	30	12 weeks	Participants underwent ten 45-minute treadmill training sessions, divided into three groups based on weekly frequency: a low-frequency (LF) group training twice a week, an intermediate-frequency (IF) group	The Timed Up and Go (TUG) test, 10-meter walking test (10M-WT), Berg Balance Scale (BBS),	Middle-aged individuals with obesity experienced improvements in muscle power, exercise capacity, and functional physical performance when combining exercise with a high-protein diet.

			training three times a week, and a high-frequency (HF) group training five times a week.	and Falls Efficacy Scale (FES) were used.	
Elisa Pelosin, Laura Avanzino et.al, 2019 (7)	38	12 weeks	Participants underwent a ten-session Treadmill Training (TT) program, with each session lasting 45 minutes. They were divided into three groups based on weekly frequency: a low-frequency (LF) group training twice a week, an intermediate-frequency (IF) group training three times a week, and a high-frequency (HF) group training five times a week.	The Timed Up and Go (TUG) test, 10-meter walking test (10M-WT), Berg Balance Scale (BBS), and Falls Efficacy Scale (FES) were used.	Treadmill training generally reduced the fear of falling. Analysis of the Falls Efficacy Scale (FES) data showed a significant change over time ($P<0.001$) and a significant interaction between time and the training group ($P=0.017$). Post-hoc analysis indicated a significant decrease in FES scores immediately after training in the low-frequency (LF) group, but no changes in the high-frequency (HF) group.
Simon Steiba, Sarah Klamrothaet.al,2022 (8)	57	6 weeks	Thirty-eight patients with Parkinson's disease (Hoehn & Yahr stages 1–3.5) were randomly assigned to one of two eight-week treadmill training programs, each involving twice-weekly 40-minute sessions. One group (n=18) received perturbation treadmill training (PTT) with added surface perturbations, while the other (n=20) underwent conventional treadmill training (CTT) without these perturbations.	Measures of gait included stride length divided by time (likely representing gait speed or cadence) and the duration of the stance and swing phases of the gait cycle.	Parkinson's disease patients showed significant changes in their walking patterns after the eight-week treadmill training, and some of these improvements were still evident three months later. These results align with prior research suggesting that the brain's ability to adapt remains in individuals with PD. Notably, both training groups experienced the most substantial and consistent improvement in the variability of their step-to-step walking on the treadmill.
Seyed Amir Hasan Habibi1, Babak Zamani1 et.al,2019 (10)	20	12 weeks	The treadmill intervention involved two 30-minute sessions per week for 10 weeks, performed at a moderate intensity of 60% of heart rate reserve (HRR).	Balance, functional capacity, and quality of life (QoL) were assessed using the Timed Up and Go test (TUG), the 6-minute walk test (6MW), and the SF-8 health questionnaire.	The intervention significantly improved balance and functional capacity in the case group. Furthermore, these improvements were sustained, as demonstrated by the significant long-term analysis results.
Mohan Ganesan, Talakad N. et.al, 2015 (11)	60	8 weeks	The study included a Non-Exercising Parkinson's Disease (PD) group, a Conventional Gait Training (CGT) group, and	Assessments included the Ten Meter Walk Test, the Instrumented Two Minute	This study suggests that both Conventional Gait Training (CGT) and Partial Weight Supported Treadmill

			a Partial Weight Supported Treadmill Training (PWSTT) group, where 20% body weight support was utilized in the PWSTT group.	Walk Test, and the Biodex Gait Trainer Manual.	Training (PWSTT) can be beneficial additions to gait rehabilitation for individuals with Parkinson's disease (PD). Furthermore, PWSTT appears to be more effective than CGT in improving both clinical and gait outcomes.

5. Discussion

The findings from this review collectively suggest that treadmill training significantly improves gait performance in Parkinson's patients. A common thread across multiple studies was the improvement in stride length, walking speed, and balance. Particularly noteworthy is the effectiveness of body-weight-supported treadmill training (BWSTT) and perturbation-based treadmill training, which address not only strength and endurance but also dynamic balance and neuromuscular coordination.

Robot-assisted treadmill training showed promise for patients with more severe motor impairments, particularly those experiencing freezing of gait (FOG). Additionally, studies combining treadmill training with neuromodulatory techniques such as repetitive Transcranial Magnetic Stimulation (rTMS) demonstrated neuroplastic effects that support long-term functional gains.

Heterogeneity in training protocols, sample sizes, intervention durations, and outcome measures makes direct comparison challenging. Some studies lacked long-term follow-up to assess the persistence of gains.

This highlights the need for standardized protocols and longitudinal designs in future research. Moreover, considering geographical and cultural adaptations—especially in South Asian contexts—may enhance clinical relevance and applicability.

6. Conclusion

Treadmill training, particularly when enhanced with supportive technologies or protocols, offers a compelling non-pharmacological intervention for improving gait in Parkinson's disease. It supports motor function, mitigates fall risk, and enhances mobility, making it a valuable tool in comprehensive PD rehabilitation programs. Future research should focus on optimizing protocol parameters, integrating technology, and evaluating long-term effects in diverse populations.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] Bloem BR, Okun MS, Klein C. Parkinson's disease. The Lancet. 2021 Jun 12;397(10291):2284-303.

[2] Capecci M, Pournajaf S, Galafate D, Sale P, Le Pera D, Goffredo M, De Pandis MF, Andrenelli E, Pennacchioni M, Ceravolo MG, Franceschini M. Clinical effects of robot-assisted gait training and treadmill training for Parkinson's disease. A randomized controlled trial. Ann Phys Rehabil Med. 2019 Sep;62(5):303-312. doi: 10.1016/j.rehab.2019.06.016. Epub 2019 Aug 1. PMID: 31377382.

[3] Chung CL, Mak MK, Hallett M. Transcranial Magnetic Stimulation Promotes Gait Training in Parkinson Disease. Ann Neurol. 2020 Nov;88(5):933-945. doi: 10.1002/ana.25881. Epub 2020 Sep 8. PMID: 32827221; PMCID: PMC8470277.

[4] Schenkman M, Moore CG, Kohrt WM, Hall DA, Delitto A, Comella CL, Josbeno DA, Christiansen CL, Berman BD, Kluger BM, Melanson EL, Jain S, Robichaud JA, Poon C, Corcos DM. Effect of High-Intensity Treadmill Exercise on Motor Symptoms in Patients With De Novo Parkinson Disease: A Phase 2 Randomized Clinical Trial. JAMA Neurol. 2018 Feb 1;75(2):219-226. doi: 10.1001/jamaneurol.2017.3517. PMID: 29228079; PMCID: PMC5838616.

[5] Bekkers EMJ, Mirelman A, Alcock L, Rochester L, Nieuwhof F, Bloem BR, Pelosin E, Avanzino L, Cereatti A, Della Croce U, Hausdorff JM, Nieuwboer A. Do Patients With Parkinson's Disease With Freezing of Gait Respond Differently Than Those Without to Treadmill Training Augmented by Virtual Reality? Neurorehabil Neural Repair. 2020 May;34(5):440-449. doi: 10.1177/1545968320912756. Epub 2020 Mar 23. PMID: 32202203.

[6] Gaßner H, Steib S, Klamroth S, Pasluosta CF, Adler W, Eskofier BM, Pfeifer K, Winkler J, Klucken J. Perturbation Treadmill Training Improves Clinical Characteristics of Gait and Balance in Parkinson's Disease. J Parkinsons Dis. 2019;9(2):413-426. doi: 10.3233/JPD-181534. PMID: 30958316.

[7] Pelosin E, Avanzino L, Barella R, Bet C, Magioncalda E, Trompetto C, Ruggeri P, Casaleggio M, Abbruzzese G. Treadmill training frequency influences walking improvement in subjects with Parkinson's disease: a randomized pilot study. Eur J Phys Rehabil Med. 2017 Apr;53(2):201-208. doi: 10.23736/S1973-9087.16.04301-X. Epub 2016 Jul 19. PMID: 27434611.

[8] Steib S, Klamroth S, Gaßner H, Pasluosta C, Eskofier B, Winkler J, Klucken J, Pfeifer K. Exploring gait adaptations to perturbed and conventional treadmill training in Parkinson's disease: Time-course, sustainability, and transfer. Hum Mov Sci. 2019 Apr;64:123-132. doi: 10.1016/j.humov.2019.01.007. Epub 2019 Feb 1. PMID: 30711905.

[9] Atan T, Özyemişci Taşkıran Ö, Bora Tokçaer A, Kaymak Karataş G, Karakuş Çalışkan A, Karaoğlan B. Effects of different percentages of body weight-supported treadmill training in Parkinson's disease: a double-blind randomized controlled trial. Turk J Med Sci. 2019 Aug 8;49(4):999-1007. doi: 10.3906/sag-1812-57. PMID: 31292107; PMCID: PMC7018238.

[10] Arfa-Fatollahkhani P, Safar Cherati A, Habibi SAH, Shahidi GA, Sohrabi A, Zamani B. Effects of treadmill training on the balance, functional capacity and quality of life in Parkinson's disease: A randomized clinical trial. J Complement Integr Med. 2019 Aug 21;17(1):/j/jcim.2019.17.issue-1/jcim-2018-0245/jcim-2018-0245.xml. doi: 10.1515/jcim-2018-0245. PMID: 31433785.

[11] Ganesan M, Sathyaprabha TN, Pal PK, Gupta A. Partial Body Weight-Supported Treadmill Training in Patients With Parkinson Disease: Impact on Gait and Clinical Manifestation. Arch Phys Med Rehabil. 2015 Sep;96(9):1557-65. doi: 10.1016/j.apmr.2015.05.007. Epub 2015 May 23. PMID: 26008873.