Research

Yoga Improves Balance and Low-Back Pain, but Not Anxiety, in People with Parkinson’s Disease

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Abstract

Individuals with Parkinson’s disease (PD) experience postural instability, low-back pain (LBP), and anxiety. These symptoms increase the risk of falls and decrease quality of life. Research shows yoga improves balance and decreases LBP and anxiety in healthy adults, but its effects in PD are poorly understood. All participants were part of a larger intervention study. Participants received pretest and posttest evaluations, including the Balance Evaluation Systems Test (BESTest), Beck Anxiety Inventory (BAI), and Revised Oswestry Disability Index (ROSW). Total scores for each measure, as well as individual balance system section scores from the BESTest (biomechanical constraints, stability limits/verticality, transitions/anticipatory, reactive, sensory orientation, and stability in gait) were compared within groups pre- to posttest. Participants in the yoga group (n = 13) completed a twice-weekly 12-week yoga intervention, whereas controls (n = 13) continued their usual routines for 12 weeks. Both the yoga (Z = −3.20, p = 0.001) and control (Z = −2.10, p = 0.040) groups improved on the BESTest total score. The control group showed no changes in individual balance systems, whereas the yoga group improved in stability limits/verticality (Z = −2.3, p = 0.020), transitions/anticipatory (Z = −2.50, p = 0.010), reactive (Z = −2.70, p = 0.008), and sensory orientation (Z = −2.30, p = 0.020). ROSW decreased in the yoga group only (Z = −2.10, p = 0.030). BAI did not change in either group. Yoga is a nonpharmacological intervention that can improve balance and LBP in people with PD. This study demonstrated that yoga is feasible for people with PD, and participants reported high levels of enjoyment and intent to practice yoga after the study. Myers et al. Int J Yoga Therapy 2020(30). doi: 10.17761/2020-D-18-00028.

Keywords: Parkinson’s disease, yoga, postural instability, low-back pain, anxiety

Introduction

People with Parkinson’s disease (PD) suffer from balance and postural deficits, which increase the likelihood of debilitating falls. Specifically, people with PD can have insufficient responses to external forces or perturbations, leading to loss of balance. Limb stiffness and a flexed posture may also contribute to the risk of falls, and these symptoms become worse as the disease progresses. Additionally, increased flexed posture may contribute to low-back pain (LBP), a symptom often untreated in PD. Nonmotor symptoms in people with PD are also present. Increased anxiety is a common nonmotor symptom, which can affect up to 55% of individuals with PD. The combination of increased motor disability and anxiety negatively impacts the quality of life of individuals with PD. Although antiparkinsonian medications can decrease postural instability, the medications may also impact the pathogenesis of anxiety in PD, increasing symptomatology. Therefore, nonpharmacological interventions warrant exploration for long-term management of both motor and nonmotor symptoms in PD.

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Yoga has been explored in multiple populations and it has been shown to improve balance. Many yoga postures challenge balance by placing the individual’s body in unstable positions, which cannot be maintained without the appropriate muscular activation to stabilize the joints. Likely, individuals learn how to appropriately activate their muscles, resulting in balance improvements. In people with PD, yoga significantly improved measures of overall balance. However, as assessed by the Balance Evaluation Systems Test (BESTest), people with PD have deficits in all six systems of balance (biomechanical constraints, stability limits/verticality, transitions/anticipatory, reactive, sensory orientation, and stability in gait), and it is unclear which systems are most affected by yoga interventions. Yoga has other beneficial effects, such as decreasing LBP and anxiety, in non-PD populations. Improvements in LBP are likely related to physical aspects of yoga, whereas changes in anxiety could relate to both the breathing and meditative aspects of yoga; however, these benefits have not been explored in PD.

The aims of the present study, therefore, were to determine both the feasibility and the effect of a 12-week yoga intervention on the specific systems of balance as well as LBP and anxiety. We developed a yoga program that incorporated breathing, meditation, and physical postures, with a focus on postural transitions, such as getting up and down from the floor. Importantly, each posture was instructed from the ground up to ensure participants had a stable foundation. Additional layers to any posture, such as arm placement or gaze, were provided as options. Once a pose was established, the transition to the next pose was instructed to maximize safety for all participants. The goal was for participants to learn to be mindful of how to move from one position to the next. As falls are a result of loss of balance, we felt this focus to be integral to the success and safety of all participants. Furthermore, the design of our yoga program was intended to affect postural instability in people with PD by improving joint stability in static and dynamic positions. For this reason, our assessment of balance employed the full BESTest to examine changes in each system of balance. We also used the Beck Anxiety Inventory (BAI) to measure changes in anxiety and the Revised Oswestry Disability Index (ROSW) for changes in LBP.

We hypothesized that people with PD would show more improvements in BESTest, BAI, and ROSW scores after a yoga intervention than a control group receiving no intervention. Further, based on the yoga program’s transition focus, we expected to see improvements in the biomechanical constraints, stability limits/verticality, and transitions/anticipatory systems of balance in the BESTest.

Methods

Participants
All participants were part of a larger intervention study with the following inclusion criteria: (1) clinical diagnosis of Parkinson’s disease, (2) able to stand for at least 30 minutes, (3) normal peripheral nervous system function, (4) no history of vestibular disease, and (5) Mini Mental State Exam score ≥ 24. Exclusion criteria included the following: (1) diagnosis of any other major medical condition, (2) having deep brain stimulation or neural implants, (3) diagnosis of peripheral neuropathy, (4) use of neuroleptic or dopamine-blocking medications, and (5) has a current, regular yoga practice. Participants were randomized into one of three groups: controls, yoga, and mobile health. Only the control and yoga groups are included in the present analysis; however, for clarity, the mobile health group participated in a 12-week program that used a smartphone application intervention. All participants provided written informed consent, and this study was approved by the Human Research Protection Office of Washington University in St. Louis.

Evaluations

Participants received a pretest evaluation consisting of a behavioral assessment and questionnaires followed by a 12-week intervention or control period. Controls were asked to continue their usual daily routines during the 12 weeks, which began the day after their pretest evaluation, and the yoga group participated in the yoga program for 12 weeks. Pretest evaluations for the yoga group occurred within 4 weeks of starting the yoga program. All posttest evaluations occurred within 2 weeks of completing the yoga program or control period. The behavioral assessment included the full BESTest, which consists of 36 items, divided into six sections. Each section evaluates a different system of balance (biomechanical constraints, stability limits/verticality, transitions/anticipatory, reactive, sensory orientation, and stability in gait), and section scores sum for a total score. The individual section scores, as well as the total score, are valid for group comparisons and were used here to evaluate changes in balance systems and overall balance in each group. Disease severity was measured using the Movement Disorder Society Unified Parkinson’s Disease Rating Scale, Motor Symptom Subscale (MDS-UPDRS III). BESTest and MDS-UPDRS III were videotaped and scored by a rater blinded to group assignment. To minimize effects of medications, evaluation time remained consistent for both evaluations within each participant.

Participants received questionnaire packets electronically or through the mail 1 week before their scheduled evaluations and were asked to complete the entire packet before...
their evaluations. The packet of questionnaires included a demographics sheet, the BAI, and the ROSW. The BAI is a self-report measure of anxiety that asks the participant to rate how much they are bothered by each of 21 items on a scale of 1 (not bothered at all) to 3 (severely, it bothered me a lot), for a maximum possible score of 63. The ROSW asks whether the participant experiences LBP chronically or when engaging in a list of 10 different activities. Each activity has a possible answer of 0 (no disability) to 5 (severe disability), giving a maximum possible score of 50. ROSW scores are multiplied by 2 to provide a percentage of total disability. The BAI and ROSW were used to measure anxiety, and LBP, respectively, before and after the intervention or control period. As part of the posttest questionnaire, participants in the yoga group also completed an exit questionnaire to evaluate their perceptions of the effectiveness of, and to elicit feedback on, the yoga program.

Yoga Intervention
Participants in the yoga intervention were assigned to one of two class sections (Monday/Wednesday mornings or Tuesday/Thursday afternoons) depending on their personal schedules. Classes had 7–9 participants, and 3–5 research team members, including two certified yoga instructors, were present at each class to assist participants when necessary. This arrangement guaranteed sufficient staff on hand to help all participants when necessary without significantly slowing down the pace of the class. Instructors alternated teaching the classes to ensure all participants had equal exposure to both instructors, and the instructors discussed class format prior to the classes to ensure content and difficulty were consistent across class sections. Participants were required to attend at least 20/24 classes for inclusion in the present analysis. Of the 15 enrolled participants, 13 completed enough classes for inclusion. Two participants discontinued participation in the study, one due to leg pain unrelated to the intervention and one due to employment conflicts.

All classes maintained the following format: 5 minutes of introduction with relaxation and guided meditation, 10 minutes of gentle spinal movements, 30–35 minutes of standing poses, 5–10 minutes of cool down, and 5 minutes of rest and relaxation. Standing poses focused on balance and stability and included warrior I and II, crescent lunge, downward-facing dog, and tree. Participants were encouraged to work on safely transitioning between poses, with or without assistance from research staff. All poses were instructed with breath cues to encourage breath with movement, and the simplest, most accessible form of a pose was taught first, with more advanced variations offered as skill levels improved. During the final 5 minutes of every class, participants lay in savasana, a resting pose during which one lies supine on the floor with eyes closed in meditation. Instructors provided a brief, gentle axial pull on the legs or neck intended to maximize relaxation and comfort to all participants during this time.

The yoga intervention was designed to build on itself. The intervention began with basic spinal movements and integration of breath and movement, building up to a beginner vinyasa, or flow, class (Fig. 1). As individuals with PD often contend with bradykinesia, or a slowness in movement, classes were slow but evenly paced to accommodate all levels. Furthermore, as participants were not familiar with yoga poses, the instructors chose to avoid Sanskrit names, favoring English translations or descriptions instead. All participants were provided with a yoga mat (68 x 24 in.), high-density foam blocks (9 x 6 x 4 in.), and a cloth strap (1 x 120 in.). Foam blocks and straps were used to assist participants in poses. Chairs were available upon request should a participant need to rest but were not part of the yoga class. There were no adverse events such as falls or muscular injuries during the classes.

Statistical Analyses
Statistical analyses were conducted using IBM SPSS Statistics, version 24. For the 13 yoga participants who completed the study, we used propensity score matching to identify 13 age-matched control participants. Analyses reported include the 13 yoga completers and these 13 age-matched controls. Because of the small group sample sizes and data skewness, nonparametric tests were used. Mann-Whitney U tests were used to compare baseline performance for BESTest, BAI, and ROSW between groups. Wilcoxon signed-rank tests were used to compare pre- and posttest scores for BESTest, BAI, and ROSW within each group. Statistical significance was set at \( \alpha < 0.050 \).

Results
Participants in the yoga group attended an average of 22 classes, with a range of 20–24 classes. There were no significant demographic differences between groups at pretest (Table 1). Mann-Whitney U tests comparing pretest performance for BESTest total, each BESTest section, BAI, and ROSW showed no significant differences between groups at pretest.

BESTest total score and the six section scores were compared for each group. In the control group, there was a significant improvement in overall score (\( Z = -2.10, p = 0.040 \)) but not in any of the individual sections. The yoga group showed significant improvement in overall score (\( Z = -3.20, p = 0.001 \)) as well as improvement in the following sections: stability limits/verticality (\( Z = -2.30, p = 0.020 \)), transitions/anticipatory (\( Z = -2.50, p = 0.010 \)), reac-

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Focus for Each Week

Week 1 Sample Class Outline

Begin sitting
- Guided breathing, emphasis on deeper breaths
- Left knee to chest, draw circles with knee, gentle twist right*
- Both knees to chest, rock body to side and press up to comfortable seat

Demonstration of possible areas for blocks:
- Seated spinal flexion and extension (3x)
- Left arm reaches up, gentle twist to right, supporting with arm (3x)*
- Transition to hands-on-knees tabletop position, spinal flexion and extension (5x)
- Puppy pose: arms extended forward onto mat, hips stacked over knees, shins parallel, head on block or mat
- Child's pose: reach hips toward heels, knee apart or together, forehead to block or mat, arms reach forward or lay by sides

Demonstration of tabletop, spinal flexion and extension, puppy, and child's pose
- Repeat tabletop, spinal flexion and extension, puppy, and child's pose (3x)
- Lower onto belly and roll onto back
- Knees to chest, gentle rock side to side
- Bridge pose: feet flat on floor, palms beside hips, press into heels and lift hips off mat (option to use block for support)
- Supported shoulder stand: head under low back on sacrum, lift 1 or both feet off mat

Savasana

Week 12 Sample Class Outline

Begin sitting
- Guided full body scan of muscles and joints
- Left knee to chest, knee circles, twist right*
- Tabletop, spinal flexion and extension
- Right leg extends back (tie on mat or line), left arm reaches forward, opposite knee to elbow crunch (5x)*
- Downward-facing dog

Come to standing:
- Modified ten salutation A: standing arms by side, arms raise up, forward fold, lift spine halfway, forward fold, step back with right foot then left to plank position, downward-facing dog, come to standing (3x)*
- Modified plank (knees down), slowly lower to belly, press back up to modified plank (3x)
- Baby cobras on belly, hands below shoulders, elbows press down to midline, head/neck/chest (3x), hold last repetition for 5 breaths
- Child's pose

Come to standing:
- Sun salutation A, incorporating modified plank and baby cobras before downward-facing dog (3x)*
- Chair pose (3x), hold last repetition for 5 breaths
- Chair pose, arms to 2 position, twist right*
- Chair pose, forward fold, right leg steps back, low lunge with hands and right knee on mat, right hand on block or mat, twist reaching left arm up, high lunge, warrior II, reverse warrior, hands down to floor, step to downward-facing dog, come to standing*

Come to seated:
- Seated forward fold: legs extended forward, wrap around feet if needed

Come to supine:
- Supine figure-4 pose on right (right ankle on left thigh), then cross right thigh over left thigh, twist to the right*
- Both knees bag to chest as tightly as possible

Savasana
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Eleven participants reported feeling physical benefits, such as improved balance, strength, and flexibility. Finally, 10 participants said they planned on continuing yoga after the study, commenting that they enjoyed the program.

Discussion

Here we have shown that yoga can both improve balance and decrease LBP-related disability in people with PD. Specifically, our results indicate that after 12 weeks of yoga, people with PD were more stable and upright, better at transitions and anticipatory movements, more able to react quickly and appropriately to external stimuli, and better at sensory orientation. Additionally, people with PD reported significantly less LBP after the yoga intervention. In addition to the quantitative evidence, qualitative feedback from the exit survey was highly positive, with more than three-quarters of the participants intending to continue yoga after the research study.

The BESTest results illuminate which specific systems of balance changed over the course of the yoga intervention. Minimal clinically important differences for the BESTest, particularly for the individual balance systems, have not been established in PD. However, people in the yoga class did report feeling physical improvements after the intervention, which may have contributed to improved performance on the BESTest. The improvement in the transitions/anticipatory balance system suggests a yoga program emphasizing transitions is effective for targeted improvements in this system of balance. Additionally, the program helped people with PD improve their responses to external perturbations (i.e., postural instability). As people with PD are highly prone to debilitating falls due to increased limb stiffness and poorly directed arm movements, significantly improving these balance systems may help reduce fall risk. Furthermore, the stability limits/verticality balance system improved in the yoga group, suggesting yoga may have been

Table 1. Demographics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Control (n = 13)</th>
<th>Yoga (n = 13)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age in y, mean (SD)</td>
<td>65.0 (8.7)</td>
<td>70.5 (8.7)</td>
<td>0.12</td>
</tr>
<tr>
<td>Sex, No. female</td>
<td>5</td>
<td>6</td>
<td>0.99</td>
</tr>
<tr>
<td>MMSE, median (range)</td>
<td>29 (25–30)</td>
<td>29 (27–30)</td>
<td>0.73</td>
</tr>
<tr>
<td>UPDRS-III, median (range)</td>
<td>24 (18–42)</td>
<td>29 (10–49)</td>
<td>0.74</td>
</tr>
<tr>
<td>H&amp;Y, median (range)</td>
<td>2 (2–3)</td>
<td>2 (2–3)</td>
<td>0.99</td>
</tr>
</tbody>
</table>

SD = standard deviation; MMSE = Mini Mental State Exam; UPDRS-III = Unified Parkinson’s Disease Rating Scale, Motor Symptom Subscale; H&Y = Hohn and Yahr stage.

Table 2. Outcome Measures, Median (Range)*

<table>
<thead>
<tr>
<th></th>
<th>Controls</th>
<th>Yoga</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pretest</td>
<td>Posttest</td>
<td></td>
</tr>
<tr>
<td>Biomechanical</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>constraints</td>
<td>10 (4–12)</td>
<td>11 (5–13)</td>
<td>0.100</td>
</tr>
<tr>
<td>Stability limits</td>
<td>18 (15–21)</td>
<td>19 (11–21)</td>
<td>0.170</td>
</tr>
<tr>
<td>verticality</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transitions/</td>
<td>14 (10–18)</td>
<td>13 (11–18)</td>
<td>0.390</td>
</tr>
<tr>
<td>anticipatory</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reactive</td>
<td>12 (6–18)</td>
<td>13 (5–17)</td>
<td>0.660</td>
</tr>
<tr>
<td>Sensory orientation</td>
<td>13 (10–14)</td>
<td>13 (9–15)</td>
<td>0.060</td>
</tr>
<tr>
<td>Stability in gait</td>
<td>16 (10–19)</td>
<td>17 (13–20)</td>
<td>0.110</td>
</tr>
<tr>
<td>Total</td>
<td>84 (63–95)</td>
<td>86 (66–100)</td>
<td>0.040*</td>
</tr>
<tr>
<td>Beck Anxiety</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inventory</td>
<td>8 (0–14)</td>
<td>6 (1–14)</td>
<td>0.690</td>
</tr>
<tr>
<td>Revised Oswestry</td>
<td>14 (0–40)</td>
<td>14 (0–40)</td>
<td>0.630</td>
</tr>
<tr>
<td>Disability Index</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Wilcoxon signed-rank test compared pre- and posttest within each group, separately.

Significant at α < 0.050.
Figure 2. Box-and-Whisker Plots for Changes in Outcomes from Pre- to Posttest

For the Balance Evaluation Systems Test (BESTest) and its system sections, a positive change denotes improvement; for the Revised Oswestry Disability Index (ROSW), a negative change denotes reduced disability; for the Beck Anxiety Inventory (BAI), a negative change denotes reduced anxiety; the bottom two rows show the different balance systems within the BESTest; + indicates mean value.

able to mitigate the tendency toward the flexed trunk associated with increased disease severity.

The yoga group results stand in contrast to control group performance. Although the controls improved in the BESTest total score, none of the individual systems significantly changed. This indicates the control group improved performance overall, but improvement was random, with no systematic change leading to this result. Additionally, controls were asked to continue their normal routines of physical activity, so changes in total BESTest score may be due to improvements associated with outside routines or with a practice effect from pre- to posttest.

The LBP improvements are noteworthy, as little research has been conducted looking at LBP treatment in PD. Exercises to address stooped posture and motor function are often given as the treatment for LBP, and the multiple motor and nonmotor symptoms associated with PD may impact traditional LBP treatment efficacy. Our yoga group reported both significantly reduced LBP after the yoga intervention and enjoyment of the class overall. Previous research on LBP suggests a reduction of 10% for the ROSW is clinically meaningful. Because of our smaller sample size, whether this threshold was truly met cannot be determined, but our data suggest the mean change in ROSW for the yoga group was around 10% (Fig. 2).

Participant enjoyment of an activity is important for activity adherence, and group exercise increases participant enjoyment compared to exercising on one’s own. Not only did the yoga group report enjoying the classes, but 10 of the 13 participants said they planned to continue practicing yoga after the study. This suggests the benefits of the yoga class went beyond quantifiable changes in balance and LBP
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and indicates that yoga was perceived as an accessible activity to the participants. A regular yoga class would promote activity and provide a social support system, both of which are important among people with PD.28

Surprisingly, we did not see a significant decrease in BAI in the yoga group, but this may have been due to participants reporting low anxiety at baseline, with all pretest scores less than 21, except for one participant in the yoga group. That participant went from a pretest BAI score of 35 to a posttest BAI score of 18. Additionally, although relaxation and guided meditation were offered at the beginning and end of each class, our yoga program did not focus on meditation.

Although this study’s sample size was small, groups were similar at pretest and significant differences were detected from pre- to posttest. Additionally, we showed that a transition-focused yoga program is feasible, having had no adverse events during class; most individuals who completed the program intended to continue to practice yoga after the study because of perceived physical benefits from the intervention. Importantly, a significant amount of assistance from research team members was needed to ensure the safety of participants. The ratio of research staff to participants was never lower than 1:3. This may suggest this yoga program would not be as safe and effective for individuals with more severe PD. Future research is needed to assess the implementation of a yoga program in a community setting where the ratio of instructors to participants would decrease.

Future studies would also benefit from including active control groups, such as one that received a bodyweight exercise intervention. We have shown that a yoga practice may be an accessible alternative for people with PD who do not wish to engage in more traditional forms of exercise, but we are unable to compare yoga’s effects to those exercise forms. During classes, some participants used the foam blocks to adapt poses based on their flexibility or to increase stability. This introduces variability in the received intervention, but it is standard in any yoga class to provide each student with the necessary tools to fully participate in a safe and effective manner. Importantly, this yoga program did not use chairs, encouraging participants to challenge themselves and learn strategies for safe postural transitions.

Overall, our study showed that yoga is potentially beneficial for people with PD and further examination is warranted. Although we have shown improvements in specific systems of balance, future research should examine whether these improvements are due to improved muscle strength, changes in muscle activation patterns, or other factors. Future work may also provide further insight into why yoga impacted LBP and its relationship to different systems of balance. Additionally, yoga’s impact on fall risk requires further research. Although we report balance improvements, whether that translates to full reduction is beyond the scope of this study. Nevertheless, yoga offers a nonpharmacological treatment for balance deficits in people with PD, as well as other physical and social benefits important for maintaining high quality of life.

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Conflict-of-Interest Statement
The authors have no conflicts of interest to report.

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