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Controlled pilot study of the effects of power yoga in Parkinson's disease

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ABSTRACT

Objectives: To evaluate the effects of a specially designed power yoga program (YOGA) on bradykinesia, rigidity, muscular performance and quality of life in older patients with PD.
Design: Randomized controlled trial.
Setting: University laboratory, US.
Intervention: Twenty-six patients with mild to moderate PD were randomly assigned to a YOGA or control group (CON). The YOGA program was three months, incorporating two sessions/wk of yoga classes.
Main outcome measures: Upper and lower limb bradykinesia and rigidity scores from the Unified Parkinson's Disease Rating Scale, one repetition maximums (1RM) and peak powers on biceps curl, chest press, leg press, hip abduction and seated calf, and quality of life (PDQ-39).
Results: The YOGA group produced significant improvement in both upper and lower limbs bradykinesia scores, rigidity score, 1RM for all 5 machines and leg press power ($p < .05$). Significant improvements were seen in the PDQ-39 overall score, mobility and activities of daily living domain for the YOGA group.
Conclusion: The 3-month YOGA program significantly reduced bradykinesia and rigidity, and increased muscle strength and power in older patients with PD. Power training is an effective training modality to improve physical function and quality of life for PD.

1. Introduction

Parkinson's disease (PD), a degenerative neurological disorder, affects .5–1% of older adults aged 65–69 years old and 1–3% of those above 80 years old,[1] with an average age of diagnosis being 62.[2] It primarily affects motor function, contributing to increasing disability over time. Patients commonly exhibit bradykinesia, rigidity, tremor, progressive postural instability,[3–5] and muscle weakness.[6,7] The declined movement function, along with the associated decrease in quality of life (QoL), necessitates the development of interventions that ameliorate these impairments.

Various exercise strategies,[8–10] including physical therapy, resistance or aerobic training, martial arts, and other complementary therapies, such as dance, have been suggested to address movement deficits in order to improve motor function and quality of life for individuals with PD. Yoga practice, becoming increasingly popular as a health-based activity, offer a highly refined, specifically delineated practice for affecting human behavior primarily through the close integration of the central and peripheral nervous systems during yoga performance.[11] The reported benefits of yogic training for healthy populations include improving muscle strength and endurance,[12–16] muscle power,[17] flexibility,[12,15,16] balance and coordination,[13,16] and health-related functions.[18] Additionally, yoga-based interventions have the potential to reduce the risk of falling[18,19] and improve quality of life[20] in individuals with musculoskeletal disorders. Although yogic therapeutic principles and interventions have been adopted by major rehabilitation clinics and hospitals across the country, very little controlled scientific research has been conducted to examine the efficacy of yoga as an intervention for PD.

One pilot study[21] indicated that a 12-week yoga intervention significantly improved motor Unified Parkinson's Disease Rating Scale (UPDRS) scores, balance function, flexibility, posture, and locomotion compared to a control group receiving no intervention. Another one reported positive symptom changes, including acute tremor reduction, and improved QoL.[22] However, there is no recent literature evaluating the effects of yoga on muscle function in older patients with PD.

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The purpose of this study was to examine the effects of a high-speed power yoga program on bradykinesia, muscle function and quality of life in older persons with mild to moderate PD, and to examine the relationship of clinical measures of bradykinesia to muscle power. Our research is novel in that we structured the power yoga program, using Vinyasa style, specifically designed to target bradykinesia, by using high-speed movement, and to muscle weakness by using strengthening postures. We hypothesized that this specially designed yoga program would significantly reduce bradykinesia, muscle strength and power, and quality of life for PD.

2. Methods

2.1. Participants

We performed a secondary analysis of results from a randomized controlled study examining the comparative impacts of power resistance training and power yoga on physical functions and quality of life in older individuals with PD over 3-month exercise interventions.[23] Baseline and 3-month post-training data was used for analysis. Methods for this study were approved by the University of Miami Subcommittee for the Use and Protection of Human Subjects, and all participants signed an informed written consent.

Patients with idiopathic PD participated in this study. The inclusion criteria included: 60–90 years old, diagnosed mild to moderate PD (Hoehn & Yahr stages I–III), capable of ambulation for at least 50 feet with or without an assistive device and able to get up and down from the floor with minimal assistance, and the Folstein Mini-Mental State Examination score ≥ 24 to ensure that participants could adequately understand the requirements during testing and training. Participants were excluded if they have PD symptoms greater than stage III symptoms on the Hoehn & Yahr Scale, have a decline in immune function such as pneumonia or systemic infection, or progressive degenerative disease besides PD; had orthopedic surgery in the past six months, and inability to make regular time commitments to the scheduled YOGA or engaging in regular practice (1–2 times weekly) of yoga within the past year.

The procedure of randomization was performed for the overall sample, using stratified randomization controlling for the Hoehn & Yahr stage employing Excel software (Microsoft Excel 2013; Microsoft Corp., Redmond, WA). Participants were assessed at the Laboratory of Neuromuscular Research and Active Aging, one hour after taking their usual PD medication ("on" state). The order of test administration was standardized among subjects and testing sessions. Pretests and post-tests were performed within a 2-week period before and after the intervention, respectively. All assessments were performed by the same testers.

2.2. Intervention

2.2.1. Yoga

The specially designed power yoga program (YOGA) was designed to improve movement speed, muscle strength and power specific to PD-related decrements. Power yoga is a yoga practice using Vinyasa style which incorporates vigorous, fitness-based positions.[24] Based on the characteristic of Vinyasa yoga (transitions between positions), the program used fast transitions from one posture to another,[25] thereby targeting bradykinesia and rigidity caused by PD. Additionally, strength, power, flexibility, and balance were addressed by stabilizing body extremities and strengthening core muscles through the YOGA intervention. This targeted yoga program was based on our earlier studies showing that muscle utilization patterns differed among Vinyasa yoga poses,[26,27] and that a 12-week, 2 times/week specially designed yoga program could improve balance function in older fallers to the same degree as an established balance training program and Tai Chi.[19] The specially designed yoga program for PD was given as group class for 12 weeks, 2 sessions/week, 1 h/session. During the practice, participants were instructed to perform fast transition of pose sequences, with holding one position no more than 3 breathes. This program incorporated three difficulty levels, which became progressively more challenging throughout the study. During the first four weeks, the training incorporated predominantly standing poses and a floor and balance series at mild to moderate intensity. For the next four weeks, the same pattern was used; however, more advanced poses were incorporated into the training. In the remaining weeks, the program incorporated progressively more difficult poses and transitions. The program was taught by three certified yoga instructors.

2.2.2. Control

For the control group (CON), participants continued receiving their usual care. And non-exercise health education classes were provided over the 12 weeks, with one class per month (totally 3 classes) on life style modification, medication, therapy and exercise, nutrition and long-term care.

2.3. Outcome measures

2.3.1. Bradykinesia

The bradykinesia score from the UPDRS motor exam was used to evaluate the effectiveness of the yoga intervention in addressing bradykinesia and improving movement speed. An upper limb bradykinesia score was derived by summing UPDRS motor exam items 23, 24 and 25[28]; while a lower limb bradykinesia subscore was calculated by summing UPDRS motor exam items 26, 27, 29 and 31.[7] The test was conducted by an experienced physical therapist.

2.3.2. Rigidity

Rigidity of the major joints, including neck, shoulder, elbow, wrist and knee, was measured using the item 22 from the UPDRS motor.

2.3.3. Strength and power

Measurements of strength and power were taken on five pneumatic resistance machines(Keiser A420, Keiser Sports Health Equipment, Fresno, CA), biceps curl, chest press, leg press, hip abduction, and seated calf. Muscle strength was measured using a one-repetition maximum (1RM). After measurement of the 1RM for each movement, power was assessed using the same pneumatic resistance machine. Peak power was assessed at seven relative intensities (30%, 40%, 50%, 60%, 70%, 80%, and 90% 1 RM) for each exercise. The testing order was randomized to reduce any fatigue or learning effects. For strength testing participants were provided a 2-min recovery between trials; while for power testing, a 1-min recovery was provided.

2.3.4. Parkinson's disease questionnaire (PDQ-39)

The PDQ-39 was used to measure the QoL of the PD patients before and after training. 39 items in this questionnaire and are categorized into 8 categories: mobility (10 items), activity of daily living (ADL) (6 items), emotional well-being (6 items), stigma (4 items), social support (3 items), cognitive impairment (4 items), communication (3 items), and bodily discomfort (3 items).

2.4. Data analyses

Power calculations (G-power, Universitat Dusseldorf, Germany) indicated that a sample size of 14 participants per group was required to detect an effect size of Cohen's $d = .56$ for reduction in the UPDRS motor score (5 point decrease) in the exercise groups

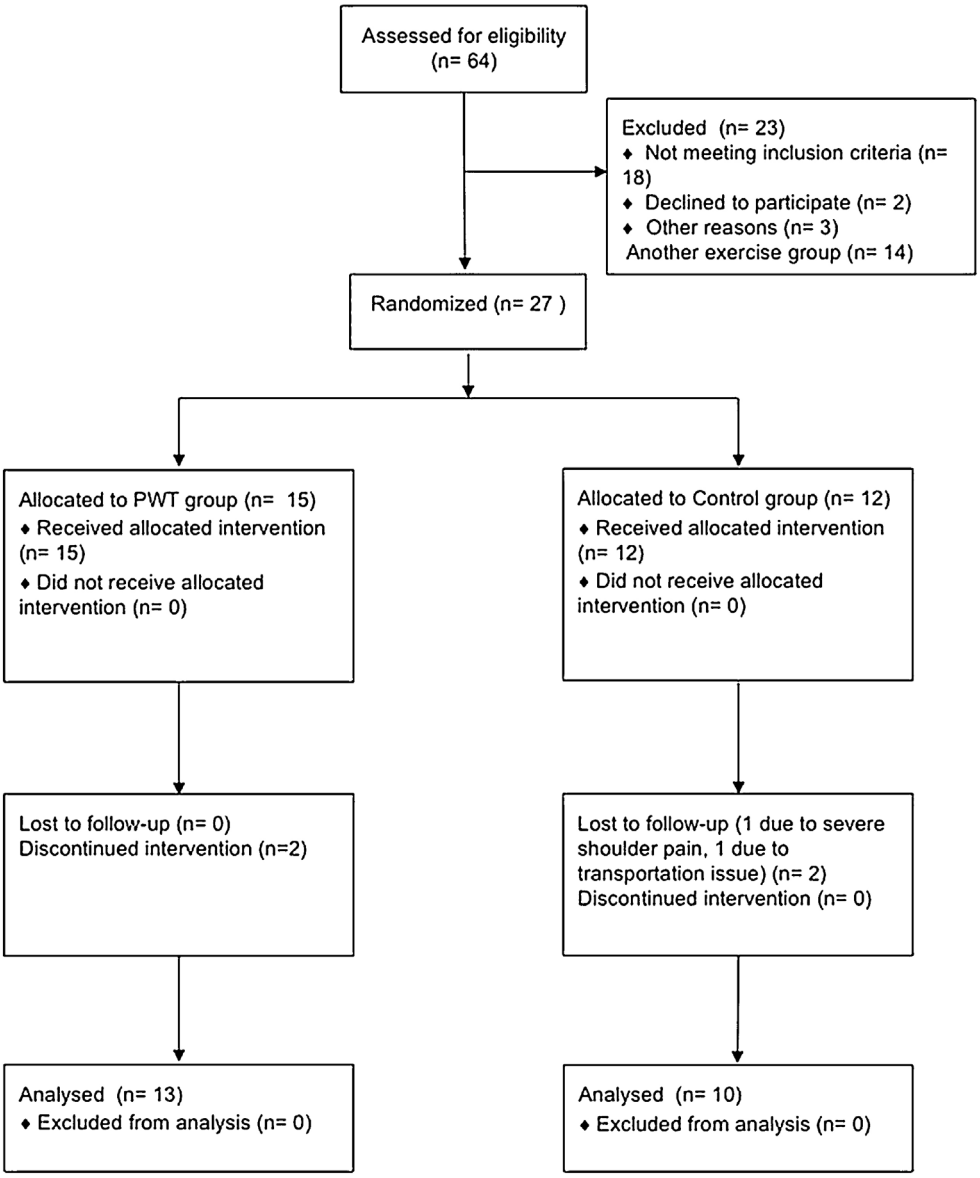

Fig. 1. Study flow.

compared with the control group (power = .8, alpha = .05, correlation with covariate = .05).[29] The sample size calculation allowed a 10% drop-out rate.

All statistical analyses were performed with SPSS (Chicago, IL, Version 22). An analysis of covariance (ANCOVA) of repeated measure was used to examine time (pretest vs. post-test) and group (YOGA vs. CON) differences while using the pre-score as the covariate. Post hoc test by Bonferroni adjustment was used to detect the statistical significance of the change in outcome variables between the baseline and the 3-month training period for each group, and the group difference at each time point.

The 95% confidence intervals (95% CI) of mean differences were calculated, as were effect sizes (hedge's g) and their 95% CI using adjusted means and pooled standard deviation as standardizers to compare the magnitude of changes between YOGA and CON. The interpretation of *g* is similar to that of Cohen's *d* where .80 is considered large, .50 is considered medium, and .20 is considered small. A value of $p = .05$ was established a priori for statistical significance.

3. Results

3.1. Study flow and characteristics of participants

Twenty-seven participants were randomized into the YOGA or CON groups. Fig. 1 shows the study design and flow of participants

Table 1
Participant characteristics. Data was presented as mean (SD).

Variable	YOGA ($n = 15$)	CON ($n = 12$)	*P*
Age (year)	71.2 (6.5)	74.9 (8.3)	.25
Gender (male/female)	11/4	6/6	.071
Height (m)	1.73 (0.08)	1.64 (0.10)	.029*
Weight (kg)	75.1 (11.9)	71.5 (13.4)	.51
Disease duration (y)	6.9 (6.3)	5.9 (6.2)	.71
H & Y stage	2.2 (.7)	2.1 (.7)	.67
Exercise (h/week)	3.6 (2.8)	3.3 (3.2)	.81
Taking sinement as a single medication	5	4	.89
Taking sinement with other PD medications	10	8	.74

Baseline differences were analyzed using *t*-test for independent samples.
H & Y = Hoehn & Yahr.
* Significant different from the CON group.

Table 2
Baseline, changes, treatment effects and effect sizes of bradykinesia score, muscle strength and power.

	Pre-test		Changes at post-test		Treatment effect	Effect size	*P*
	YOGA (*N* = 13) mean (SD)	CON (*N* = 10) mean (SD)	YOGA (*N* = 13) mean (95% CI)	CON (*N* = 10) mean (95% CI)	Mean (95% CI)	*g* (95% CI)	Adjusted
Bradykinesia (range, 0–20)[a]							
Upper limb	9.2 (2.5)	9.0 (1.6)	−4.5 (−5.4, −3.6)*	.4 (.04, .8)	−5.0 (−6.1, −3.9)	−1.75 (−2.69, −.81)	.000*
Lower limb	6.5 (2.1)	6.9 (2.5)	−2.5 (−3.6, −1.4)*	.3 (−.9, 1.5)	−2.9 (−4.4, −1.4)	−1.11 (−1.97, −.25)	.000*
Rigidity (range, 0–36)[a]	7.2 (6.1)	9.4 (2.1)	−2.6 (−3.7, −1.6)*	.7 (−.6, 2.0)	−3.3 (1.6, 5.0)	−.64 (−.18, 1.46)	.001*
Strength (kg)							
Biceps curl	12.8 (7.0)	7.7 (5.7)	2.2 (.1, 4.3)*	−.5 (−1.0, −.04)	2.7 (.1, 5.3)	.52 (−.29, 1.33)	.036*
Chest press	23.2 (11.6)	18.8 (16.3)	2.2 (.5, 3.9)*	−.3 (−1.3, .7)	2.5 (.4, 4.6)	.16 (−.63, .96)	.023*
Leg press	110.0 (43.1)	114.2 (77.6)	21.3 (9.5, 33.1)*	1.4 (-6.3, 9.0)	23.2 (11.1, 35.3)	.35 (−.45, 1.15)	.001*
Hip abduction	34.3 (12.4)	31.9 (15.4)	5.7 (2.5, 8.9)*	.3 (−1.1, 1.7)	5.4 (.2, 10.6)	.55 −.27, 1.36)	.042*
Seated calf	87.8 (29.1)	89.5 (36.7)	36.5 (26.7, 46.3)*	2.6 (−3.2, 8.3)	33.9 (18.4, 49.4)	.80 (−.03, 1.63)	.000*
Power (Watts)							
Biceps curl	90.9 (47.8)	50.2 (36.2)	5.2 (−10.7, 21.0)	−2.6 (−9.3, 4.1)	7.8 (−27.1, 11.5)	.30 (−.50, 1.10)	.408
Chest press	194.4 (83.7)	162.7 (117.8)	11.2 (−6.4, 28.7)	−7.4 (−19.4, 4.5)	18.6 (−8.4, 45.6)	.21 (−.59, 1.01)	.164
Leg press	467.7 (199.6)	495.8 (195.5)	128.7 (73.3, 184.0)*	−8.5 (−32.6, 15.3)	134.2 (44.5, 223.9)	.69 (−.13, 1.52)	.005*
Hip abduction	103.4 (35.1)	103.5 (57.1)	8.0 (−5.6, 21.6)	−2.3 (-9.0, 4.5)	10.2 (−11.9, 32.4)	.26 (−.54, 1.06)	.162
Seated calf	185.3 (44.2)	202.4 (69.9)	10.0 (−18.0, 37.9)	7.0 (−6.8, 20.8)	3.0 (−41.2, 47.1)	.19 (−.61, .99)	.890

Treatment effect = group difference in the changes at post-test.
[a] High score reflects poor performance.
* $P < .05$, are adjusted for baseline values based on ANCOVA.

Table 3
PDQ-39. High score reflects poor performance.

	Pretest		Changes at the post-test		Treatment effects	Effect sizes	*P*
	YOGA (*n* = 13) mean (SD)	CON (*n* = 10) mean (SD)	YOGA (*n* = 13) mean (95% CI)	CON (*n* = 10) mean (95% CI)	Mean (95% CI)	*g* (95% CI)	Adjusted
Mobility (10)	14.5 (10.2)	15.9 (9.9)	−5.6 (−10.0, −1.2)*	1.1 (−3.0, 5.1)	−6.7 (−12.5, −.9)	−.82 (−1.65, .01)	.025*
ADL (6)	6.8 (6.4)	4.2 (3.1)	−1.4 (−3.5, .7)	1.2 (.3, 2.1)	−2.6 (−5.0, −.2)	−.46 (−1.27, .34)	.035*
Emotional well-being (6)	5.7 (5.5)	3.0 (2.8)	−1.2 (−3.2, .9)	.6 (−.7, 1.8)	−1.8 (−4.3, .8)	−.43 (−1.23, .38)	.162
Stigma (4)	3.9 (4.1)	2.0 (2.4)	−1.3 (−2.9, .2)	.5 (−.3, 1.3)	−1.8 (−3.6, .02)	−.57 (−1.38, .24)	.052
Social support (3)	.9 (2.2)	1.3 (.6)	.1 (−.8, .9)	.1 (−.9, .9)	−.5 (−1.8, .7)	.00 (−.80, .80)	.385
Cognitive impairment (4)	4.5 (3.1)	3.8 (2.6)	−.5 (−1.3, .4)	.1 (−.9, 1.0)	−.5 (−1.7, .7)	−.18 (−.98, .62)	.431
Communication (3)	3.7 (3.1)	1.7 (2.0)	−1.0 (−2.2, .2)	−.1 (−1.2, 1.0)	−.9 (−2.5, .7)	−.35 (−1.15, .46)	.257
Bodily discomfort (3)	4.2 (2.2)	4.5 (2.7)	−.7 (−2.2, .8)	.7 (−.7, 2.1)	−1.4 (−3.4, .6)	−.46 (−1.27, .34)	.161
Sum	44.2 (32.5)	34.2 (16.9)	−11.5 (−22.7, −.4)*	5.2 (−1.3, 11.7)	−16.7 (−29.1, −4.4)	−.70 (−1.52, .013)	.016*

* $P < .05$, are adjusted for baseline values based on ANCOVA.

through the study. The characteristics of the participants are presented in Table 1. No participants have changed their PD medication during the 3-month training period. As can be seen in Fig. 1, there were no adverse events related to the yoga program that caused individuals to stop training. The YOGA intervention was well tolerated by our participants with high attendance rate. Thirteen of 15 patients completed the YOGA program and the average number of sessions attended by each group was 22.08 ± 1.2 (total: 24 sessions) for YOGA.

3.2. Effect of intervention

3.2.1. Bradykinesia

The values from pre-test, changes in the post-test and the treatment effect are presented in Table 2. The YOGA group generated a significant decrease in the upper (4.5 points) and lower limb (2.5 points) bradykinesia score, and large effect size compared to the CON group (upper limb: $g = -1.75$; lower limb: $g = -1.11$, $p < .001$).

3.2.2. Rigidity

The YOGA group generated a significant 2.6 point decrease in overall rigidity score, and large effect size compared to the CON group ($g = -.64$, $p = .001$) (see Table 2).

3.2.3. Muscle strength and power

For muscle strength, the YOGA group produced significant improvements for all five testing machines following training ($p < .05$). Significant differences were also seen between groups for changes across the training period with large effect sizes seen for seated calf ($g = .80$, $p < .001$), moderate effect sizes seen for the biceps curl ($g = .52$, $p = .036$) and hip abduction ($g = .55$, $p = .042$), and small effect sizes for the chest press ($g = .16$, $p = .023$) and leg press ($g = .35$, $p = .001$).

For muscle power, significantly higher value was only seen on the leg press machine for the YOGA group after training ($p < .05$), with a moderate effect sizes ($g = .69$, $p = .005$) compared to the CON group (Table 2).

3.2.3. PDQ-39

For the PDQ-39 (Table 3), the YOGA group produced significantly better scores in the mobility domain and sum score for the post-test compared to the pretest, also significant differences were seen in the mobility ($g = -.82$, $p = .025$), ADL ($g = -.46$, $p = .035$) domain, and the sum score ($g = -.70$, $p = .016$) between the YOGA and CON groups after training.

4. Discussion

This is the first randomized controlled study to investigate the impact of Power (Vinyasa) yoga practice on movement speed, joint

rigidity, muscle function and quality of life in older individuals with PD. The main findings of this study were the 3-month specially designed yoga program significantly reduced limb bradykinesia and joint rigidity score, increased muscular strength and power, and improved quality of life.

The results of this 12-week controlled study suggest that YOGA applied twice per week can significantly reduce Parkinsonian symptom as measured by the UPDRS motor symptoms, bradykinesia and rigidity. Vinyasa yoga incorporates several aspects of movement that may be especially beneficial for older adults with PD, such as the movement initiation, moving at different speeds, static and dynamic balance, and flexibility. For instance, the upper and lower limb bradykinesia score decreased by 4.5 and 2.5 respectively, and the rigidity score decreased by 2.6. Although the mechanisms for improvement with yoga have not been examined yet, it is reasonable to postulate that yoga exercise may mediate the function of basal ganglia. Since both bradykinesia and rigidity are considered a deficiency in nigrostriatal dopamine,[30] yoga may facilitate the activity of dopaminergic neurons, thereby reducing bradykinesia and rigidity.

4.1. Effect of training on muscle strength and power

YOGA group also showed improved upper body (biceps curls = 16%, chest press = 10%) and lower body strength (leg press = 19%, hip abduction = 23%, seated calf = 38%) across the training period. It is likely that YOGA intervention has provided a volume of overloads for the lower body muscles due to the predominance of standing positions and particular use of the lower body musculature during most transitions. For instance, the poses requiring static or dynamic balance may enhance ankle and hip strategies,[31] and subsequently strengthening lower limb muscles. Meanwhile, poses with upper body weight-bearing were used during yoga class, thus may induce increased upper body strength. However, for the muscle power, the improvement only limited to the leg press test. Although poses engaged dynamic transition, the training intensity may have been not sufficient to induce significant improvement in muscle power. Nevertheless, YOGA program can be considered effective at increasing leg extension power, which can improve mobility,[32] preserve independence[33] and reduce fall risks,[34] as leg power is a strong predictor of physical performance[35] and functional status[36] in older persons.

4.2. Effect of training on quality of life

Exercise has been found to improve health related quality of life in people with PD.[10] However, whether the improvement in PD symptoms, muscle strength and power could be transferrable to functional improvement is questionable. In the current study, the YOGA group reported significant improvements in the physical subsections (mobility, ADL) as measured by the PDQ-39 over the 3-month training (Table 3), where the majority of participants reported reduced perceived difficulty in "walk in half a mile" and "getting around the house and in public". Participants showed significantly increased leg muscle strength and power after yoga intervention, thus may result in improved gait function. These findings are consistent with previous studies that report improvements in the similar QoL outcomes using other exercise modes.[37,38] Moreover, it is likely that our yoga program could diminish the fear of falling, as evidenced by most of the participants indicating reduced level of "feeling frightened or worried about falling over in public", and it may also result from increased leg power, as leg power is a measure of the efficacy of interventions on neuromuscular capacity as it relates to fall risk.[39] Furthermore, the PDQ-39 questionnaire is sensitive to changes that specific to patients' daily life[40]; the improvement in the perceived level of mobility and ADL domain suggest a reasonable response and the changes are consistent with patients' retrospective judgment of changes.[40] However, no significant time or group difference was detected in other domains. It may be due to high level of performance reflected by that the participants' self-reported score for other domains at the baseline was not as high as that of the mobility or ADL domain. The ceiling effect would limit the magnitude of the changes in scores. Also, the YOGA program primarily focused on improving physical functions, which were mainly reflected by questions from the mobility and ADL domains. In addition, although the 3-month training induced significant improvement in physical subsections, whether the long-term effect of the YOGA program may affect other psychological sections, such as emotional well-being and cognitive impairment, needs further investigation.

4.3. Limitations

First, the sample was small and this likely affected the interpretation of the effect size. Second, it was not tester-blind and this may have affected testers' evaluations. Third, the short training duration used in this study may not sufficient to induce improvement in upper body strength. Further investigation with longer training period is recommended. Finally, all training and testing sessions were given under "on" state, future studies are needed to examine and compare the training effect of yoga intervention for patients in their "off" state.

5. Conclusion

Three months of our specially-designed Power (Vinyasa) yoga program were able to reduce limb bradykinesia and joint rigidity, increase muscle strength and power, and improve self-reported quality of life in Hoehn & Yahr stage I–III PD patients. The YOGA program proved to be well-tolerated by patients and resulted in an exceptional level of exercise adherence. The YOGA program should be considered be viable interventions to increase function in patients with PD either alone, in concert, or as components of a planned exercise program designed to translate improvements in physical function into improvements in daily performance, increases in quality of life and self-efficacy.

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Appendix A. Supplementary data

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