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REVIEW ARTICLE

Effects of Yoga in Parkinson's Disease: A Systematic Review of Randomized Controlled Trials

Selvaraj Giridharan[1]*, Jawaher Ansari[1], Hari Pannerselvam[2], Mrunmai Godbole[3]

[1]Consultant Oncologist, Department of Medical Oncology, Tawam Hospitals, Al Ain, UAE.
[2]Specialist Registrar, Department of Hepatology, Queen Elizabeth Hospital NHS Trust, Birmingham, United Kingdom.
[3]Assistant Professor of Yoga, Department of Psychology, School of liberal Arts and Social Sciences, JSPM University, Pune, Maharashtra, India.

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ABSTRACT

Background: Parkinson's disease (PD) is a progressive neurodegenerative disorder characterized by motor and non-motor symptoms that diminish the quality of life (QoL). While pharmacological interventions target dopamine deficiencies, they often fail to address non-motor symptoms such as anxiety and depression. Yoga, a mind–body practice that includes posture, breathing techniques, and meditation, has gained recognition as a promising complementary therapy. This systematic review synthesized randomized controlled trials (RCTs) to assess the impact of yoga on motor and non-motor symptoms, QoL, and safety in PD patients.

Methods: Following Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram guidelines, we searched PubMed, Embase, Cochrane Library, Scopus, and Web of Science for RCTs published between January 2020 and April 2025. The inclusion criteria were adult participants with idiopathic PD, yoga as the primary intervention, and comparisons with active or passive control groups. The outcomes assessed included motor function, non-motor symptoms (e.g., anxiety and depression), QoL, and adverse events. The risk of bias was evaluated using the Cochrane Risk of Bias 2 tool, and evidence certainty was appraised using the Grading of Recommendations Assessment, Development, and Evaluation approach. Due to heterogeneity, a narrative synthesis was conducted.

Results: Seven RCTs, involving 475 participants with mild-to-moderate PD, analyzed hatha or mindfulness yoga interventions over 6–12 weeks. The findings showed that yoga significantly improved motor symptoms with moderate-to-large effect sizes. Studies have reported improvements in balance, although the gait effects were inconsistent. For non-motor outcomes, anxiety, and depression showed moderate reductions, while QoL improvements lasted for 6 months. Evidence indicates improvements in biomarkers such as interleukin-6. Yoga was safe with no serious adverse events. Evidence certainty was moderate for motor and non-motor outcomes.

Conclusion: Yoga is a safe and feasible adjunct for PD, offering benefits for motor function, mood, and QoL. Larger, standardized RCTs with longer follow-up periods are needed to confirm and optimize protocols.

1. INTRODUCTION

Parkinson's disease (PD) is a progressive neurodegenerative disorder characterized by the loss of dopaminergic neurones in the substantia nigra pars compacta, leading to disruptions in motor control and a range of non-motor functions.[1,2] Globally, PD affects approximately 6.1 million individuals, with prevalence increasing sharply with age, rising from 0.04% to 0.05% in those aged 45–54 years to 1.90–1.95% in those over 80 years.[3] Clinically, PD manifests through cardinal motor symptoms, including resting tremor, bradykinesia, rigidity, and postural instability, which contribute to gait disturbances, falls, and reduced mobility. Non-motor symptoms, such as depression, anxiety, cognitive impairment, sleep disorders, autonomic dysfunction, and fatigue, often precede motor manifestations and significantly exacerbate the disease burden.[4,5] As PD progresses, these symptoms lead to functional decline, dependency in activities of daily living, and diminished quality of life (QoL), imposing substantial emotional, social, and economic costs on patients, caregivers, and healthcare systems.[6]

Corresponding Author:
Selvaraj Giridharan,
Consultant Oncologist, Department of Medical Oncology,
Tawam Hospitals, Al Ain, UAE.
Email: selvagiri@icloud.com

The annual economic burden of PD in the United States alone exceeds $50 billion, encompassing direct medical costs, lost productivity, and informal caregiving.[7] Despite advances in understanding its pathophysiology, PD remains incurable, with management focused on symptom alleviation rather than disease modification.[8]

Standard treatments for PD primarily involve pharmacological interventions, such as levodopa and dopamine agonists, which aim to replenish dopamine levels and mitigate motor symptoms.[9] Surgical options, including deep brain stimulation targeting the subthalamic nucleus or globus pallidus, offer relief in advanced cases with motor fluctuations or dyskinesias.[10] Adjunctive therapies such as physical therapy, occupational therapy, and speech therapy are recommended to enhance mobility, balance, and functional independence.[11] However, these approaches have limitations. Pharmacological treatments often lose efficacy over time due to tolerance, leading to "on-off" fluctuations, dyskinesias, and psychiatric side effects such as hallucinations or impulse control disorders.[12] Surgical interventions, while effective for motor symptoms, carry risks of infection, cognitive decline, and mood alterations, and are unsuitable for all patients. Moreover, these modalities inadequately address non-motor symptoms, which affect up to 90% of patients and are major determinants of long-term QoL.[13] Physical therapies improve motor function but show inconsistent benefits for non-motor aspects, such as depression or sleep, and adherence can wane due to disease progression.[14] Consequently, there is a growing interest in complementary and integrative therapies that offer holistic, low-risk alternatives to support symptom management and enhance overall well-being.[15]

Yoga, an ancient mind–body practice originating in India, integrates physical postures (asanas), controlled breathing (pranayama), and meditation (dhyana) to promote harmony between the body, mind, and breath, respectively.[16] As a complementary therapy, yoga is adaptable to varying abilities, often incorporating props such as chairs or blocks for accessibility, and emphasizes mindfulness alongside movement. Styles such as Hatha or Iyengar yoga, which focus on gentle alignments and sustained poses, are particularly suitable for populations with mobility challenges. Yoga's non-pharmacological nature makes it appealing for chronic conditions, with global participation rates exceeding 300 million practitioners.[17] In the context of neurological disorders, yoga has demonstrated benefits in multiple sclerosis, stroke, and epilepsy, improving fatigue, mood, and motor coordination.[18]

The theoretical rationale for yoga in PD stems from its multifaceted mechanisms that target both the motor and non-motor pathways. For motor symptoms, asanas enhance flexibility, strength, and balance by stimulating proprioceptive feedback and neuromuscular coordination, potentially counteracting rigidity and bradykinesia.[19] Pranayama may improve respiratory efficiency and autonomic regulation by addressing postural instability and gait deficits.[20] Neurobiologically, yoga promotes neuroplasticity through increased brain-derived neurotrophic factor (BDNF) levels, which support dopaminergic neuron survival and synaptic plasticity in the basal ganglia.[21] It also modulates the hypothalamic–pituitary–adrenal axis, reducing cortisol levels and oxidative stress, which are implicated in the progression of PD. For non-motor symptoms, yoga's meditative components elevate gamma-aminobutyric acid (GABA) activity, alleviating anxiety and depression while enhancing serotonin and dopamine release to improve mood and sleep.[22] Preliminary evidence suggests that yoga fosters resilience against stress, potentially slowing cognitive decline by improving executive function and attention.[23] These effects align with PD's multifactorial pathology of PD, offering a holistic approach beyond dopamine-centric therapy.

Early studies and reviews have indicated the potential of yoga in PD. A 2014 systematic review identified modest improvements in mobility, balance, and flexibility from yoga interventions, although limited by small sample sizes and heterogeneous designs.[24] Subsequent randomized controlled trials (RCTs) reported benefits in motor function (e.g., Unified PD rating scale [UPDRS] scores) and QoL, with some showing superior effects compared to resistance training.[25,26] However, inconsistencies persist; while some trials demonstrate reduced depression and anxiety, others find no significant changes in fear of falling or sleep.[27,28] Gaps include a lack of long-term follow-up, standardized protocols, and a focus on non-motor outcomes, with meta-analyses often pooling yoga with other mind–body practices, obscuring its specific efficacy. Moreover, cultural variations in yoga styles and the underrepresentation of diverse populations limit generalizability.[29,30]

This systematic review addresses these gaps by synthesizing RCTs on the effects of yoga on PD and evaluating its efficacy for motor and non-motor symptoms, QoL, and safety. By critically appraising methodological quality and performing meta-analyses where feasible, we aimed to provide robust evidence to guide clinical integration, inform future research on optimal protocols, and highlight areas needing investigation, such as dose–response and mechanisms such as neuroplasticity. Ultimately, this review underscores the potential of yoga as an accessible, cost-effective adjunct to standard care, empowering patients to manage PD holistically.

2. METHODS

2.1. Search Strategy

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses 2020 (Preferred Reporting Items for Systematic Reviews And Meta-Analyses Flow Diagram [PRISMA]) guidelines.[31] We conducted a systematic review of RCTs evaluating the effects of yoga on motor and non-motor symptoms in individuals with PD, focusing on studies published between January 2020 and April 2025. The electronic databases searched included PubMed, Embase, Cochrane Library, Scopus, and Web of Science. The search terms used were: ("yoga" OR "hatha yoga" OR "mindfulness yoga" OR "tele-yoga") AND ("Parkinson's disease" OR "Parkinson disease" OR "PD") AND ("randomized controlled trial" OR "RCT" OR "randomized" OR "randomized"). No language restrictions were applied, and only English-language publications were included for practicality. The reference lists of the included studies and relevant reviews were manually searched for additional studies.

2.2. Inclusion and Exclusion Criteria

The study selection was guided by the population, intervention, comparator, outcome, and study (PICOS) framework PICOS design. This review focused exclusively on adult participants (aged >18 years) with a confirmed diagnosis of idiopathic PD at any disease stage. The primary intervention was yoga, either as a stand-alone treatment or in conjunction with standard care. Comparisons were made with active controls, such as stretching and Tai Chi, as well as passive controls, including waitlists and usual care, or the absence of any intervention. The outcomes assessed included motor symptoms, measured using the UPDRS (UPDRS/movement disorder society-UPDRS), balance, and gait, as well as non-motor symptoms, such as anxiety, depression, sleep, and QoL, in addition to biomarkers. Studies with a non-randomized design, such as pre–post studies, case series, and observational studies,

were excluded. Studies involving healthy individuals or pediatric populations (<18 years of age) were excluded. In addition, protocols lacking results and interventions in which yoga was not the primary focus were excluded.

2.3. Study Selection and Data Extraction

Two reviewers independently screened titles, abstracts, and full texts using Rayyan software, with disagreements resolved by consensus or by a third reviewer.[32] Data extracted included study ID (authors, year, title, journal, DOI), design (RCT type, randomization, blinding, duration), participants (number randomized/completed, demographics, PD characteristics, inclusion/exclusion, dropouts), intervention/control (yoga type, components, duration/frequency, instructor; control type; co-interventions), outcomes (primary/secondary, time points, adverse events), results (means/SD, effect sizes, *P*-values, confidence intervals (CI) for key outcomes such as UPDRS, balance, QoL), and other information (funding, conflicts, ethics, registration).

2.4. Risk of Bias Assessment

The risk of bias was assessed using the Cochrane Risk of Bias 2 (RoB 2) tool for RCTs, covering the following domains: random sequence generation, allocation concealment, blinding (participants/personnel, outcome assessment), incomplete outcome data, selective reporting, and other biases.[33] Each domain was rated as low-risk, high-risk, or some concern. Overall risk was determined to be the highest risk in any domain. Single-group studies were rated as having a high risk of randomization/allocation.

2.5. Data Synthesis and Analysis

Given the heterogeneity in design, interventions, outcomes, and follow-up durations, narrative synthesis summarized the findings across studies. Where sufficient homogeneity existed (≥3 studies reporting the same outcome with comparable measures), quantitative data were synthesized in tables. For continuous outcomes, mean differences (MD) or standardized MDs with 95% CI were calculated when possible. A sensitivity analysis, excluding studies with high-risk bias, assessed the robustness of the findings. Evidence certainty was evaluated using the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) approach.[34]

3. RESULTS

The search yielded 557 records from PubMed/MEDLINE, Embase, Cochrane Library, Scopus, Web of Science, and ClinicalTrials.gov. After removing 85 duplicates, 472 titles and abstracts were screened, leading to the exclusion of 416 records that did not meet the inclusion criteria (e.g., non-RCT designs, irrelevant interventions, or non-PD populations). The full texts of the remaining 56 articles were assessed for eligibility, resulting in the exclusion of 49 studies (e.g., protocols without results, non-randomized designs, or yoga not being the primary intervention). Ultimately, 7 RCTs were included in this systematic review.[35-41] A PRISMA flow diagram illustrating the selection process is shown in Figure 1.

3.1. Study Characteristics

All 7 included studies were parallel-group RCTs, with one employing a pilot crossover design. Studies have been conducted across diverse settings: the USA,[35,37,38] Spain,[36] India,[39] and Hong Kong SAR.[40,41] Sample sizes varied from 20 to 159 participants, with a total of 475 participants randomized across studies (mean age range: 63.6–70.6 years; 50–64% males where reported). Participants had mild-to-moderate PD (Hoehn and Yahr stages 1–3), with disease duration averaging 5.8–7.3 years where specified. Inclusion criteria consistently required an idiopathic PD diagnosis, ability to ambulate independently or with minimal aid, and no recent yoga practice; exclusions often involved cognitive impairment, comorbidities contraindicating exercise, or concurrent therapies. Dropout rates ranged from 0%[35,36,39] to 28%,[37] with reasons including unrelated injuries, family emergencies, and intervention dissatisfaction.

3.2. Summary of Results

Yoga interventions were predominantly Hatha-based,[35,36,38,39] with variations including mindfulness yoga,[40,41] yoga meditation with action observation, and motor imagery.[37] Components typically integrate physical postures (asanas), breathing exercises (pranayama), relaxation, and meditation, adapted for PD (e.g., chair support and gentle modifications). Session durations ranged from 30 to 90 min, frequencies from 1 to 5 times/week, and total durations from 6 to 12 weeks. The instructors were certified yoga professionals or physiotherapists with PD experience. Control groups included active comparators such as stretching,[36,40] proprioceptive training,[37] conventional balance exercises, or Tai Chi,[39] and passive controls such as waitlists[35,41] or usual care.[38] Co-interventions involved stable PD medications with assessments conducted in the "ON" state. Adherence was high (85–97% where reported) and was monitored through session attendance or self-reports.

Primary outcomes focused on motor function, assessed primarily through UPDRS or MDS-UPDRS scores,[35-38,40,41] balance and proprioception,[35,37-39] and non-motor symptoms such as anxiety and depression.[40,41] The secondary outcomes included QoL measured using the PD questionnaire (PDQ)-39 or PDQ-8,[36,40,41] gait and walking speed,[35,36,39] flexibility and strength,[36] and biomarkers (for example, interleukin-6 [IL-6]).[41] Most studies conducted assessments at baseline and post-intervention (ranging from 6 to 12 weeks), with some including long-term follow-up (up to 6 months[41] and 20 weeks.[40] Adverse events were minimal and generally mild, including transient pain, dizziness, or fatigue.[37,40,41] No serious adverse events or complications directly attributable to yoga were reported. Table 1 summarizes the study's characteristics and key findings.

3.3. Risk of Bias

Using the Cochrane RoB 2 tool; overall risk was rated as "some concerns" in six studies and "high" in one due to unclear randomization. Common issues included a high risk of blinding for participants and personnel (all studies, inherent to behavioral interventions) and some concerns for allocation concealment (four studies). Random sequence generation was low-risk in five studies. Blinding of outcome assessors was low risk in six studies. Incomplete outcome data were low risk across all, with low attrition and intent-to-treat analyses where applicable. Selective reporting was low risk, as all prespecified outcomes were reported. Other biases included small sample sizes (five studies) and potential COVID-19 impacts. The risk of bias assessment is shown in Figure 2.

3.4. Synthesis of Results

Given the heterogeneity in yoga styles, control types, outcome measures, and follow-up durations, a narrative synthesis was performed with quantitative data tabulated for key outcomes [Table 2]. Yoga consistently demonstrated the benefits of motor symptoms

across studies. For UPDRS/MDS-UPDRS scores (reported in six studies), yoga groups showed within-group reductions (e.g., −8.0 in Elangovan *et al*., −4.2 at 2 months in Kwok *et al*.,) and between-group superiority over controls. Effect sizes ranged from moderate (d = 0.33–0.62) to large, with sustained effects at follow-up in two studies.[41,42] Balance outcomes, as measured by tools such as the Tinetti, balance evaluation systems test, and Berg Balance Scale in five studies, showed significant improvement with yoga. For instance, Cherup *et al*. reported a +2.2 increase on the Tinetti scale (d = 0.77, p= 0.01) compared to proprioceptive training,[37] while Khuzema *et al*. found a +6.4 increase on the BBS ($\eta\_p^2 = 0.28$ interaction, $P = 0.001$) compared to conventional methods or Tai Chi.[39] However, Ayan *et al*. observed no differences between groups when compared to stretching.[36] In terms of gait and mobility, assessed by tests such as the Timed Up and Go (TUG) and the 10 m Walk Test in four studies, yoga and its comparators showed similar benefits. For example, Khuzema *et al*. reported a −2.6 s improvement in the TUG for the yoga group (interaction $P = 0.008$),[39] while Elangovan *et al*. noted no change.[35]

The non-motor symptoms also improved with yoga. Anxiety and depression (measured using the Hospital Anxiety and Depression Scale [HADS] in two studies) decreased significantly (e.g., HADS anxiety subscale [HADS-A] MD −1.6 at 2 months, Cohen's d = 0.69, $P < 0.001$ in Kwok *et al*. vs. waitlist;[41] HADS depression subscale [HADS-D] change −2.53, d = 0.79, $P < 0.001$ in Kwok *et al*. vs. stretching[40]), with mediation analyses in Kwok *et al*.[40] indicating anxiety/depression as pathways for better health-related QoL (HRQOL). However, Myers *et al*.[38] found no changes in anxiety (Beck anxiety inventory, $P = 0.97$). QoL (PD Questionnaire-39/8 [PDQ-39/8] in three studies) was enhanced post-yoga (e.g., −1.25 in Ayan *et al*.,[36] non-significant vs. stretching; MD −4.2, d = 0.51, $P < 0.001$ in Kwok *et al*.[41]), with sustained effects at 6 months. Biomarkers (IL-6 −1.1 pg/mL, d = 0.53, $P = 0.03$ in Kwok *et al*.[41]) supported the benefits of yoga. Proprioception and flexibility showed mixed results, with improvements as reported by Cherup *et al*.[37] (Joint Kinesthesia Flexion [JK Flex] d = −0.72, $P = 0.05$), but not in Ayan *et al*.[36]

Safety was deemed high, as no serious adverse events were reported; mild events, such as dizziness, were transient and potentially related in three studies.[37,40,41] Subgroup analyses indicated greater benefits in groups with high- or at-risk levels of anxiety and depression.[41] Sensitivity analysis, which excluded high-risk studies, did not alter the overall findings.[40] Although publication bias could not be formally assessed owing to fewer than 10 studies per outcome, inspection of the funnel plot revealed no asymmetry. GRADE certainty was assessed as moderate for motor and non-motor outcomes, downgraded due to inconsistency and imprecision, and low for biomarkers, with an additional downgrade for indirectness. The certainty of evidence was evaluated using GRADE and is summarized in Table 3.

4. DISCUSSION

4.1. Summary of Main Findings

The findings of this systematic review provide moderate evidence supporting the benefits of yoga as adjunctive therapy for individuals with mild-to-moderate PD. Yoga interventions, predominantly Hatha-based or mindfulness variants, consistently demonstrated improvements in motor symptoms, including reductions in the UPDRS or MDS-UPDRS scores and enhancements in balance. Gait and mobility outcomes showed significant improvements in some studies (e.g. via TUG),[39] but no significant changes were observed in others.[35] Non-motor symptoms also benefited, with significant reductions in anxiety and depression and improvements in QoL (PDQ-39/8; sustained for up to 6 months). Preliminary evidence from a single study suggests positive effects on biomarkers such as IL-6.[41] Safety was a key strength, and no serious adverse events were reported. Mild, transient issues (e.g., dizziness and fatigue) occurred infrequently across the three studies, underscoring yoga's feasibility and low-risk profile for this population.[37,40,41]

4.2. Comparison with Previous Studies

These results align closely with prior systematic reviews on yoga in PD; however, they extend the evidence base by incorporating more recent trials. For instance, Ban *et al*.'s meta-analysis of RCTs similarly concluded that yoga improved motor function (e.g., UPDRS scores and balance) and QoL, with moderate effects on depression, but noted mixed findings for anxiety.[29] Suárez-Iglesias *et al*.'s review and meta-analysis echoed these benefits, emphasizing yoga's equivalence or superiority to exercise controls for motor outcomes and HRQoL, while highlighting inconsistencies in non-motor effects like fear of falling.[30] Both reviews shared our conclusions on yoga safety and potential as a complementary therapy. However, differences in scope are notable; previous reviews included older studies and broader inclusion criteria, such as non-randomized designs or pooled mind–body practices, potentially diluting yoga-specific effects. Our focus on post-2019 RCTs captures emerging trends, such as mindfulness variants, which address modern challenges, such as psychological symptoms during pandemics. This adds a contemporary perspective, revealing sustained non-motor benefits (e.g., 6-month follow-up) and biomarker insights not emphasized in earlier syntheses, thus strengthening the role of yoga in holistic PD management.

4.3. Potential Mechanisms of Action

The therapeutic mechanism of yoga in PD involves multifaceted neurobiological and physiological pathways. Yoga's postures (asanas) enhance proprioceptive feedback and neuromuscular coordination, counteracting rigidity and bradykinesia by improving flexibility and strength.[19] Breathing exercises (pranayama) promote autonomic balance and modulate the sympathetic–parasympathetic response to alleviate postural instability and gait deficits.[20] Neuroplasticity is a plausible driver, with yoga elevating BDNF levels to support dopaminergic neuron survival and basal ganglia plasticity.[21] Stress regulation through the hypothalamic–pituitary–adrenal axis reduces cortisol levels and oxidative stress, which are key contributors to PD progression.[22] For non-motor symptoms, meditative components (dhyana) boost GABA activity and serotonin/dopamine release, mitigating anxiety, depression, and sleep disturbances.[23] These mechanisms align with PD's multifactorial pathology of PD, offering a non-pharmacological complement to dopamine-focused treatment.

4.4. Strengths and Limitations of the Included Studies

Heterogeneity across studies limits meta-analytic pooling and may explain variable outcomes. Yoga styles vary, potentially influencing intensity and emphasis on physical versus meditative elements. Intervention durations (6–12 weeks) and frequencies (1–5 sessions/week) differed, with longer protocols showing more sustained effects.[41] Outcome measures were inconsistent (e.g., UPDRS-III vs. MDS-UPDRS-III for motor function; PDQ-39 vs. PDQ-8 for QoL), complicating comparisons. Control groups ranged from passive (waitlist) to active (stretching), affecting effect sizes; yoga often

matched or exceeded active comparators, suggesting specific benefits beyond general exercise.

Methodological limitations temper these findings. Small sample sizes (median $n = 46$) in most studies increased imprecision and risk of type II errors, particularly for non-motor outcomes. Blinding of participants/personnel was inherently challenging in behavioral trials, introducing performance bias, while allocation concealment concerns persisted in four studies. Variability in controls and short follow-ups hindered long-term efficacy assessment. Potential publication bias, though not formally detectable due to few studies per outcome, may overrepresent positive results. These issues contributed to moderate GRADE certainty for motor/non-motor outcomes and low for biomarkers.

4.5. Implications for Clinical Practice

Clinically, yoga can be recommended as a safe, accessible adjunct to standard PD care, particularly for mild-to-moderate stages. Its low cost, adaptability (e.g., chair-based modifications), and high adherence (85–92%) make it feasible for community settings. Benefits in motor function and QoL may reduce fall risk and enhance independence, while non-motor improvements address unmet needs such as mood disorders. However, individualization is key, considering disease severity, OFF/ON states, and comorbidities, to minimize rare mild adverse events.

4.6. Implications for Future Research

Future research should prioritize larger, multicenter RCTs with standardized protocols (e.g., Hatha-based, 60-min sessions, 2–×3/week) and outcomes (e.g., MDS-UPDRS and PDQ-39). Longer follow-ups (≥6 months) and biomarker endpoints (e.g., BDNF and cortisol) could elucidate these mechanisms and durability. Stratification by PD stage or subtype and comparisons with other mind–body practices would refine the recommendations. Addressing gaps in diverse populations (e.g., advanced PD and underrepresented regions) will enhance generalizability.

5. CONCLUSION

This systematic review provides moderate evidence supporting yoga as an adjunctive therapy for mild-to-moderate PD. Yoga improved motor symptoms and balance with moderate-–to-large effects, while showing benefits for anxiety, depression, QoL, and biomarkers. With high safety and adherence rates, yoga represents a low-risk complement to pharmacological treatments. These findings confirm yoga's efficacy while incorporating recent mindfulness variants. Yoga can enhance functional independence in PD management, particularly in community settings. However, study heterogeneity, small samples, and short follow-ups limit result generalization. Future large-scale RCTs with standardized protocols and longer follow-up periods are needed to solidify the benefits and explore the underlying mechanisms. Yoga shows promise as a cost-effective tool for PD care, warranting broader adoption and research.

6. ACKNOWLEDGMENTS

None.

7. AUTHOR'S CONTRIBUTIONS

All the authors have read and approved the final version of the manuscript.

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9. ETHICAL STATEMENT

Ethical approval was not required for this study as it was a review article with data obtained through a literature search.

10. CONFLICT OF INTERESTS

The authors declare no conflicts of interest regarding the publication of this paper.

11. DATA AVAILABILITY STATEMENT

The data analysed in this review were obtained from publicly available sources, including peer-reviewed articles, observational studies, and surveys accessible via databases.

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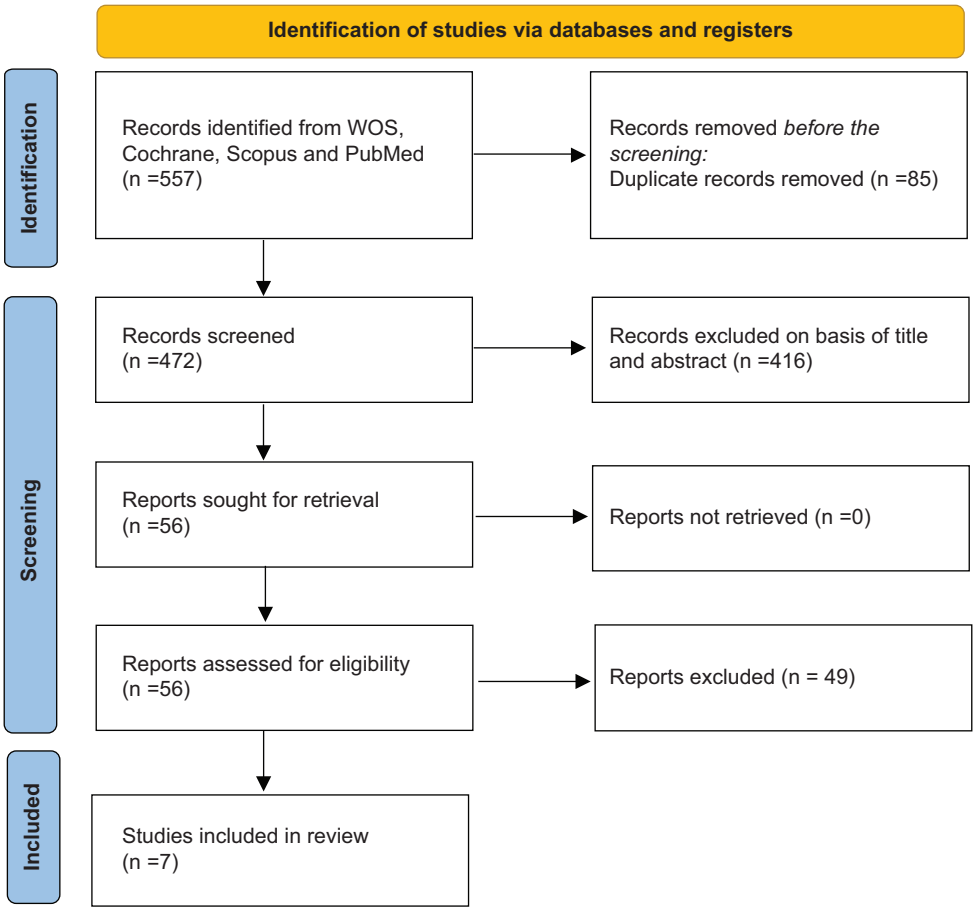

Figure 1: Summarized search strategy (preferred reporting items for systematic reviews and meta-analyses flow diagram)

Table 1: Summary of included studies

Study ID (citation)	Design	Participants (N randomized; age mean/SD; % male)	Intervention (yoga type; duration/frequency)	Control	Key outcomes	Follow-up
Elangovan *et al.*	Pilot parallel-group RCT with crossover	20; 66.4±10.7; NR	Hatha yoga; 60 min, ×2/week, 12 weeks	Waitlist	Balance (postural sway), gait, UPDRS-III	12 weeks
Ayan *et al.*	Parallel-group RCT	23; NR; NR	Hatha yoga; 60 min, ×1/week, 8 weeks	Stretching	UPDRS-III, PDQ-39, TUG, flexibility, strength, gait, balance	8 weeks
Cherup *et al.*	Parallel-group RCT	46; 70.6±9.9; 64%	Yoga meditation (YoMed); 45 min, ×2/week, 12 weeks	Proprioceptive training	Proprioception (JPS/JK), balance (Tinetti, BESS, TUG), FES	12 weeks
Myers *et al.*	Parallel-group RCT	28 (15 yoga, 13 control); Yoga: 69.5±8.5; NR	Hatha yoga; 60 min, ×2/week, 12 weeks	Usual care	Balance (BESTest), anxiety (BAI), low back pain (ROSW), MDS-UPDRS-III	12 weeks
Khuzema *et al.*	Parallel-group RCT (3 arms)	27; ~64.4±7.9; NR	Hatha yoga; 30-40 min, ×5/week, 8 weeks	Conventional balance or Tai Chi	Balance (BBS), mobility (TUG, 10mWT)	8 weeks
Kwok *et al.* (2022)	Parallel-group RCT	138; 63.6±8.7; ~47% (52.9% female)	Mindfulness yoga; 90 min, ×1/week, 8 weeks	Stretching/ resistance	MDS-UPDRS I/II/III, HADS anxiety/depression, PDQ-8	8 weeks+12 weeks follow-up (20 weeks)
Kwok *et al.* (2025)	Parallel-group RCT (3 arms)	159; 64.8±7.9; ~47.7% (52.3% female)	Mindfulness yoga (Raja); 90 min, ×1/week, 8 weeks	Waitlist (or meditation arm)	HADS anxiety/depression, MDS-UPDRS, PDQ-8, biomarkers (IL-6)	2 months+6 months

NR: Not reported, UPDRS-III: Unified Parkinson's disease rating scale - Part III, PDQ-39: Parkinson's disease questionnaire - 39 items, TUG: Timed Up and Go, JPS: Joint position sense, JK: Joint Kinesthesia, BESS: Balance error scoring system, FES: Falls efficacy scale, BESTest: Balance evaluation systems test, ROSW: Revised oswestry low back pain disability questionnaire, MDS-UPDRS-III: Movement disorder society - Unified Parkinson's disease rating scale - Part III, BBS: Berg balance scale, 10mWT: 10-meter Walk test, HADS: Hospital anxiety and depression scale, PDQ-8: Parkinson's disease questionnaire - 8 items, IL-6: Interleukin-6, NMSS: Non-motor symptoms scale, RCT: Randomized controlled trial

Table 2: Quantitative findings for key outcomes

Outcome	Study ID (citation)	Measure	Yoga change (mean Δ ± SD or calculated)	Control change (mean Δ ± SD or calculated)	Between-group effect (MD/SMD, 95% CI, *P* value)	Effect size (d or η^2)
Motor Function (UPDRS/ MDS-UPDRS-III)	Elangovan *et al*.	UPDRS-III	−8.0 (calculated)	No change	Significant within-yoga ($P<0.05$)	NR
	Ayan *et al*.	UPDRS-III	−0.75 (calculated)	−1.63 (calculated)	Interaction $P=0.76$ (NS)	NR
	Cherup *et al*.	UPDRS (baseline reported, but not primary)	NR (focus on balance)	NR	N/A	N/A
	Myers *et al*.	MDS-UPDRS-III	−3.6 (calculated)	−0.4 (calculated)	NR	NR
	Khuzema *et al*.	UPDRS (baseline reported, but not primary)	NR (focus on balance)	NR	N/A	N/A
	Kwok *et al*. (2022)	MDS-UPDRS-III	NR (focus on experiences)	NR	N/A	N/A
	Kwok *et al*. (2025)	MDS-UPDRS-III	−4.2 (calculated)	−0.4 (calculated)	MD−4.2 (−6.85 to−1.55, $P<0.001$)	d=0.62
Balance	Elangovan *et al*.	Postural sway (eyes open, mm)	−84.3 (calculated)	−9.3 (calculated)	Within-yoga $P=0.03$	NR
	Ayan *et al*.	Stabilometric test	−0.15 (calculated)	−0.35 (calculated)	Interaction $P=0.65$ (NS)	NR
	Cherup *et al*	Tinetti	+2.2 (NR)	+0.5 (NR)	MD 2.3 (0.7–4.0, $P=0.01$)	d=0.77
	Myers *et al*.	BESTest (%)	+3 (median)	+2 (median)	Within-yoga $P=0.001$	NR
	Khuzema *et al*.	BBS	+6.4 (calculated)	+4.4 (conventional)	Interaction $P=0.001$ ($\eta\_P^2=0.28$)	$\eta\_P^2=0.28$
Anxiety/ depression	Myers *et al*.	BAI	−1 (median)	−2 (median)	$P=0.97$ (NS)	NR
	Kwok *et al*. (2025)	HADS-A	−2.12±3.06	−0.48±3.06	β=−1.79 ($P<0.001$)	d=0.66
	Kwok *et al*. (2025)	HADS-A	−1.6 (calculated)	−0.2 (calculated)	MD−1.6 (−2.70 to−0.52, $P<0.001$)	d=0.69
Quality of life	Ayan *et al*.	PDQ-39	−1.25 (calculated)	−1.28 (calculated)	Interaction $P=0.98$ (NS)	NR
	Kwok *et al*. (2022)	PDQ-8	−2.48±2.58	+0.03±3.80	β=−7.77 ($P<0.001$)	d=0.66
	Kwok *et al*. (2025)	PDQ-8	−4.2 (calculated)	−0.4 (calculated)	MD−4.2 (−6.85 to−1.55, $P<0.001$)	d=0.51
Biomarkers	Kwok *et al*. (2025)	IL-6 (pg/mL)	−1.1 (calculated)	−0.2 (calculated)	MD−1.1 (−2.09 to−0.13, $P=0.03$)	d=0.53

BAI: Beck anxiety inventory, BBS: Berg balance scale, BESTest: Balance evaluation systems test, CI: Confidence interval, d: Cohen's d, Δ: Delta, HADS-A: Hospital anxiety and depression scale - anxiety subscale, IL-6: Interleukin-6, JK Flex: Joint Kinesthesia flexion, MD: Mean difference, MDS-UPDRS-III: Movement disorder society - Unified Parkinson's disease rating scale - Part III, N/A: Not applicable, NR: Not reported, NS: Not significant, PDQ-39: Parkinson's disease questionnaire - 39 items, PDQ-8: Parkinson's disease questionnaire - 8 items, SMD: Standardized mean difference, Tinetti: Tinetti balance, UPDRS-III: Unified Parkinson's disease rating scale - Part III, η_p^2: Partial Eta squared

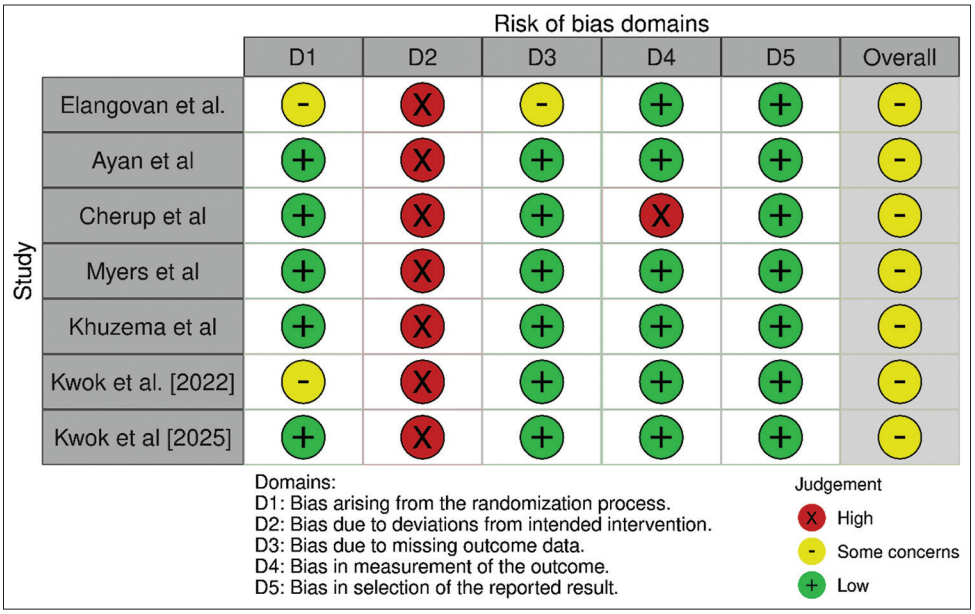

Figure 2: Risk of bias assessment using the RoB 2 tool across included studies

Table 3: GRADE assessment of evidence certainty

Outcome	Number of studies	Risk of bias	Inconsistency	Indirectness	Imprecision	Publication bias	Overall certainty
Motor function (UPDRS/MDS-UPDRS)	6	Serious (some concerns in most)	Moderate (heterogeneous effects)	Low	Moderate (small samples)	Undetected	Moderate ⊕⊕⊕◯
Balance	5	Serious	Moderate	Low	Serious (wide CIs)	Undetected	Moderate ⊕⊕⊕◯
Anxiety/depression	3	Serious	Moderate	Low	Moderate	Undetected	Moderate ⊕⊕⊕◯
Quality of Life (PDQ-39/8)	3	Serious	Low	Low	Moderate	Undetected	Moderate⊕⊕⊕◯
Biomarkers (e.g., IL-6)	1	Some concerns	N/A (single study)	Serious (surrogate outcome)	Serious (small sample)	Undetected	Low ⊕⊕⊕◯

GRADE ratings: Moderate ⊕⊕⊕◯, Low ⊕⊕⊕◯. GRADE: Grading of Recommendations Assessment, Development, and Evaluation