Research

Predictors of Functional Improvements After Therapeutic Yoga Intervention for People with Parkinson's Disease

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Abstract

Parkinson's disease (PD) affects nearly 10 million people worldwide, leading to decreased mobility and balance and potential loss of independence. Yoga has been associated with improved function for people with PD, but the predictive factors for improved functional outcomes as a result of yoga participation remain unexamined. The objective of this secondary data analysis was to identify predictive factors of functional improvement for people with PD after an 8-week yoga intervention. Stepwise multiple linear regression was used to identify significant predictors of improvement in balance, fall control, PD symptoms, and activity constraints. Lower cognitive functioning was predictive of improvement in perceived control over falls, body responsiveness was predictive of improvement in PD-specific symptoms, and gait velocity was predictive of improvement in balance and activity constraints. Future research is warranted to evaluate the use of screeners to predict who is the best fit for yoga therapy. Additional research is needed to evaluate the need to include cognitive self-management training concurrent with yoga therapy. *Adams et al. Int J Yoga Therapy 2020(30). doi: 10.17761/2020-D-18-00005.*

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Introduction

Parkinson's disease (PD) affects approximately 10 million people in the world and is the second most common neurological disorder in the United States.[1] PD is chronic and progressive, affecting movement and including symptoms such as resting tremor, slow movements (bradykinesia), impaired posture and balance, increased fatigue, inhibited facial expression, monotone voice, increased rates of orthostatic hypotension (OH), and declining cognitive functioning.[1–3] The average age of PD onset is 55 years old, and one in 100 people over age 55 will develop the illness.[4] PD is a multifactorial disease associated with a combination of genetic predisposition and environmental factors,[5] although the exact cause is unknown. PD affects the substantia nigra, the part of the brain that produces dopamine; as cells in the substantia nigra die, the amount of dopamine released decreases and leads to issues with functional movement.[6] As the disease progresses and functional movement decreases, people with PD experience higher rates of falls, leading to fear of falling and decreased engagement in occupational, recreational, and social activities. This progression of PD ultimately leads to decreased functioning, independence, and quality of life.[7]

People with PD experience a risk of falling that is two times greater than that of older adults in the general population.[8] Predictive factors for fall risks include OH, postural instability, gait difficulty, and muscle weakness.[9] In addition, balance impairment and a person's history of falls increases their risk of future falls.[10,11] Sixty-eight percent of people with PD experience a fall over the course of 1 year,[12] with 55% experiencing more than one fall.[8] Longer years living with PD is associated with higher frequency of falls.[13] Falls have serious consequences, including increased risk of mortality, increased dependency and admission to assisted-living facilities, as well as decreased quality of life.[8] The prevalence of falls and the detrimental consequences of falling demonstrate the widespread need for alternative therapies to complement usual care to help improve balance and reduce falls.[10]

Standard treatment for PD primarily consists of pharmacotherapy to increase dopamine levels in the brain.[1] Historically, medications had intolerable side-effects, but improvements in medications have reduced negative side-effects and improved the prognosis for people with PD, especially with early diagnosis and treatment.[1] Despite these advances in treatment, symptoms persist for most, and participation in community activities, leisure pursuits, and independent living typically continues to decrease.[3]

Prior research indicates people with PD experience positive outcomes in response to physical exercise, including improved flexibility, muscle strength, balance, aerobic capacity, reduced fear of falling, and improved quality of life.[14–16] Despite indications that physical exercise leads to improved symptoms, there are no specific recommendations for exercise in the current practice guidelines for PD.[17] As people with PD try to maintain muscle function and reduce their perceived risk of falls, they often request physical therapy referrals.[1] However, as the focus of physical therapy is not typically to simply maintain fitness levels, people are often referred to fitness instructors instead, posing a danger if the fitness instructor is not trained in adapting physical exercise programs.[18,19] To address these concerns, many practitioners perceive a need to revise the current practice guidelines, as research indicates exercise may help slow the progression of the disease.[14,20] As professionals consider reassessing standard treatment for PD, research is needed to identify the most effective treatments for maintaining and improving physical function for this population.[18]

Yoga asana has been explored as a form of exercise to be used, in conjunction with medication, to improve functional outcomes for people with PD. Results of two individual case studies and three randomized controlled pilot studies, including the primary findings from the present data, have demonstrated promising outcomes such as improved balance,[18,21,22] improved motor control,[18,22] decreased bradykinesia and rigidity,[23] improved muscle strength,[14,18] improved gait,[22] reduced fear of falling,[22] and increased participation in leisure activities and community events.[14,22,24] This research shows promise for yoga's ability to improve balance and indicates that yoga may help people with PD maintain independent functioning and improve quality of life. It remains unclear, however, whether yoga may be effective for all people with PD, or whether predictive factors exist that may help clinicians determine the appropriateness of a yoga prescription. To our knowledge, no research has explored predictive factors for improved functional outcomes during a yoga intervention for people with PD. Therefore, the purpose of this post-hoc secondary analysis was to determine the demographic, physical, and mental factors that predict functional outcomes for people with PD.

Methods

Design

The secondary data analyzed in this article were obtained from an exploratory randomized waitlist controlled study that used yoga as an intervention for people with PD.[22] Potential participants were identified through the healthcare system where they received treatment and were contacted by a member of the research team to determine interest. Participants were randomly assigned to either an experimental group, who received the yoga intervention, or to the control group, who were placed on a waitlist for 8 weeks before receiving the yoga intervention. Both the experimental and control groups were reassessed after 8 weeks to determine any change in outcome measures.

The intervention was a progressively difficult Hatha Yoga class taught by an IAYT-certified yoga therapist (C-IAYT). Participants met twice a week for 60-minute group yoga sessions for 8 weeks. The yoga intervention was designed with the primary intention to improve balance and reduce fear of falling. The intervention included breath exercises; modified yoga postures in sitting, standing, and supine positions (Table 1); and a 10-minute relaxation pose *(savasana)* at the end. Props (including chairs, blankets, blocks, bolsters, straps, and sandbags) were used to modify poses to meet participants' physical ability.

To be included in the study, participants had to have a diagnosis of PD and a score of 1.5–4 on the modified Hoehn and Yahr scale of PD progression,[25] report a fear of falling, speak English, score 4/6 or higher on the Six-Item Screener,[26] and commit to attend the intervention twice weekly for 8 weeks. Exclusion criteria included people with a self-reported life expectancy of less than 12 months, inconsistent transportation to the intervention, or inability/refusal to provide informed consent.

Instrumentation and Analysis

The demographic information collected included age, race, marital status, education level, and self-reported overall health. A battery of assessments was administered to evaluate functional outcomes at baseline (T1) and immediately following the 8-week intervention (T2). The outcome measures included the Mini-Balance Evaluation Systems Test (Mini-BESTest),[27,28] Functional Gait Assessment (FGA),[29] Falls Management Scale (FMS),[30] Falls Control Scale (FCS),[31] Parkinson's Fatigue Scale (PFS),[32] Parkinson's Disease Questionnaire-8 (PDQ-8),[33] OH,[34] the Montreal Cognitive Assessment (MoCA),[35] Movement Disorders Society–Sponsored Revision of the Unified Parkinson's Disease Rating Scale (MDS-UPDRS), Body Responsiveness Questionnaire (BRQ),[36,37] and the 10-Meter Walk Test (10MWT).[38]

Table 1. Sequences for 8-Week Yoga Intervention

Breathing Exercises and Postures	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Pranayama in/out and *ujjayi* breath	X	X	X	X	X	X	X	X
Alternate-nostril breathing			X	X				
Humming-bee breath					X	X		
Four-part breath							X	X
Tadasana (mountain: seated & standing)	X	X	X	X	X	X	X	X
Alanasana (high lunge)	X	X	X					
Tadasana (mountain: seated with twist)	X	X	X	X	X	X	X	X
Uttanasana (standing forward bend)	X	X	X	X	X	X	X	X
Sukhasana (easy pose)						X	X	X
Parivritta sukhasana (simple twist)						X	X	X
Bharmanasana (tabletop: seated)	X	X	X	X	X	X	X	X
Ardha uttanasana (standing half forward bend)	X	X						
Dandayamna bharmanasana (balancing table)			X	X	X	X	X	X
Dandayamna bharmanasana (balancing table: with wide base of support)			X	X				
Dandayamna bharmanasana (balancing table: tripod or contralateral balance)			X	X	X	X	X	X
Dandayamna bharmanasana (balancing table: contralateral arm and leg balance)			X	X	X	X	X	X
Chaturanga dandasana (four-limbed staff)					X	X	X	X
Malasana (garland: dynamic using back of chair for support)	X	X	X	X	X	X	X	X
Utkatasana (chair)			X	X	X	X	X	X
Virabhadrasana II (warrior II: dynamic)	X	X	X	X	X	X	X	X
Virabhadrasana II (warrior II: static)					X	X	X	X
Virabhadrasana II (warrior II: step into warrior and step back)	X	X	X	X	X	X	X	X
Trikonasana (triangle)			X	X	X	X	X	X
Vriksasana (tree: prep)		X	X					
Vriksasana (tree)			X	X	X	X		
Utkatasana (chair: sitting and standing)	X	X						X
Navasana (boat: in chair)	X	X	X					
Navasana (boat: on mat)					X	X	X	X
Kapotasana (pigeon prep and pigeon)					X	X	X	X
Ardha chandrasana (half-moon: seated)		X	X					X
Ardha chandrasana (half-moon: standing)				X	X	X	X	X
Soaring seagull wrist stretch					X	X	X	X
Shoulder roll (forward and back)	X	X	X	X	X	X	X	X
Hand mudra (opposition/apposition and palm stretch)	X	X	X					X
Neck stretch (lateral flexion and extension)	X	X	X	X	X	X	X	X
Shoulder flexion	X	X	X	X	X	X	X	X
Shoulder circles	X	X	X	X	X	X	X	X
Supination/pronation	X	X	X	X	X	X	X	X
Heel and toes (rocking and raising: seated	X	X	X					
Heel and toes (rocking and raising: standing)				X	X	X	X	X

(continued on next page)

Table 1. *continued*

Breathing Exercises and Postures	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Marching (narrow and wide)	X	X	X	X	X	X	X	X
Marching (narrow and wide slowly)				X	X	X	X	X
Anjaneyasana (low lunge/half kneel: floor transition)	X	X	X	X	X	X	X	X
Savasana (corpse: on chair or mat)	X	X	X	X	X	X	X	X
Alanasana (high lunge)				X	X	X	X	X
Anjaneyasana (low lunge/hamstring stretch: dynamic)	X	X	X	X	X	X	X	X
Padangustasana (hand to big toe: with strap)					X	X	X	X

Mini-Balance Evaluation Systems Test

The Mini-BESTest is an abbreviated version of the Balance Evaluation Systems Test.[27] The test was conducted by the study physical therapist, who had the participants perform specific tasks such as lifting the right leg, standing with closed eyes, and moving from sitting to standing and back again. The Mini-BESTest consists of 14 items scored 0–2, for a total score possibility of 0–28; higher scores indicate higher ability to achieve and maintain balance.[27] For PD, the Mini-BESTest has excellent test-retest reliability (intraclass correlation coefficient [ICC] = 0.96) and excellent internal consistency (Cronbach's alpha = 0.91).[39] Minimal clinically important difference (MCID) is an improvement of 4 points out of 28 total.[39]

Functional Gait Assessment

This 10-item functional assessment evaluated participants' postural stability as measured while completing various walking tasks[28,29] and was administered by the study physical therapist. The FGA has excellent test-retest reliability (ICC = 0.91) and excellent internal consistency (Cronbach's alpha = 0.79). Scores range from 0–30, with a lower score indicating lower functioning. MCID is 8 points from pretest to follow-up.[40]

Falls Control Scale

The 4-item FCS assesses participants' confidence in their ability to prevent a future fall.[41] Each item is rated on a 4-point Likert scale. Scores range from 4–20, with a higher score indicating higher perceived control. Among the general population, it has excellent test-retest reliability (ICC = 0.93)[30] and adequate internal consistency (Cronbach's alpha = 0.70).[42]

Falls Management Scale

The 5-item FMS assesses participants' confidence in their ability to manage and recover from fall if a fall were to occur. Scores range from 5–20, with higher scores indicating that the participant is better able to manage falls. Among the general population it has adequate test-retest reliability (ICC = 0.74)[30] and acceptable internal consistency (Cronbach's alpha-0.88).[42]

Parkinson's Fatigue Scale

The 16-item PFS measures the subjective experiences of PD-related fatigue reported by the participant. Seven items focus on physical symptoms of fatigue, and nine items focus on the effect fatigue has on daily activities, including socializing. The scale has excellent test-retest reliability for people with PD (ICC = 0.83) and excellent internal consistency (Cronbach's alpha = 0.98).[32] Scores range from 16–80, with higher scores indicating greater fatigue.[32]

Parkinson's Disease Questionnaire-8

This is a short-form of the Parkinson's Disease Questionnaire-39 that measures quality of life constructs for people with PD.[33] Each item is scored from 0–4 points, and scores are summed and divided by the total possible to give a final score as a percentage; higher percentages signify higher symptoms and/or lower quality of life. The PDQ-8 has acceptable test-retest reliability (ICC = 0.72)[43] and excellent internal consistency (Cronbach's alpha = 0.88).[44] MCID is 5.4 points from pretest to follow-up.

Orthostatic hypotension

OH is diagnosed when a 20-mmHg drop in systolic blood pressure or a 10-mmHg drop in diastolic blood pressure occurs when a participant moves from a supine or sitting position to a standing position.[13,34] Blood pressure was measured while participants were sitting and again immediately upon standing. A 20-mmHg drop in systolic blood pressure was the criterion for OH in this analysis.

Montreal Cognitive Assessment (MoCA)

The MoCA is a cognitive screening tool developed to identify mild cognitive impairments and dementia.[35] A score of 26–30 indicates normal cognitive functioning, a score less than 26 indicates mild cognitive impairment, and a score of 21 or less indicates dementia.[45] The assessment has excellent reliability (ICC = 0.81) and excellent internal consistency.[46]

Dyskinesia

Presence of dyskinesia (sporadic and uncontrolled body movement) was determined by a physician at the first assessment. In this analysis, it was treated as a binary variable (1 = dyskinesia was present, 2 = dyskinesia was not present) that indicated whether the participant presented with dyskinesia during pretest. This was established during the administration of the MDS-UPDRS. This test was administered by an MDS-trained physician or, in a few cases, by a physical therapist who had been specially trained by an MDS-trained neurologist.

Body Responsiveness Questionnaire

This 7-item scale measures participants' confidence in trusting their body, suppression of bodily sensation, awareness of body sensations throughout the day, and enjoyment of body sensations. Scores range from 7–49, with higher scores equaling higher body responsiveness.[37] The BRQ has excellent reliability in the general population (Cronbach alpha = 0.62–0.83),[47] but there is no information on validity, and it has not been tested in a PD population.

10-Meter Walk Test

The 10MWT is designed to test gait speed over a short distance.[38] It has excellent reliability for both comfortable (ICC = 0.96) and maximum gait speed (ICC = 0.97) for people with PD.[48] Internal consistency has not been established.[49]

Data Analysis

Data analysis was conducted using SPSS 24. First, dependent variables were computed by calculating changes in functional outcome measure scores between T1 and T2. Data were transformed so that a higher score on any measure was indicative of better functioning. Stepwise linear regression is especially useful when comparing a large number of variables and predictive factors, as was the case with this analysis.[50] The analysis used stepwise linear regression with the set of predictive variables against each dependent variable (Table 2).

Results

A total of 27 participants completed the study, with 15 in the experimental group and 12 in the waitlist control group. (See Walter et al.[51] for the CONSORT diagram.) Participants in the experimental and waitlist control groups were included in the regression models because both groups received the yoga intervention, albeit at different time points. The demographics of the sample were 63% male, 88.9% married, 92.5% educated beyond high school, average age was 67, and all were Caucasian (Table 3).

Table 2. Outcome Measures

Measure	Construct	Time Point
Predictive variables		
OH	Balance	T1
MoCA	Cognitive functioning	T2
Dyskinesia	PD symptoms	T1
BRS	Body awareness and responsiveness	T1
10MWT	Gait speed	T1
Gender	Demographic	T1
Overall health	Demographic	T1
Dependent variables		
Mini-BESTest	Balance	*T1–T2
FGA	Gait	*T1–T2
PFS	Fatigue	*T1–T2
PDQ-8	PD symptoms	*T1–T2
FMS	Fear of falling	*T1–T2
FCS	Fear of falling	*T1–T2

OH = orthostatic hypotension; MoCA = Montreal Cognitive Assessment; BRS = Body Responsiveness Scale; 10MWT = 10-Meter Walk Test; Mini-BESTest = Mini-Balance Evaluation Systems Test; FGA = Functional Gait Assessment; PFS = Parkinson's Fatigue Scale; PDQ-8 = Parkinson's Disease Questionnaire-8; FMS = Falls Management Scale; FCS = Falls Control Scale; PD = Parkinson's disease; T1 = baseline; T2 = immediately following the 8-week intervention.

*All data were transformed so a higher score = more improvement.

Table 3. Demographics of Yoga and Control Groups

	Yoga Only (n = 15)	Waitlist Control (n = 12)
Age (mean [SD])	65.53 (6.09)	70.5 (4.44)
Gender (% [n])		
Male	66.67 (10)	58.33 (7)
Female	33.33 (5)	41.67 (5)
Marital status (% [n])		
Married	86.67 (13)	91.67 (11)
Widowed	0 (0)	8.33 (1)
Divorced	6.67 (1)	0 (0)
Separated	6.67 (1)	0 (0)
Race (% [n])		
White	100 (15)	100 (12)
Education (% [n])		
Less than high school	6.67 (1)	0 (0)
High school	0 (0)	8.33 (1)
Some college	13.33 (2)	25.00 (3)
College graduate	46.67 (7)	33.33 (4)
Some postgraduate	6.67 (1)	8.33 (1)
Postgraduate degree	26.67 (4)	25.00 (3)
Overall health (% [n])		
Excellent	6.67 (1)	0 (0)
Very good	60.00 (9)	33.33 (4)
Good	6.67 (1)	16.67 (2)
Fair	26.67 (4)	41.67 (5)
Poor	0 (0)	8.33 (1)

SD = standard deviation.

Table 4. Predictors of Functional Improvements

Independent Variable	Predictive Variable(s)	R^2	df	F	p Value	β	p Value
Mini-BESTest	10MWT	0.188	22	4.875	0.038	0.299	0.038
FGA	Dyskinesia	0.177	22	4.516	0.046	0.421	0.047
FMS	MoCA	0.233	22	6.372	0.020	−0.482	0.020
FCS	MoCA	0.243	22	6.729	0.017	−2.594	0.017
PFS	BRQ	0.205	22	5.417	0.030	−0.453	0.030
PDQ-8	BRQ	0.172	22	4.355	0.049	−4.140	0.049

df = degrees of freedom; Mini-BESTest = Mini-Balance Evaluation Systems Test; FGA = Functional Gait Assessment; FMS = Falls Management Scale; FCS = Falls Control Scale; PFS = Parkinson's Fatigue Scale; PDQ-8 = Parkinson's Disease Questionnaire-8; 10MWT = 10-Meter Walk Test; MoCA = Montreal Cognitive Assessment; BRQ = Body Responsiveness Questionnaire.

Mini-Balance Evaluation Systems Test

Participants in the study experienced an overall 29.6% improvement on total Mini-BESTest scores between T1 and T2, with 69% of participants (n = 16) experiencing a clinically significant change. A stepwise linear regression resulted in one significant model with one factor (F = 4.86, p = 0.038, R^2 = 0.188) predicting improvement on Mini-BESTest scores. According to the stepwise regression analysis, the 10MWT scores at T1 explained 19% of the variance in improvement on the Mini-BESTest. (See Table 4 for a summary of outcomes measures and predictive factors.) This model indicated that faster gait speed at T1 predicted greater improvements in balance at T2.

Functional Gait Assessment

Participants in the study experienced an overall 37.5% improvement on total FGA scores between T1 and T2, with 30% of participants (n = 7) experiencing a clinically significant change. A stepwise linear regression resulted in one significant model with one factor (F = 4.52, p = 0.046, R^2 = 0.177) predicting improvement on FGA scores. According to the stepwise regression analysis, the presence of dyskinesia explained 17% of the variance in improvement on the FGA. This model indicated that the absence of dyskinesia at T1 predicted greater improvements of postural stability at T2.

Falls Management Scale

Participants in the study experienced an overall 8.6% improvement on total FMS scores between T1 and T2. A stepwise linear regression resulted in one significant model with one factor (F = 6.37, p = 0.020, R^2 = 0.234) predicting improvement on FMS scores. According to the stepwise regression analysis, MoCA scores explained 23% of the variance in improvement on the FMS. This model indicated that lower cognitive functioning at T2 predicted greater improvement in efficacy to manage falls at T2.

Falls Control Scale

Participants in the study experienced an overall 3.5% improvement on total FCS scores between T1 and T2. A stepwise linear regression resulted in one significant model with one factor (F = 6.729, p = 0.017, R^2 = 0.243) predicting improvement on FCS scores. According to the stepwise regression analysis, MoCA scores explained 24% of the variance in improvement on the FCS. This model indicated that lower cognitive functioning at T2 predicted greater improvements in the efficacy of falls control at T2.

Parkinson's Fatigue Scale

Participants in the study experienced an overall 12% improvement on total PFS scores between T1 and T2. A stepwise linear regression resulted in one significant model with one factor (F = 5.417, p = 0.030, R^2 = 0.205) predicting improvement on PFS scores. According to the stepwise regression analysis, BRQ at T1 scores explained 20% of the variance in improvement on the PFS. This model indicated that lower body awareness at T1 predicted greater improvements in PD-related fatigue at T2.

Parkinson's Disease Questionnaire-8

Participants in the study experienced an overall 28.65% improvement on total PDQ-8 scores between T1 and T2, with 34.7% of participants (n = 8) experiencing a clinically significant change. A stepwise linear regression resulted in one significant model with one factor (F = 4.355, p = 0.049, R^2 = 0.172) predicting improvement on PDQ-8 scores. According to the stepwise regression analysis, BRQ scores explained 17% of the variance in improvement on the PDQ-8. This model indicated that lower levels of body awareness at T1 predicted greater improvements in quality of life at T2.

Discussion

The purpose of this study was to evaluate the predictive factors of functional improvement after an 8-week therapeutic yoga intervention. Although research indicates promising outcomes for people with PD after a yoga intervention, to our knowledge this is the first study to examine predictive factors for successful outcomes from a yoga intervention. Analyses indicated that initial BRQ scores predicted improved outcomes on PD-related fatigue and quality of life symptoms (PFS, PDQ-8), impaired cognitive functioning (MoCA scores) predicted greater improvement on perceptions of falls (FMS, FCS), and initial performance on the 10MWT predicted improvement on the MiniBESTest.

Body Responsiveness as a Predictive Factor for Quality of Life and PD Fatigue

Lower BRQ scores predicted greater improvement in quality of life and PD-related fatigue as measured by the PDQ-8 and PFS, respectively. Past research indicates that people with PD generally demonstrate lower body responsiveness (also known as interoception sensitivity, or the ability to sense the internal state of the body).[52] However, in contrast to the definition of interoception, some studies have found lower interoception sensitivity to be correlated with higher perceived control of and connection with the body.[53] This was explored in a study evaluating people's perception of control and ownership of a rubber hand; people with low interoception sensitivity exhibited a stronger illusion of ownership over body parts that did not belong to them than people with high interoception sensitivity.[53] Thus, people with lower objective interoception had higher confidence in their ability to be aware of and control their bodies, whereas people with higher objective interoception more accurately recognized their inability to control the prosthetic appendage.

Although some past research correlates increased interoception with positive emotions, other research indicates that increased interoception sensitivity is associated with higher anxiety and other negative emotions.[54] It is possible that body awareness, in general, makes people more aware of and sensitive to pain, discomfort, and fatigue.[54] In this study, PD-related fatigue and PD-related quality of life were both negatively predicted by body responsiveness, potentially because higher body responsiveness led to higher awareness of pain and fatigue. Further research is warranted to explore this connection specifically and to potentially explain conflicting findings in past research.

Cognitive Functioning as a Predictive Factor for Fall Efficacy

Improvements on scales used to predict perception of one's ability to prevent falls from occurring (FCS) and recover from a fall if it does occur (FMS) were both predicted by cognitive functioning, with lower cognitive functioning predicting greater self-efficacy in participants' ability to prevent and manage falls. Past research has correlated higher fall efficacy with higher functional improvement.[55] However, in this study, MoCA scores were not related to improvement in any observed functional outcome measures such as balance, muscle strength, or gait speed. These results are consistent with Uemura et al.'s[56] findings that community-dwelling adults with global cognitive impairment demonstrate the least amount of fear of falling compared to adults in the same community without a global cognitive impairment. Persad et al.[57] found older adults with impaired cognition performed more poorly on tasks related to fall predictions and concluded that impaired cognitive functioning increases fall risk. This discrepancy between confidence in the ability to manage falls and observed performance during a fall risk assessment was specifically observed in a study of community-dwelling adults over 50 years old in Korea.[58]

Because the FCS and FMS measure participants' perception of their ability to control falls, and not the actual function, perhaps only the perceptions of ability increase when cognitive functioning is impaired. One explanation for this discrepancy between reported perceived ability and observed ability is that people with cognitive impairments do not understand the self-report questionnaires despite the administration and clarification by researchers. Hauer et al.[59] recommended researchers conduct interviews to assess falls efficacy rather than relying on self-report questionnaires when conducting research with people who have a cognitive impairment. Another explanation is that successfully completing the yoga intervention gives people a false sense of confidence because of their ability to balance in the controlled environment of the yoga studio. People with lower cognitive functioning may more readily generalize this success to all activities.

Gait Velocity as a Predictive Factor

Gait velocity, as measured by the 10MWT, predicted improvement in observed functional balance, as measured by the MiniBESTest. This supports previous research that indicates gait velocity might be used as a "functional vital sign"[60] for a general indicator of vitality. Research has established that gait velocity is predictive of disability, cognitive impairment, independent living, falls risk, and quality of life.[22,61] The present analysis adds that gait speed may predict a person's ability to improve balance through yoga interventions. This has the potential to be a simple, efficient, and effective screening tool to indicate who might functionally benefit from a yoga intervention.

Implications and Recommendations

Research indicates that yoga interventions may be an effective adjunct therapy to help improve balance and functional strength and to reduce falls, activity constraints, and PD fatigue, but not every person responds the same to therapeutic yoga. Further study is needed to explore the factors that predict a positive outcome of a yoga intervention. Because the research has mixed results, further research is needed to evaluate whether there exists a relationship between interoception and experiences of pain, fatigue, positive emotions, negative emotions, and overall quality of life.

Additionally, participants with lower interoceptive awareness may have the potential to experience a greater improvement in interoceptive awareness after a yoga intervention. However, researchers and practitioners may consider that increasing interoception sensitivity may need to be paired with cognitive training or a self-management program so participants are able to experience these sensations without judgment or can cope with body sensation in a helpful manner. The present analysis presents the potential pitfall of increasing interoception without also increasing the ability to cope with sensations such as pain and fatigue.

When evaluating program outcomes, researchers and practitioners should consider the possibility that self-report surveys on fall efficacy may not be reliable or valid for people with impaired cognitive functioning. Additionally, people may improve their confidence at a rate that does not match their skill level, and care should be taken to include educational components of fall management.

Finally, future research should further evaluate the ability of the 10MWT, MoCA, and BRQ to be used as screeners to predict success in functional outcomes from yoga interventions in populations with PD, in other clinical populations (e.g., stroke, cancer), and with the general older adult population. Specifically, the 10MWT may be a simple screening tool to predict the degree of improved function that may be expected following a yoga intervention. Such tools can help practitioners better match people to the type of yoga that would be most beneficial. Lower scores on the MoCA may indicate the need for additional self-management education, whereas lower scores on the BRQ may indicate the need for concurrent mindfulness training.

Limitations

The sample size for the intervention was small and consisted of participants who were all Caucasian, and all self-selected based on interest. It is difficult to know if these individuals were more physically active, more motivated to engage in physical activity, more social, or had higher perceived health than the general PD population. Additionally, assessors were only blinded during baseline measures—not at posttesting—and this introduces the potential for bias in results. These potential differences may have influenced the outcomes and predictors of outcomes differently. Overall, the data provide interesting insight into potential relationships between factors that have previously been unexplored.

Conflict-of-Interest Statement

The authors confirm they have no conflicts of interest to declare.

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