REVIEW ARTICLE

Evidence Synthesis on Gait and Balance Training: Meta-Analysis of Physical Therapy Intervention in Parkinson's Patients

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Abstract

Background: Parkinson Disease is considered to be posing a significant impact worldwide. According to the Global Burden of Disease study (GBD), there has been 1.02 million incident cases recorded in 2017 and 6.1 million cases worldwide in 2016. Between 1990 and 2016, the standardized rate of age among Parkinson's disease prevalence rose by 21.7%.

Methods: Studies examining the effects of physiotherapy on balance, gait and other pertinent outcomes among individuals with PD undergoing rehabilitation program were included in the inclusion criteria. Studies performed between 2015 and 2023 were taken into account for inclusion. Studies conducted in languages other than English, or those that did not have readily available open access or for which open access could not receive after contacting corresponding authors were all excluded.

Results: The risk of bias assessment was performed based on the guidelines of SYRCLE. The author- The findings of this meta-analysis examining the effectiveness of rehabilitation on balance across different trials. Results of fixed-effects model analysis indicated that physical therapy showed a statistically significant favorable influence on balance among individuals with Parkinson's disease, with an overall affect size (Standardized Mean Difference, SMD) of 0.511 (95% CI: 0.255 to 0.766). A somewhat greater impact size of 0.654 (95% CI: 0.0441 to 1.264) was seen in the model of the random-effects. Noticeable heterogeneity was detected in the test ($Q = 32.8633$, $DF = 6$, $p < 0.0001$), indicating a highest degree of variability among included studies.

Conclusion: In conclusion, a thorough meta-analysis of research on the influence of physical therapy treatments on gait, balance among people with Parkinson's disease found positive findings.

Keywords
Gait, Risk of Fall, Parkinson Disease, Postural Balance.

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Introduction

The most common neurological motor disorder i.e. Parkinson's is outlined by bradykinesia/akinesia, postural instability, stiffness, and tremor[1]. Beyond these, PD manifests various motor and non-motor signs, adding to the clinical complexity of the condition. According to the Global Burden of Disease (GBD) research, PD has a significant impact, with 1.02 million incident cases recorded in 2017 and 6.1 million cases worldwide in 2016[2]. Between 1990 and 2016, the age-standardized rate of Parkinson's disease prevalence rose by 21.7%[2-3]. Years being lived with disability (YLDs), measuring the index of the typical time from incident cases to recovery or death showed a noteworthy increase of 8.9% between 1990 and 2007 and then 1.0% between 2007 and 2017[4]. Based on projections, there will be a substantial future burden, with 4.94 million PD sufferers globally. This increasing incidence presents significant obstacles to society, people, and healthcare systems; they include negative effects on healthcare-related quality of life and high costs connected with drug treatment, rehabilitation, and caregiving[5].

Notwithstanding these developments, the social and health systems of many nations are unable to handle the problems brought on by the rising incidence of Parkinson's disease (PD) as the population ages[5-6]. Approximately 80% of people with neurological illnesses experience problems related to their gait and balance. These deficiencies provide important obstacles in neurological diseases. These deficits, especially in Parkinson's disease (PD), can majorly impact negatively on (Quality of Life) QoL, raising the chance of falling, thus lowering general well-being[7-8]. The contextual specificity required for real-world circumstances is absent from traditional rehabilitation, predominantly in clinical settings. Interventions based on physical therapy (PT) are essential for treating balance and walking pattern abnormalities in Parkinson's disease (PD) patients. They significantly enhance their functional results and general quality of life[9-10].

Notwithstanding the acknowledged effectiveness of physical therapy therapies, a thorough comprehension of their combined influence on gait and balance in individuals with Parkinson's disease is still to be determined[11-12]. Having the necessity for a more comprehensive investigation, the current study intends to fill this significant gap by conducting a meta-analysis. Identifying the overall impact of PT-based therapies on gait and balance among subjects with Parkinson's disease (PD) involves a comprehensive literature review and synthesis of pertinent data. This meta-analysis aims to contribute to the continuous improvement of evidence-based practices in neurorehabilitation by shedding light on the combined effects of various PT techniques. By doing so, it could be possible to optimize rehabilitation protocols for improved results in managing Parkinson's disease.

Materials and Methods

Electronic Database and Searching Strategies

Following databases were methodically searched by two separate reviewers: Google Scholar, PEDro, MEDLINE, Cochrane Library, EMBASE, and Web of Science. MeSH phrases that used included "Parkinson's disease, balance, gait, physical therapy, and rehabilitation." The objective was to identify research investigating physical therapy treatments affected gait and balance in Parkinson's disease patients. Search had been conducted in agreement with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) standards, & the timeframe covered was 2015–2023 (Figure-1).

Inclusion and Exclusion Criteria

Studies examining the effects and other pertinent outcomes in individuals with Parkinson's disease undergoing rehabilitation program were included in the inclusion criteria. Studies performed between 2015 and 2023 were taken into account for inclusion. Studies conducted in languages other than English, or those that did not have readily available open access or for which open access could not receive after contacting corresponding authors were all excluded. To get relevant data, a structured data extraction form was utilized, which included fields for author names, publication year, targeted population and intervention strategies used for treatment (Table-1).

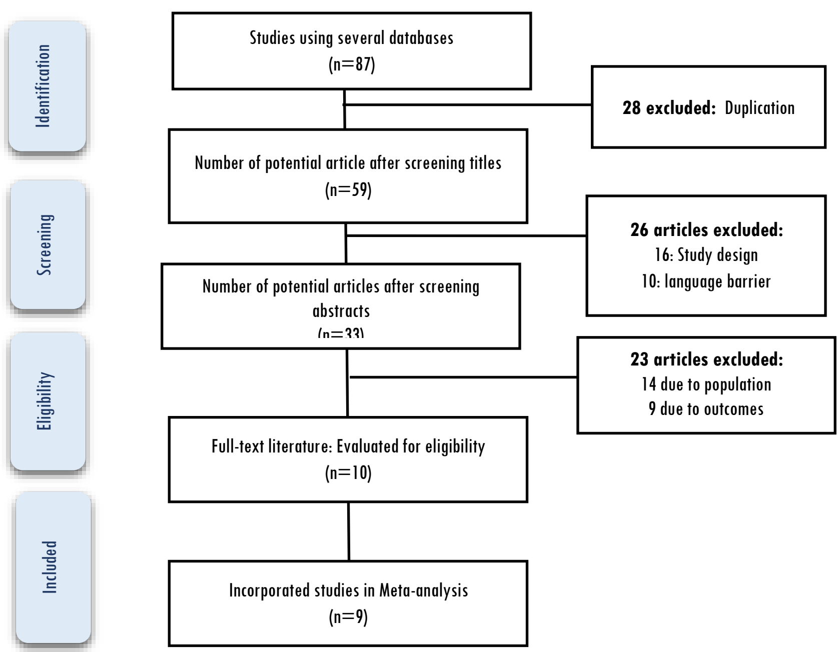

Figure-1 Flow of Studies

Table-1 Description: Studies incorporated for the purpose of Meta-Analysis							
Author & Publication Year	**Sample Size**	**Target Population**	**Study Design**	**Age in Years**	**Intervention**		**Outcome**
					Intervention Group	**Control Group**	
de Faria, 2023[15]	EG=10 CG=12	PD Patients	RCT	60-65 years	Pilate Training	Conventional multicomponent training	Gait
Kawashima, 2022[16]	EG=7 CG=8	Idiopathic PD Patients	RCT	75 years	Gait Training with SMA	Gait Training without SMA	Balance and Gait
Kim, 2022[17]	EG=22 CG=22	PD Patients	RCT	>18 years	Gait Training	Treadmill Training	Balance and Gait
Li, 2022[18]	EG=14 CG=18	PD Patients	RCT	40-85 years	Conventional exercises and music	Conventional exercises	Balance
Liu, 2022[19]	EG=14 CG=14	PD subjects	RCT	50-85 years	Balance Training	Control Group	Balance
Gaßner, 2022[20]	EG=51 CG=49	PD Patients	RCT	30-90 years	Physiotherapy	Treadmill	Gait
Kashif, 2022[21]	EG=20 CG=21	PD Patients	RCT	50-80 years	VR based rehabilitation	Routine treatment	Balance
Chen, 2021[22]	EG=23 CG=25	Parkinson Disease Patients	RCT	50-75 years	Resistance Taining	Stretching Exercise	Balance and Gait
Cabrera-Martos, 2020[23]	EG=22 CG=22	Parkinson Disease Patients	RCT	>30 years	Core Stability	Control Group	Balance

EG denotes Experimental group performed interval training exercises
CG denotes Control Group performed continuous exercises or no exercises

Assessment of Risk of Bias

The Cochran tool parameters had been employed in order to evaluate the possibility of biasness in included studies. The assessment took into account the possibility of allocation bias, taking into account elements like randomization and concealment[13]. The evaluation also included selective reporting, data completeness, blinding techniques for both participant and outcome assessors based on author's judgment.

Quantitative Analyses

Quantitative analysis using MedCalc Statistical Software version 20.112, and the pooled effect was calculated using SMD with a 95% confidence interval (CI). Cohen's rule of thumb was used to estimate the effect size and categories it as minor (0.2 to 0.5), moderate (0.5 to 0.8), or large (> 0.8). The I^2 value was utilized to evaluate heterogeneity and inform the selection of a fixed effect model ($I^2 < 50$) or a random effect model ($I^2 > 50$)[14].

Results

Flow of Study

Initially, six database searches retrieved a total of 87 studies. After the title screening process, 59 articles were left for additional assessment. Thirty-three papers had been found to be eligible full-text evaluation following the screening of abstracts. Finally, nine papers completed the predetermined inclusion criteria incorporated into analysis. Across these nine investigations, 374 patients made up the sample size. The research was centered on assessing the way various physical therapy-based therapies affected the gait and balance of individuals with Parkinson's disease.

Estimating the Pool Effects of Physical Therapy Based Interventions on Balance

The findings of an analysis examining the effectiveness of physical therapy on balance across different trials. Results of fixed-effects model analysis reports physical therapy had a statistically significant favorable influence, with an overall effect size (Standardized Mean Difference, SMD) of 0.511 (95% CI: 0.255 to 0.766). A somewhat greater impact size of 0.654 (95% CI: 0.0441 to 1.264) was seen in the random-effects model. Significant heterogeneity was detected in the test ($Q = 32.8633$, $DF = 6$, $p < 0.0001$), indicating a high degree of variability among the included studies. With a computed inconsistency (I^2) of 81.74%, there was a significant degree of heterogeneity. Although there was a great deal of variation throughout the included trials, the results show that physical therapy had a significant favorable impact on the parameters (Table-3, Figure-2).

Table-3 Pool effects model illustrating the effects of intervention on balance

Study	N1	N2	Total	SMD	SE	95% CI	t	P	Weight (%)	
									Fixed	Random
Kashif, 2022	20	21	41	2.90	0.44	2.01 to 3.80			8.54	13.04
Chen, 2021	23	25	48	0.21	0.28	-0.36 to 0.78			20.7	15.48
Liu, 2022	14	14	28	0.31	0.36	-0.44 to 1.07			12.32	14.22
Li, 2022	14	18	32	0.14	0.34	-0.57 to 0.85			13.90	14.55
Kim, 2022	22	22	44	0.26	0.29	-0.33 to 0.86			19.01	15.30
Kawashima, 2022	7	8	15	0.70	0.504	-0.38to 1.78			6.63	12.11
Cabrera-Martos, 2020	22	22	44	0.33	0.29	-0.26 to 0.93			18.90	15.29

Total (fixed effects)	122	130	252	0.511	0.130	0.25 to 0.76	3.93	<0.001	100.0	100.00
Total (random effects)	122	130	252	0.654	0.310	0.041 to 1.26	2.11	0.036	100.0	100.00

Test for heterogeneity	
Q	32.8633
DF	6
Significance level	P < 0.0001
I^2 (inconsistency)	81.74%
95% CI for I^2	63.39 to 90.90

Estimating the pool effects of physical therapy based interventions on gait

The results show that physical protocol had a statistically significant favorable influence on gait in individuals with Parkinson's disease, with an overall effect size (Standardized Mean Difference, SMD) of 0.311 (95% CI: 0.0713 to 0.550). A somewhat greater impact size of 0.404 (95% CI: -0.0506 to 0.858) was seen in the random-effects model. With a significant test for heterogeneity (Q = 15.2934, DF = 5, p = 0.0092), the included research varied from one another. The computed inconsistency (I^2) was 67.31%, indicating a considerable degree of variability. With considerable variation across the included studies, the meta-analysis concludes that physical treatment had a substantial favorable impact on gait in people with Parkinson's disease. (Table-4, Figure-3).

Table-4 Pool effects model illustrating the effects of intervention on balance

Study	N1	N2	Total	SMD	SE	95% CI	t	P	Weight (%)	
									Fixed	Random
Kashif, 2022	22	22	44	0.13	0.29	-0.46 to 0.73			16.82	18.59
Chen, 2021	51	49	100	0.34	0.20	-0.049 to 0.74			36.93	22.32
de Faria, 2023	23	25	48	0.30	0.28	-0.27 to 0.87			18.08	19.00
Liu, 2022	10	12	22	0.000	0.412	-0.85 to 0.85			8.71	14.46
Kawashima, 2022	22	22	44	0.137	0.296	-0.46 to 0.73			16.81	18.59

Cabrera-Martos, 2020	7	8	15	3.107	0.748	1.49 to 4.72			2.64	7.03
Total (fixed effects)	135	138	273	0.311	0.122	0.071 to 0.55	2.555	0.011	100.00	100.00
Total (random effects)	135	138	273	0.404	0.231	-0.050 to 0.85	1.750	0.081	100.00	100.00
Test for heterogeneity										
Q	15.2934									
DF	5									
Level of significance	P = 0.0092									
I^2 (inconsistency)	67.31%									
95% CI I^2	22.28 to 86.25									

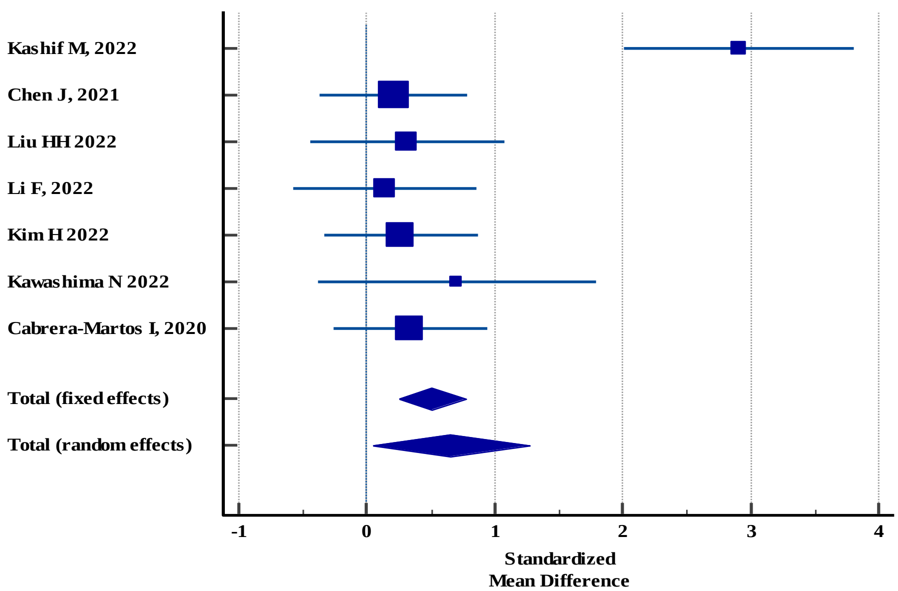

Figure-2 Forest plot depicting effects of physical therapy intervention on balance

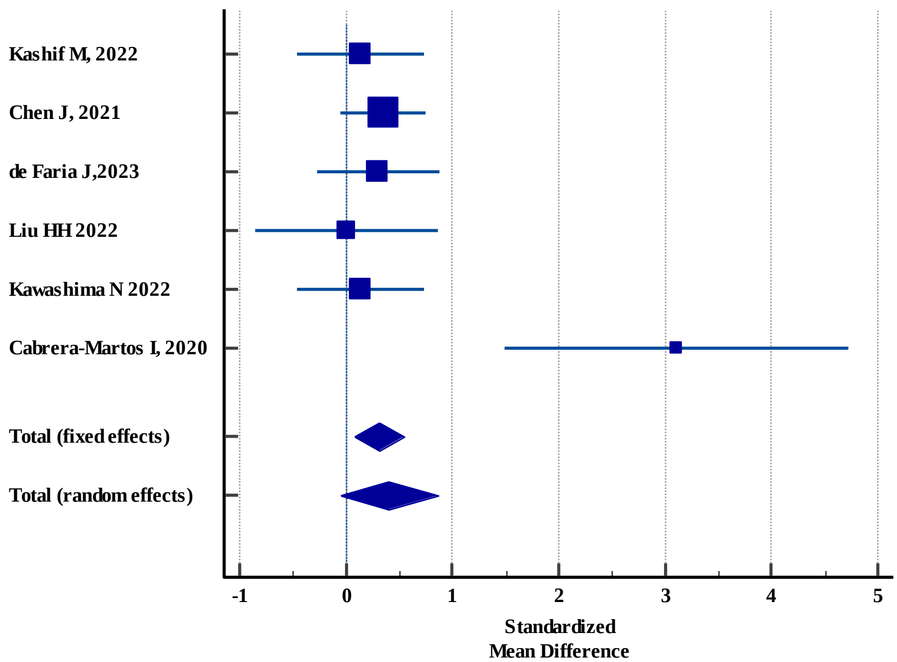

Figure-3: Forest plot: depicting effects of physical therapy intervention on Gait

Quality Appraisal and Risk of Bias

Judgment is solely based on guidelines of Cochrane is provided in Table-5, Figure-5.

- ***Random Sequence Generation***
  The randomization analysis suggested all 9 studies showing low risk of bias[15-23].

- ***Allocation Concealment***
  Studies under this measure reveled low risk of bias as per author's discernment[15-23].

- ***Participants and Personnel Blinding***
  Three studies[15, 17, 23] considered the participants blinding whereas two studies[16,18] reflects high risk and in five studies blinding of participants and personnel was unknown[19, 20, 21, 22].

- ***Outcome Assessment Blinding***
  Five studies[15,16,17,18,19] considered the participants blinding, two studies[22,23] reflects high risk whereas one study[21] proved unknown risk.

- ***In completed Outcome Data***
  All nine articles had revealed low risk of bias[15-23].

- ***Reporting Selection Bias***
  All studies reflects low bias risk under this head bias1[5-23].

Table-5 Assessment of Risk of Bias using a Cochrane Collaboration's Tool

Study	"Random Allocation"	"Allocation Concealment"	"Participants Blinding"	"Outcome Assessment Blinding"	"Incomplete Outcome Data"	"Selective Reporting"
de Faria, 2023[15]	+	+	+	+	+	+
Kawashima, 2022 [16]	+	+	-	+	+	+
Kim, 2022 [17]	+	+	+	+	+	+
Li, 2022[18]	+	+	-	+	+	+
Liu, 2022 [19]	+	+	?	+	+	+
Gaßner, 2022[20]	+	+	?	+	+	+
Kashif, 2022[21]	+	+	?	?	+	+
Chen, 2021[22]	+	+	?	-	+	+
Cabrera-Martos, 2020[23]	+	+	+	-	+	+

–, High risk biasness
+, Low risk biasness
? , unknown risk of bias

Discussion

There were notable positive results from the meta-analysis that examined physical therapy treatment strategies. Analysis through fixed effects model presented a clear improvement in balance, which showed a high effect size overall (Standardized Mean Difference, SMD) 0.511 (CI of 95%: 0.255 - 0.766). A somewhat greater impact size of 0.654 (95% CI: 0.0441 - 1.264) obtained using model of the random-effect, and heterogeneity was significant across the included studies (Q = 32.8633, DF = 6, p<0.0001, I2 = 81.74%). In a similar vein, positive results have been demonstrated on physical therapy based intervention on gait among Parkinson's disease patients. An overall effect size (SMD): 0.311 (95% CI: 0.0713 to 0.550) was found in the fixed-effects model, showing a statistically significant improvement in gait. A somewhat greater impact value of 0.404 (95% CI: -0.0506 to 0.858) was found in the random-effects model, along with considerable heterogeneity (Q = 15.2934, DF = 5, p = 0.0092, I2 = 67.31%). A randomized controlled experiment study conducted in order to determine the effects of 8 week of core stability on Parkinson's disease patients. An experimental group consisting of 24 sessions of core training was randomly allocated to 44 participants, whereas control group had received a treatment protocol consisting of joint mobilization, muscle stretch, and coordination rehabilitation. In particular, during balance evaluations, the experimental group showed more center of mass excursion in different directions and better confidence than the control group. According to the results, a core stability program helps people with PD improvise their dynamic balance, confidence, and center of mass excursion more than non-specific exercises group[15]. In a prospective randomized controlled trial both treadmill training (TT) and robot-assisted gait training (RAGT) showed comparable benefits on gait speed under comfortable study settings. However in contrast to TT, RAGT may appear more advantageous enhancing gait ability under cognitive dual tasking situations[17]. In a study, comparison of the effects of exercise treatment on motor function in individuals with Parkinson's disease (PD), Yang-ge dancing (YG), a traditional Chinese form of dance, as a potentially helpful intervention. Participants in this 51-patient randomized experiment with Parkinson's disease (PD) were divided into three groups: Yang-ge dance, traditional exercise, and conventional exercise with music. Berg balancing test and timed up. All three groups displayed improvements in their total motor function, but as compared to traditional exercise alone, Yang-ge dance and conventional exercise with music exhibited much greater benefits in improving balance and gait[18]. Research was conducted in investigation of the effects of treadmill training vs customized physical treatment on gait performance of 105 Parkinson's disease (PD) during dual-task activities. The results indicate that both interventions—physiotherapy and treadmill effectively improve dual-task walking in individuals with mild to moderate Parkinson's disease (PD), promoting safe and independent ambulation. Participants were randomized to either the treadmill or physiotherapy intervention group. Importantly, treadmill walking did not show any additional advantages over customized physiotherapy, highlighting the possibility for more specialized therapeutic techniques in the treatment of Parkinson's disease[20]. Thus a useful insights into the possible advantages of various physical therapy modalities, laying the groundwork for future research and emphasizing the need of personalized therapeutic strategies in Parkinson's disease care.

Conclusion

In conclusion, the thorough rigorous analysis of research on the influence of physical therapy treatments on gait & balance in Parkinson's disease has been found positive. The study comprised nine trials with n=374 participants and found that physical therapy, whether through individualized sessions, treadmill training, or other focused therapies, significantly improved the overall condition in general and gait and balance in particular.

Acknowledgment
None.

Conflict of Interest
None.

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None.

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AUTHORS' CONTRIBUTION

The following authors have made substantial contributions to the manuscript as under:

Conception or Design: Ayaz P, Raza Q

Acquisition, Analysis or Interpretation of Data: Ayaz P, Tabba A

Manuscript Writing & Approval: Tabba A, Baig MU

All the authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.