MEDICALFITNESS Association

Power Training for Parkinson's Disease

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Parkinson's Disease and Exercise: Why Power?

REDUCED MUSCLE POWER IS ASSOCIATED WITH SLOWER WALKING VELOCITY AND FALLS IN PEOPLE WITH PARKINSON'S DISEASE

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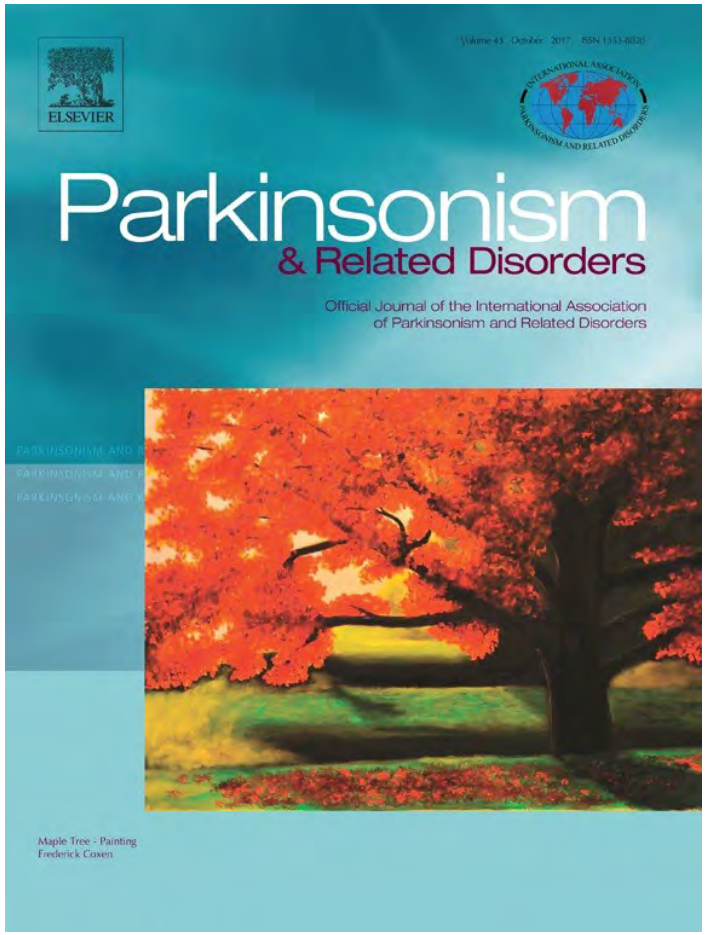


Participants

Table 1
Participant characteristics ($n = 40$).

Age (y)	63.5 ± 7.8
Gender (men/women)	23/17
Height (m)	1.70 ± 0.09
Mass (kg)	74.1 ± 13.2
Body mass index (kg/m^2)	25.5 ± 3.3
MMSE (range, 0–30)	29.1 ± 1.3
Disease duration (y)	6.8 ± 4.9
Exercise (h/wk)	4.0 ± 3.3
ADL (h/day)	2.9 ± 1.1

MMSE, Mini-Mental State Examination; 1RM, 1 repetition maximum; ADL, activities of daily living.
Values are mean ± SD.

Physical Performance and Fall History

Table 2
Physical assessment and falls history ($n = 40$).

		Median
UPDRS motor score	31.9 ± 9.5	32.5
Comfortable walking velocity (m/s)	± 0.3	1.3
Maximal walking velocity (m/s)	1.7 ± 0.4	1.7
Leg power at peak power (W)	± 186.3	392.1
Leg power at 30% 1RM (W)	± 150.8	289.1
Leg strength (N)	883.3 ± 305.7	840.5
Subjects reporting 1 fall in past 12 months	7 (17.5%)	N/A
Subjects reporting ≥ 2 falls in past 12 months	10 (25%)	N/A

UPDRS, Unified Parkinson's Disease Rating Scale; 1RM, 1 repetition maximum; N/A, not applicable.

Range = 0–132,
≤32 = mild,
≥59 = severe.

Means ± SD
1.99 ± 0. 34 = Men
1.81 ± 0.24 = Women

746 W ≈ Women

1,363 ± 372.7 N≈ Women

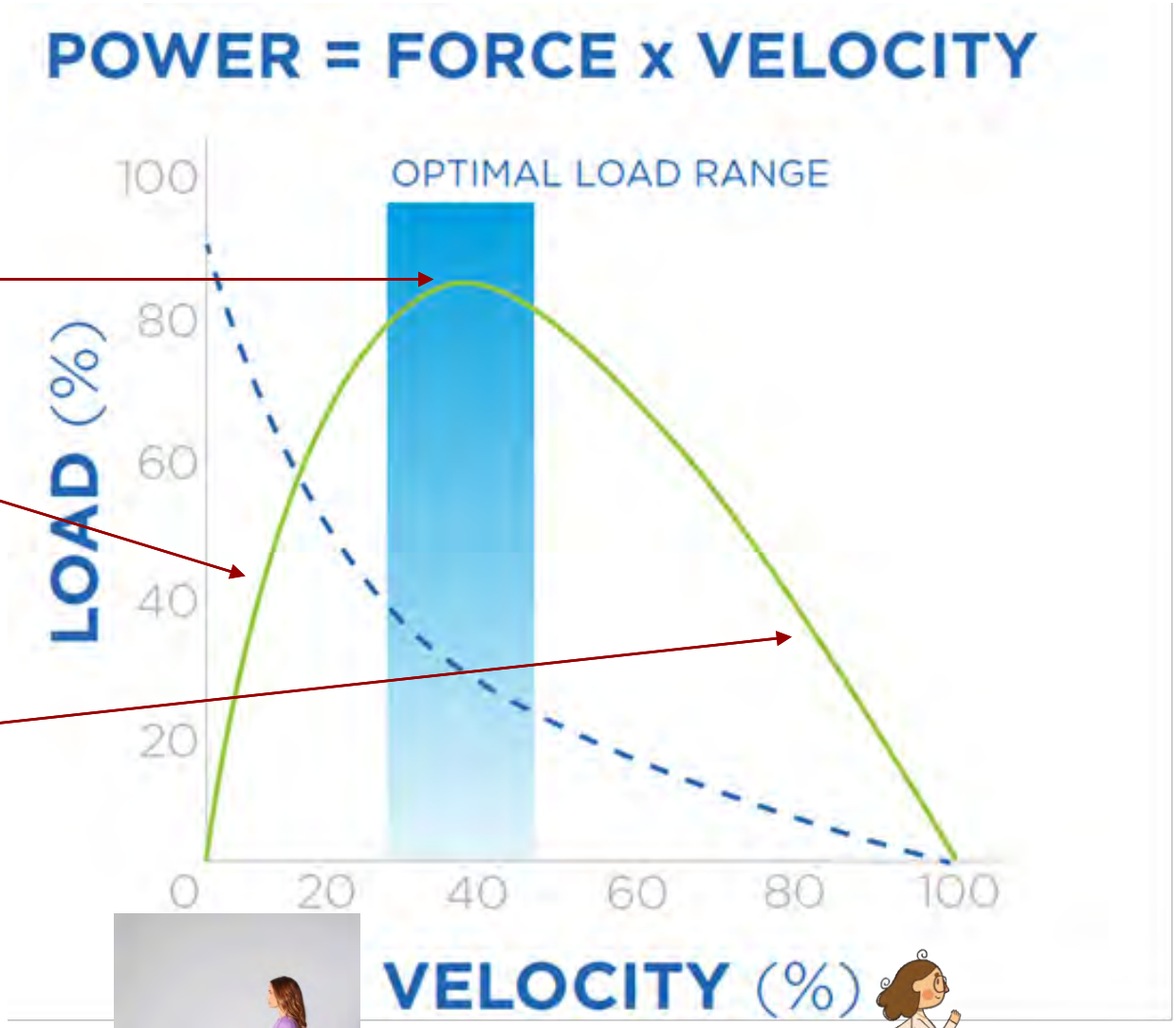
POWER DECLINES

These researchers noted that muscle power at 30% 1RM was more strongly associated with walking velocity and falls history than peak power measurements.

IS THIS SURPRISING???

NOT REALLY!!! REMEMBER…

- Maximum Power
- Training at the load end of the curve, not enough velocity, low power.
- Training at the velocity end of the curve, not enough load, low power.



FURTHER FINDINGS

- PD severity as measured by the UPDRS motor score was, as expected, strongly associated with walking velocity and reported multiple falls.
- Nevertheless, leg muscle power at 30% 1RM had a stronger association with fast walking velocity than UPDRS motor score.
- In addition, walking velocity continued to be strongly influenced by both muscle strength and power after accounting for UPDRS motor score.

CONCLUSION

Allen et al (2010) concluded "…this study has shown that reduced leg extensor muscle power is associated with reduced walking velocity and may be associated with a history of multiple falls in people with PD. The effect of muscle power training on walking velocity and falls in PD warrants investigation.

Parkinson's Disease and Power Training

LEG MUSCLE POWER IS ENHANCED BY TRAINING IN PEOPLE WITH PARKINSON'S DISEASE: A RANDOMIZED CONTROLLED TRIAL

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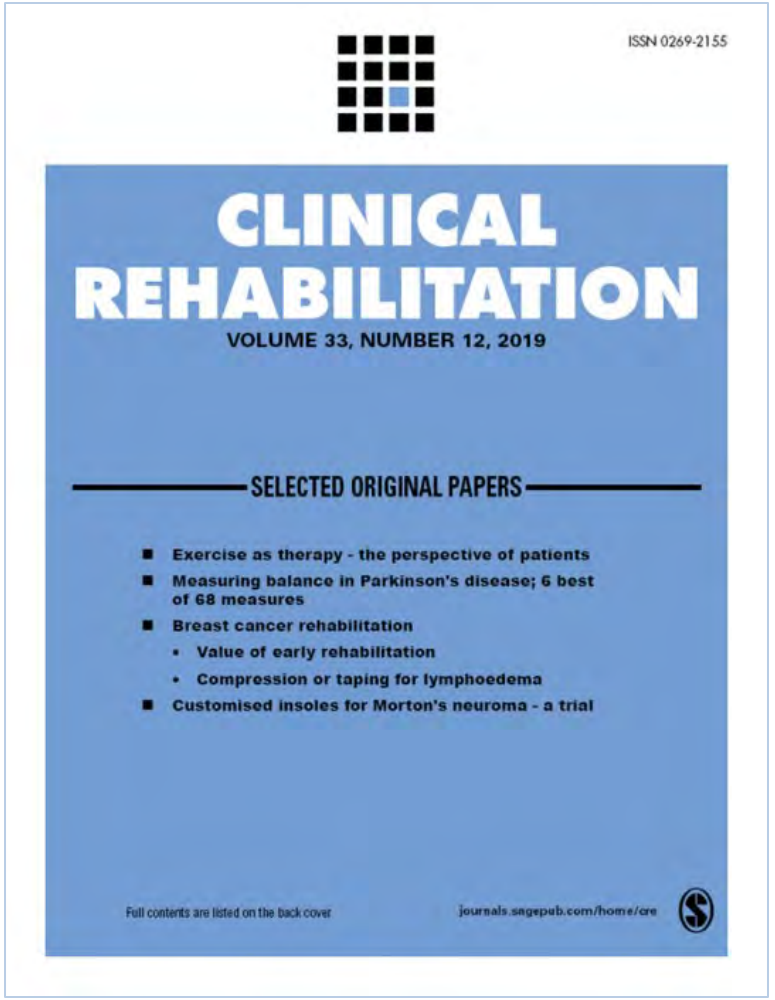


Participants

Table 1. Participant characteristics at baseline. Mean (SD) or number (%) are reported.

Variable	Muscle power training (n = 20)	Control (n = 20)
Age (year)	68.1 (5.6)	64.5 (7.4)
Gender (male)	13 (65%)	12 (60%)
Height (m)	1.71 (0.09)	1.73 (0.08)
Weight (kg)	80.6 (17.1)	80.7 (16.0)
Mini-Mental State Exam score (0–30)	29.1 (1.4)	28.9 (1.3)
Disease duration (years)	7.8 (5.2)	7.8 (5.9)
'On' MDS-UPDRS motor score (0–132)	37.1 (11.0)	35.7 (14.0)
Hoehn & Yahr stage (0–5)	2.0 (0.7)	1.9 (0.9)
Fallen in past year (number of participants)	5 (25%)	7 (35%)

MDS-UPDRS, Movement Disorders Society version of the Unified Parkinson's Disease Rating Scale.

Training

- Trained only the leg extensors, knee flexors, hip flexors and hip abductors, using pneumatic variable resistance equipment.
- Trained in pairs for 45 minutes, twice a week for 12 weeks, with at least a day's rest between training sessions.
- Cued by the physiotherapist to 'go as fast as possible' before each repetition.
- Set one @ 40%, set two @ 50%, set 3 @ 60%1RM
- When exercise was completed in good form and speed, 1RM was increased by 5%.

Power Results

Note: Power increases were significantly greater than controls for all exercises tested.

Table 2. Mean (SD) score, mean (SD) difference within groups and mean (95% confidence interval (CI)) difference between groups for the primary outcome measure (i.e. leg muscle power) for the experimental group and the control group. Scores reported are the average of both legs.

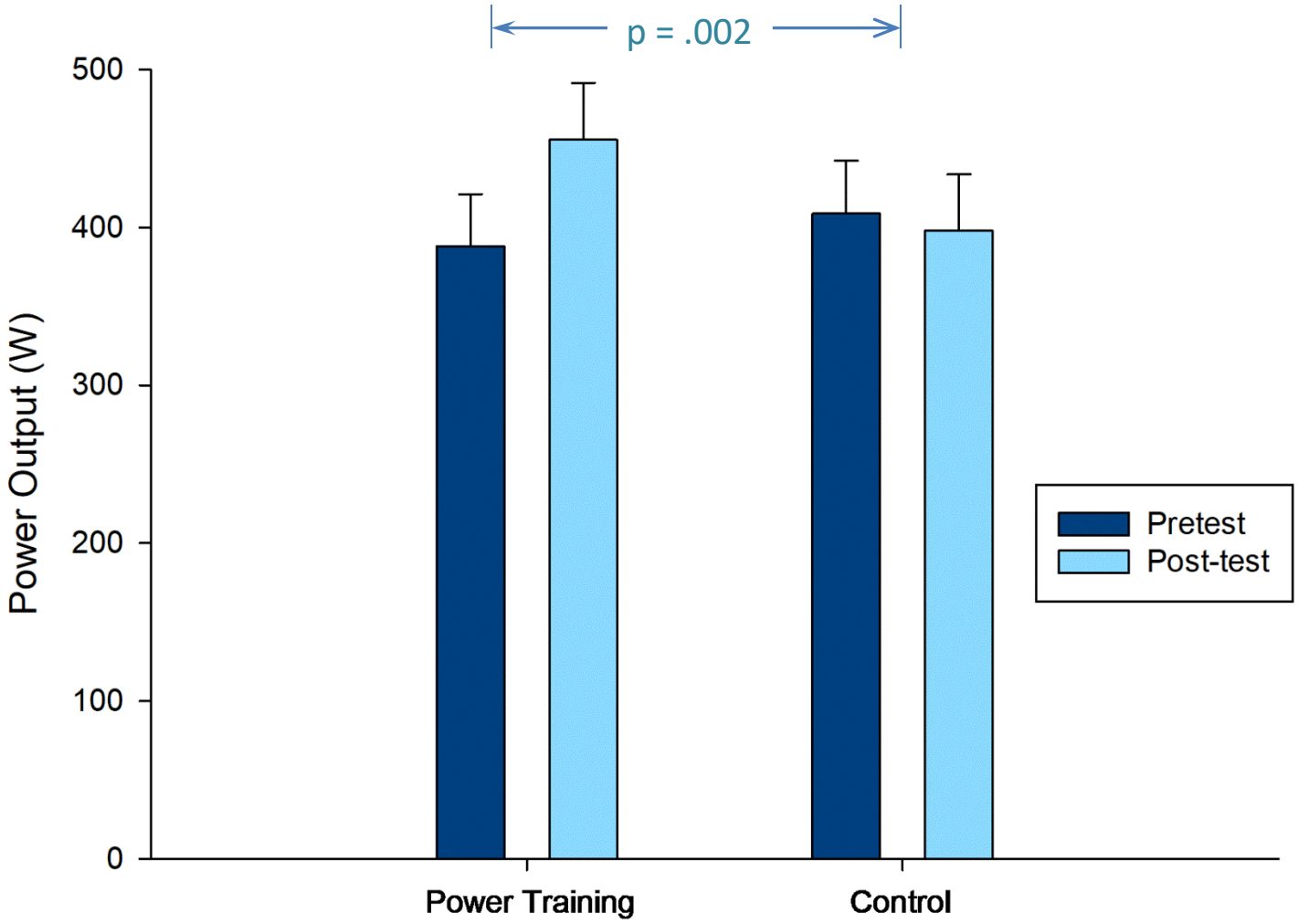
Outcome	Score				Change within groups		Difference between groups		
	Week 0		Week 12		Week 12 minus week 0		Week 12 adjusted for week 0†	Standardised effect size (Cohen's *d*)	Between-group difference as a % of baseline‡
	Exp	Con	Exp	Con	Exp	Con	Exp minus Con *p*-value	*p*-value	
	n = 20	*n* = 20	*n* = 18	*n* = 18	*n* = 18	*n* = 18	*n* = 36	*n* = 36	*n* = 36
Peak muscle power									
Leg extensors (W)	388.3 (146.4)	409.1 (148.3)	455.8 (151.8)	398.2 (150.1)	55.5 (63.8)	−2.4 (38.5)	57.9 (22.0–93.7) *0.002*	1.10 (0.40–1.80) *0.002*	15%
Knee flexors (W)	165.8 (63.3)	158.4 (54.9)	200.1 (84.1)	155.5 (60.1)	29.1 (39.6)	−1.7 (23.2)	29.6 (7.4–51.8) *0.01*	0.95 (0.26–1.64) *0.01*	18%
Hip flexors (W)	171.9 (78.2)	160.2 (65.0)	251.6 (122.3)	167.5 (63.1)	75.4 (94.9)	8.6 (28.4)	68.1 (19.6–116.5) *0.007*	0.95 (0.26–1.65) *0.007*	41%
Hip abductors (W)	85.4 (37.5)	82.7 (36.4)	122.2 (49.0)	77.1 (30.9)	33.4 (32.1)	−3.2 (16.5)	37.4 (19.9–54.9) *< 0.001*	1.43 (0.70–2.17) *< 0.001*	45%

Exp, experimental group (i.e. muscle power training); Con, control group; W, watts.

†Values adjusted for baseline (week 0) score based on ANCOVA.

‡% improvement from the intervention was calculated as the between-group difference (from linear regression analyses adjusted for baseline scores (ANCOVA)) divided by the entire sample mean at baseline.

Leg Extension Peak Power



Functional Results

Table 4. Mean (SD) score, mean (SD) difference within groups and mean (95% CI) difference between groups for mobility and balance secondary outcome measures for the experimental group and the control group. Scores for single leg stand are reported as the average of both legs.

Outcome	Score				Change within groups		Difference between groups
	Week 0		Week 12		Week 12 minus week 0		Week 12 minus week 0†
	Exp	Con	Exp	Con	Exp	Con	Exp minus Con *p*-value
	n = 20	*n* = 20	*n* = 19	*n* = 19	*n* = 19	*n* = 19	*n* = 38
Mobility							
Preferred walking speed (m/s)	1.27 (0.17)	1.17 (0.31)	1.34 (0.22)	1.24 (0.38)	0.06 (0.16)	0.05 (0.12)	0 (0.10–0.09) *0.98*
Fast walking speed (m/s)	1.77 (0.25)	1.67 (0.39)	1.81 (0.31)	1.70 (0.44)	0.02 (0.16)	0.01 (0.19)	0 (–0.11–0.12) *0.95*
Timed Up and Go (s)^#	9.7 (2.3)	9.5 (2.8)	8.3 (2.4)	8.6 (4.3)	–1.3 (2.7)	–0.1 (2.0)	*0.13*
Balance							
Choice stepping reaction time (s)^	37.0 (9.5)	34.3 (11.0)	35.2 (6.2)	37.5 (12.9)	–1.0 (7.2)	4.5 (9.9)	–4.4 (–9.9–1.1) *0.11*
Maximal balance range (cm)	16.7 (5.0)	14.4 (7.2)	18.4 (4.7)	15.1 (6.0)	1.4 (2.6)	0.9 (7.4)	2.0 (–1.1–5.1) *0.21*
Single leg stand time (s)	12.9 (7.2)	20.6 (17.3)	16.1 (10.3)	21.0 (17.2)	2.8 (7.2)	-0.4 (7.3)	2.5 (–2.5–7.5) *0.32*
Freezing							
New Freezing of Gait Questionnaire (0–25)^	6.0 (8.8)	8.0 (10.0)	5.8 (7.8)	7.4 (10.0)	0.4 (3.7)	0.1 (2.5)	0.2 (–1.9–2.2) *0.86*

Exp, experimental group (i.e. muscle power training); Con, control group.
†Values adjusted for baseline (Week 0) score based on ANCOVA.
^Lower scores indicate better performance.
#The median (interquartile range) and the result of the Wilcoxon–Mann–Whitney statistic for comparison of between-group differences are reported for the Timed Up and Go owing to the presence of an outlier with a score >5 SD above the sample mean. Linear regression analyses adjusted for baseline scores (ANCOVA) show that the between-group difference for the Timed Up and Go would be –0.8 seconds 95% CI –1.9–0.4 , $p = 0.18$) when the entire sample is included in the analysis, or –0.8 seconds 95% CI –1.9–0.2, $p = 0.12$) with the removal of one outlier.

CONCLUSION

While the training program improved power in all the muscle groups trained, none of these improvements translated into improvements in performance.

WHY NOT???

COMPARATIVE IMPACT OF POWER TRAINING AND HIGH-SPEED YOGA ON MOTOR FUNCTION IN OLDER PATIENTS WITH PARKINSON DISEASE

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Participants

Table 1 Participant characteristics

Characteristics	PWT (n=14)	YOGA (n=13)	CON (n=10)
H&Y stage	2.2±0.6	2.2±0.7	2.1±0.7
Sex (M/F)	9/5	11/2	4/6
Age (y)	71.6±6.6	71.2±6.5	74.9±8.3
Weight (kg)	78.0±18.9	75.1±11.9	71.5±13.4
Height (m)	1.73±0.1	1.73±0.8	1.64±1.0
Duration of disease (y)	6.6±4.4	6.9±6.3	5.9±6.2
Exercise level at pretest ($h \cdot wk^{-1}$)*	3.8±3.3	3.6±2.8	3.3±3.2
Sessions attended	22.79±1.2	22.08±1.2	2.5±2.3
Sinemet as single medication	4	5	4
Sinemet combined with other PD medications	9	7	6
No PD medication	1	1	0

NOTE. Values are mean ± SD or n.

Abbreviations: F, female; H&Y, Hoehn and Yahr; M, male.

* As reported through a standard health status questionnaire approved by the University Subcommittee for the Use and Protection of Human Subjects.

Power Training

- Optimal loads on 11 pneumatic machines (biceps curl, triceps push-down, chest press, seated row, latissimus pull-down, shoulder press, leg press, leg curl, hip abduction, hip adduction, and seated calf.)
- 3 circuits of 10 to 12 repetitions, twice per week, for 12 weeks (24 sessions).
- Upper and lower body exercises were alternated
- Training loads determined using specific optimal loads established on each machine.
- After a 1-week adaptation period at loads of 50% and 75% of the optimal loads for PWT, training loads for each exercise were increased weekly based on power plateaus.
- Participants were instructed to exert force as fast as possible during the concentric phase and move slowly through the eccentric phase.
- Two 2-week (weeks 5 and 6, weeks 11 and 12) translational training cycles were incorporated into the PWT program. These cycles used balance and agility activities, including line, cone, ladder, chair, step, and ball drills.

Yoga Training

- Participants held a pose statically for 1 breath and quickly transitioned to the next pose (constituted interval training).
- Static poses were included to strengthen and stabilize muscles, and stretching was included to increase flexibility.
- The program incorporated 3 difficulty levels: easy, moderate, and hard.
- All participants started at the same difficulty level, and all went through all difficulty levels.

TRAINING FOR BOTH INTERVENTIONS OCCURRED WITHIN 3 HOURS OF SUBJECTS TAKING THEIR MEDCATIONS.

FUNCTIONAL RESULTS

Table 2 Results for outcome measures related to motor function and balance for PWT group, YOGA, and CON

Outcome Measures	EXE (PWT: n=14/YOGA: n=13), CON (n=10) Baseline	Changes at 3-mo Time Point	Treatment Effect	Effect Size, g (95% CI)	Adjusted *P*
UPDRS$_{MS}$*					
PWT	32.9±12.0	−10.7 (−13.1 to −8.4)†	−11.1 (−14.1 to −8.1)	—	
YOGA	28.15±11	−10.9 (−14.0 to −7.8)†	−11.3 (−14.7 to −7.9)	—	
CON	27.6±7.8	0.4 (−1.4 to 2.2)			
Balance					
BBS					
PWT	48.8 ±5.8	4.4 (2.9 to 6.0)†	4.0 (2.4 to 5.6)	.7	
YOGA	49.22±3.9	4.2 (2.4 to 5.9)†	3.8 (2.0 to 5.5)	.8	
CON	50.9±6.1	0.4 (−0.1 to 0.9)			
Mini-BESTest					
PWT	17.6±4.6	3.4 (2.3 to 4.4)†	2.7 (1.3 to 4.0)	.5	00†
YOGA	18.92±3.9	4.0 (3.1 to 4.9)†	3.3 (2.2 to 4.4)	.7	00†
CON	16.9±5.1	0.7 (−0.1 to 1.5)			
TUG (s)*					
PWT	10.8±5.5	−1.3 (−2.4 to −0.3)†	−1.6 (−2.9 to −0.4)	—	
YOGA	10.27±3.9	−2.3 (−4.1 to −0.6)†	−2.6 (−4.6 to −0.6)	—	
CON	10.2±2.4	0.3 (−0.3 to .9)			
FR more affected (cm)					
PWT	26.4±5.3	4.3 (1.5 to 7.2)†	4.2 (1.1 to 4.8)	.6	
YOGA	27.94±3.8	1.0 (−2.0 to 4.0)	0.8 (−2.4 to 4.1)	.1	
CON	26.2±4.6	0.1 (−1.4 to 1.7)			
FR less affected (cm)					
PWT	29.4±5.8	4.8 (2.5 to 7.3)†	5.5 (2.6 to 8.5)	.9	
YOGA	29.36±4.8	3.3 (1.4 to 5.2)†	3.9 (1.6 to 6.3)	.6	
CON	28.5±5.3	0.6 (−2.1 to 0.8)			
SLS more affected (s)					
PWT	4.2±4.1	8.4 (−2.8 to 19.6)†	4.3 (−4.2 to 20.9)	.2	.536
YOGA	6.11±2.6	5.9 (1.7 to 10.2)	1.9 (−6.9 to 10.6)	.1	.657
CON	10.5±8.2	4.1 (−4.0 to 12.2)			
SLS less affected (s)					
PWT	4.8±3.6	11.8 (2.5 to 21.0)	8.4 (−9.9 to 18.6)	.37	.180
YOGA	9.24±7.4	17.7 (−0.3 to 35.8)†	14.3 (−5.0 to 33.6)	.4	.136
CON	15.1±25.6	3.4 (−5.4 to 12.2)			

NOTE. Values are mean ± SD, mean (95% CI), or as otherwise indicated.
Abbreviations: CI, confidence interval; CON, control group; EXE, exercise; FR, functional reach; SLS, single leg stance; TUG, Timed Up and Go; YOGA, yoga training group.
* High score reflects poor performance.
† Significant difference from pretest.
‡ Significant difference from CON, is adjusted for pretest score based on analysis of covariance.

↑MCID = -6.2; Max 260

↓MCID = 13.5; Max 56

↑MCID = 4; Max 28

↓MCID = 3.4; ≤10 good mobil.

↓MCID = 7.32; M = 15.4

↓MCID = 7.32; M = 15.4

↑MCID = 3.4 - 4.0

↑MCID = 3.4 - 4.0

GAIT RESULTS

Table 3 Results for outcome measures related to gait for PWT group, YOGA, and CON

Outcome Measures	EXE (PWT: n=14/YOGA: n=13), CON (n=10) Baseline	Changes at 3-mo Time Point	Treatment Effect	Effect Size, g (95% CI)	Adjusted *P*
Gait (10-MWS)					
Uwalk speed ($m \cdot s^{-1}$)					
PWT	1.03±.27	.12 (.06 to .18)*	.15 (.08 to 21)	↑MCID = .10	.000†
YOGA	1.06±.20	.14 (.02 to .26)*	.17 (.05 to .29)		.011†
CON	1.04±.28	−.03 (−.06 to .01)			
Mwalk speed ($m \cdot s^{-1}$)					
PWT	1.52±.42	.16 (.08 to .24)*	.16 (.04 to .26)	↓MCID = .22	.005†
YOGA	1.49±.25	.22 (.08 to .36)*	.22 (.07 to .37)		.008†
CON	1.41±.43	.002 (−.06 to .06)			

NOTE. Values are mean ± SD, mean (95% CI), or as otherwise indicated.

Abbreviations: CI, confidence interval; CON, control group; EXE, exercise; Mwalk, 10-m maximal walking speed; 10-MWS, 10-m walking speed; Uwalk, 10-m usual walking speed; YOGA, yoga training group.

* Significant difference from pretest.

† Significant difference from CON, is adjusted for pretest score based on analysis of covariance.

NEUROMUSCULAR PERFORMANCE RESULTS

Table 4 Results for outcome measures related to neuromuscular performance for PWT group, YOGA, and CON

	EXE (PWT: n=14/YOGA: n=13), CON (n=10)				
Outcome Measures	Baseline	Changes at 3-mo Time Point	Treatment Effect	Effect Size, g (95% CI)	Adjusted *P*
Leg press					
Strength (kg)/BW (kg)					
PWT	1.4±0.5	0.2 (0.1 to 0.3)*	.21 (−.01 to .43)	.29 (−.51 to 1.07)	.003
YOGA	1.6±0.6	0.3 (0.2 to 0.5)*	.31 (.09 to .53)	.42 (−.40 to 1.21)	.004
CON	1.4±0.9	.008 (−.06 to .07)			
Peak power (W)/BW (kg)					
PWT	7.1±2.3	2.6 (1.8 to 3.4)*	2.7 (1.3 to 4.1)	.88 (.03 to 1.67)	.000
YOGA	7.8±4.8	1.8 (0.8 to 2.7)*	1.9 (0.4 to 3.3)	.52 (−.31 to 1.31)	.008
CON	5.9±3.0	−.09 (−0.3 to 0.1)			

NOTE. Values are mean ± SD, mean (95% CI), or as otherwise indicated.

Abbreviations: BW, body weight; CI, confidence interval; CON, control group; EXE, exercise; YOGA, yoga training group.

* Significant difference from pretest.

† Significant difference from CON, is adjusted for pretest score based on analysis of covariance.

Conclusions

Our 3-month, twice-weekly PWT and modified yoga training programs were able to alleviate motor symptoms, improve balance function and gait, and increase leg muscle strength and power in patients with mild to moderate PD.

Both training systems should be considered viable interventions in rehabilitation programs designed to translate improvements in physical function into improvements in functionality and reductions in fall probability.

POWER TRAINING INDUCED CHANGE IN BRADYKINESIA AND MUSCLE POWER IN PARKINSON'S DISEASE

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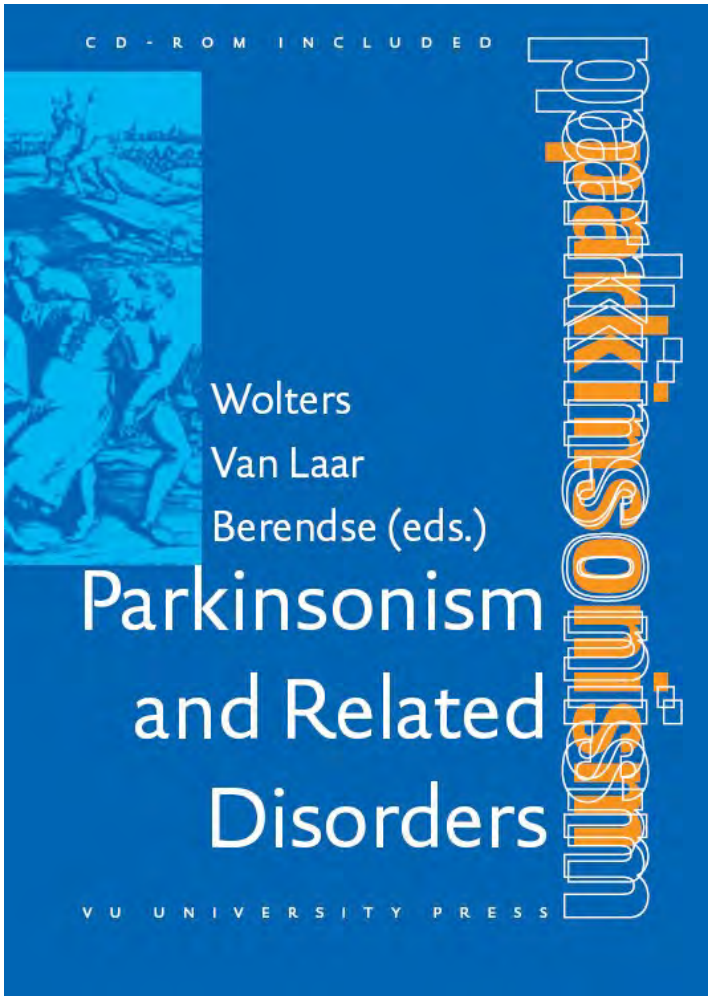


SUBJECTS' CHARACTERISTICS

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

Variable	PWT (n = 14)	CON (n = 10)	*P*
Age (yr)	71.6 (6.6)	74.9 (8.3)	.78
Gender (male/female)	9/5	4/6	NA
Height (cm)	173.2 (12.0)	163.8 (9.9)	.10
Mass (kg)	78.0 (18.9)	71.5 (13.4)	.41
Disease duration (yr)	6.6 (4.4)	5.9 (6.2)	.91
H & Y stage (1–5)	2.2 (.6)	2.1 (.7)	.89
MMSE score (0–30)	29.1 (.9)	29.4 (1.1)	.88
UPDRS motor score (0–108)	32.9 (12.0)	27.6 (7.8)	.72
Exercise level before intervention (hr/wk)	3.8 (3.3)	3.3 (3.2)	.81
Attendance	22.79 (1.2) (total: 24 sessions)	2.5 (2.3) (total: 3 sessions)	NA

Baseline differences were analyzed using t-test for independent samples.
PWT, power training; CON, control; H & Y, Hoehn & Yahr; MMSE, Mini-mental state examination; UPDRS, Unified Parkinson's Disease Rating Scale.

BRADYKINESIA, STRENGTH AND POWER

SIGNIFICANT IMPROVEMENTS IN POWER FOR ALL EXERCISES EXCEPT CALF RAISE

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

	Baseline		Changes at the post-test		Treatment effect	Effect size	*P*
	PWT (N = 14) Mean (SD)	CON (N = 10) Mean (SD)	PWT (N = 14) Mean (95% CI)	CON (N = 10) Mean (95% CI)	Mean (95% CI)	g (95% CI)	Adjusted
Bradykinesia (range, 0–20)[a]							
Upper limb	8.4 (3.1)	9.0 (1.6)	−3.0 (−3.8, −2.3)*	.4 (.04, .8)	−3.5 (−4.7, −2.3)	−1.31 (−2.18. −.44)	.000*
Lower limb	5.6 (3.4)	6.9 (2.5)	−1.6 (−2.5, −.8)*	.3 (−.9, 1.5)	−2.3 (−3.5, −1.1)	−.81 (−1.63, .01)	.001*
Strength (kg)							
Biceps curl	13.9 (6.3)	7.7 (5.7)	2.3 (1.4, 3.2)*	−.5 (−1.0, −.04)	2.8 (1.9, 3.8)	.54 (−.26, 1.34)	.000*
Chest press	24.7 (13.2)	18.8 (16.3)	3.4 (1.9, 4.8)*	−.3 (−1.3, .7)	3.6 (1.8, 5.5)	.25 (−.54, 1.04)	.001*
Leg press	111.0 (50.6)	114.2 (77.6)	13.8 (5.1, 22.5)*	−1.4 (−6.3, 9.0)	14.1 (6.0, 22.2)	.21 (−.57, .99)	.005*
Hip abduction	38.1 (17.8)	31.9 (15.4)	10.7 (5.4, 15.9)*	.3 (−1.1, 1.7)	10.4 (5.0, 15.7)	.62 (−.19, 1.43)	.000*
Seated calf	78.2 (32.4)	89.5 (36.7)	31.8 (21.4, 42.1)*	2.6 (−3.2, 8.3)	29.2 (17.9, 40.5)	.76 (−.05, 1.57)	.001*
Power (Watts)							
Biceps curl	99.0 (58.3)	50.2 (36.2)	9.3 (−3.1, 21.7)*	−2.6 (−9.3, 4.1)	11.9 (−3.4, 27.3)	.24 (−.55, 1.03)	.004*
Chest press	199.3 (118.9)	162.7 (117.8)	47.8 (11.9, 83.8)*	−7.4 (−19.4, 4.5)	55.3 (18.3, 92.3)	.50 (−.30, 1.30)	.019*
Leg press	544.6 (204.6)	495.8 (195.5)	188.3 (121.8, 254.8)*	−8.5 (−32.6, 15.3)	210.4 (126.0, 294.8)	.83 (.04, 1.62)	.002*
Hip abduction	121.0 (52.6)	103.5 (57.1)	26.9 (6.3, 47.5)*	−2.3 (−9.0, 4.5)	29.1 (7.9, 50.3)	.48 (−.32, 1.28)	.019*
Seated calf	197.6 (124.1)	202.4 (69.9)	57.9 (9.8, 105.9)*	7.0 (−6.8, 20.8)	50.9 (1.8, 100.0)	.56 (−.24, 1.36)	.075

*$P < .05$, are adjusted for baseline values based on ANCOVA.
Changes at the post-test: post-values minus pre-values.
PWT, power training; CON, control.
[a] High score reflects poor performance.

The Parkinson's Disease Questionnaire (PDQ-39)

SIGNIFICANT IMPROVEMENTS IN MOBILITY, ADL, SOCIAL SUPPORT, AND OVERALL PDQ-39 SCORES

Table 3

PDQ-39. High score reflects poor performance.

	Pretest		Changes at the post-test		Treatment effects	Effect sizes	*P*
	PWT (n = 14) mean (SD)	CON (n = 10) mean (SD)	PWT (n = 14) mean (95% CI)	CON (n = 10) mean (95% CI)	Mean (95% CI)	g (95% CI)	Adjusted
Mobility (10)	12.4 (6.8)	15.9 (9.9)	−2.4 (−7.3, 2.4)*	1.1 (−3.0, 5.1)	−3.4 (−9.2, 2.4)	−.40 (−1.19, .40)	.237
ADL (6)	5.7 (2.8)	4.2 (3.1)	−.7 (−2.3, 1.0)*	1.2 (.3, 2.1)	−2.2 (−4.0, −.4)	−.61 (−1.41, .20)	.018*
Emotional Well-being (6)	5.4 (3.3)	3.0 (2.8)	−.3 (−1.4, 1.0)	.6 (−.7, 1.9)	−.8 (−2.7, 1.1)	−.27 (−1.06, .52)	.382
Stigma (4)	2.7 (3.1)	2.0 (2.4)	.0 (−1.0, 1.0)	.5 (−.3, 1.3)	−.5 (−1.6, .6)	−.16 (−.95, .62)	.371
Social support (3)	2.2 (2.1)	1.3 (.6)	−1.0 (−1.8, .3)*	.6 (−.4, 1.6)	−1.6 (−3.1, −.1)	−.78 (−1.60, .03)	.037*
Cognitive impairment (4)	4.0 (2.6)	3.8 (2.6)	−.2 (−.9, 1.0)	.1 (−.9, 1.0)	−.3 (−1.6, 1.1)	−.12 (−.91, .67)	.666
Communication (3)	3.4 (2.8)	2.3 (2.8)	.3 (−.8, 1.3)	−.1 (−1.2, 1.0)	.2 (−1.3, 1.8)	−.13 (−.92, .65)	.743
Bodily discomfort (3)	3.5 (2.6)	4.3 (2.5)	1.1 (−.6, 3.1)	.7 (−.7, 2.1)	.4 (−1.8, 2.5)	.22 (−1.01, .57)	.726
Sum	39.3 (13.4)	35.2 (20.4)	−2.5 (−8.2, 3.2)*	5.2 (−1.3, 11.7)	−8.8 (−16	.36)	.028*

↓MCID = -4.72

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

Changes at the post-test: post-values minus pre-values.

Conclusions

Our specially-designed power training program including a high-seed circuit and activity-based recovery cycles every 4 weeks:

- **improved strength, power and motor function in older adults with PD**
- **was well-tolerated**
- **can be incorporated into outpatient rehabilitation for PD to preserve or improve movement function.**

However, further research must be done to determine the specific loading for power and the importance of "translational" cycles to improve function.

HIGH-SPEED RESISTANCE TRAINING MODIFIES LOAD-VELOCITY AND LOAD-POWER RELATIONSHIPS IN PARKINSON'S DISEASE

Meng Ni
Joseph F. Signorile

J Strength Cond Res. 2016 Nov 16.

Objective:

To examine shifts in the load-velocity and load-power curves due to high-speed resistance training in Parkinson's patients.

Objectives:

We hypothesized that:

1. **shifts in the L-V and L-P curves would be specific to the loading patterns used;**
2. **shifts would favor the velocity end of the curve, given the low baseline movement velocities of these individuals because of bradykinesia; and,**
3. **changes would be moderated by joint and muscle structure differences.**

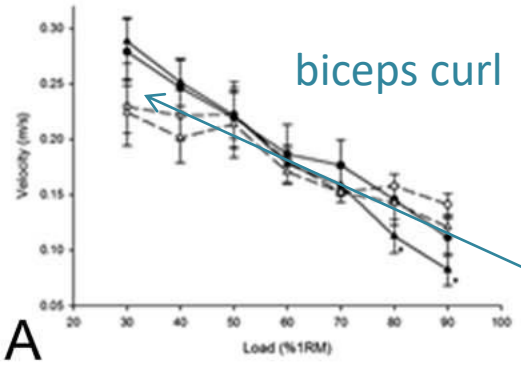
Participants:

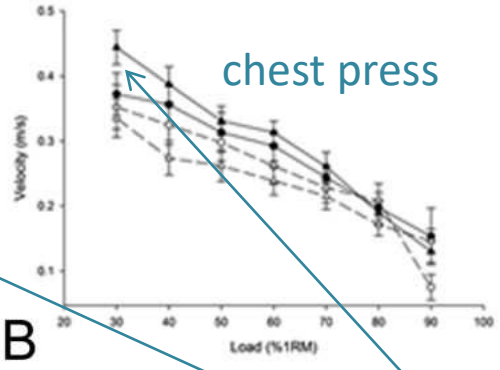
TABLE 1. Participant characteristics at the baseline.*†

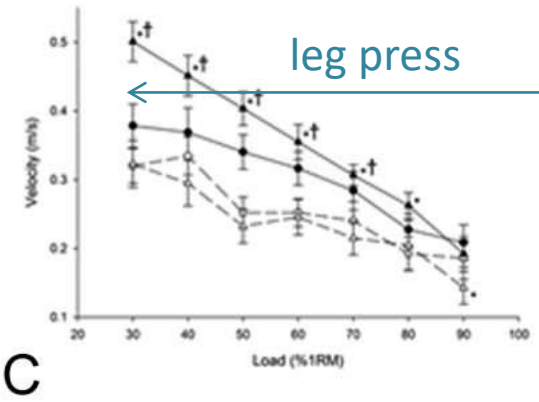
	PWR ($n = 14$)	CON ($n = 10$)
Age (y)	71.6 ± 6.6	74.9 ± 8.3
Gender (male/female)	9/5	4/6
Height (cm)	173.2 ± 12.0	163.8 ± 9.9
Weight (kg)	78.0 ± 18.9	71.5 ± 13.4
Disease duration (y)	6.6 ± 4.4	5.9 ± 6.2
H & Y stage	2.2 ± 0.6	2.1 ± 0.7
Exercise level (hr/wk)	3.8 ± 3.3	3.3 ± 3.2
UPDRS motor score	32.9 ± 12.0	27.6 ± 7.8

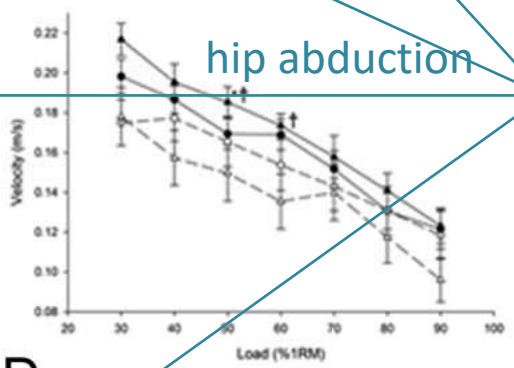
*PWR = Power-based resistance training; CON = control group; H & Y stage = Hoehn & Yahr.
†Data presented as mean ± *SD*.

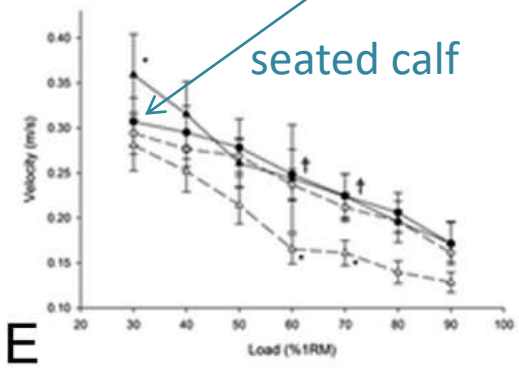
Results:





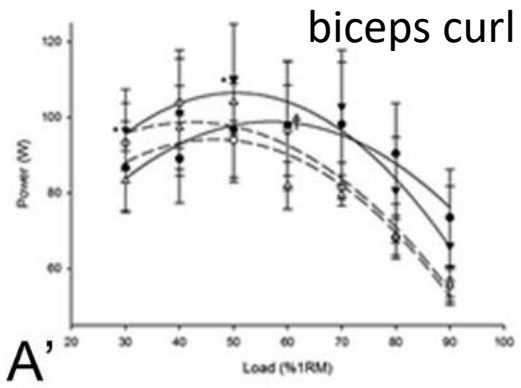


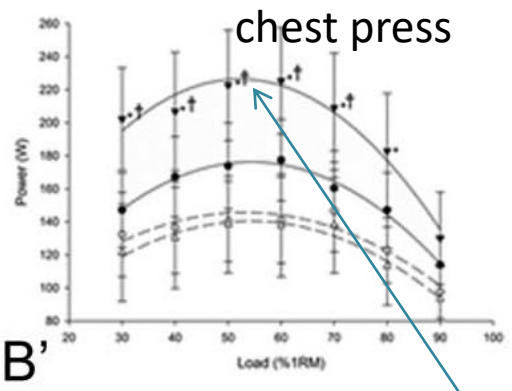


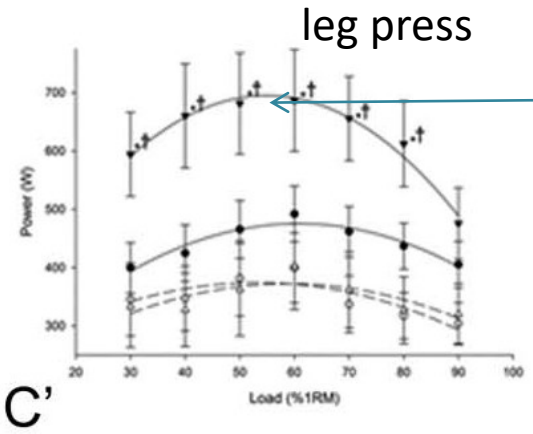


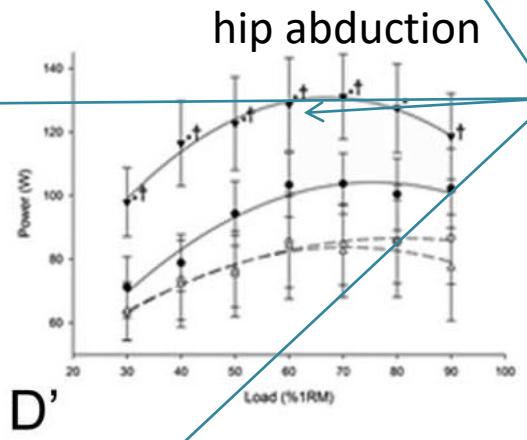
Note that the greatest changes were seen at the velocity (low load) end of the load-velocity curves…

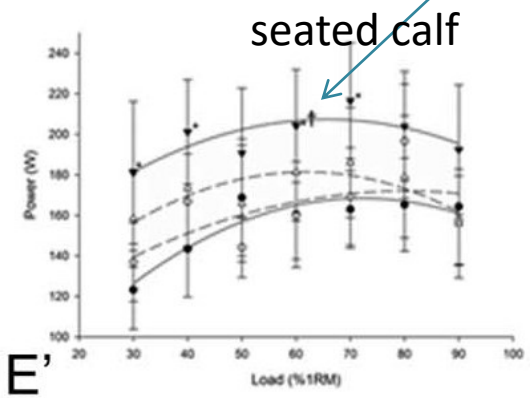
Results:







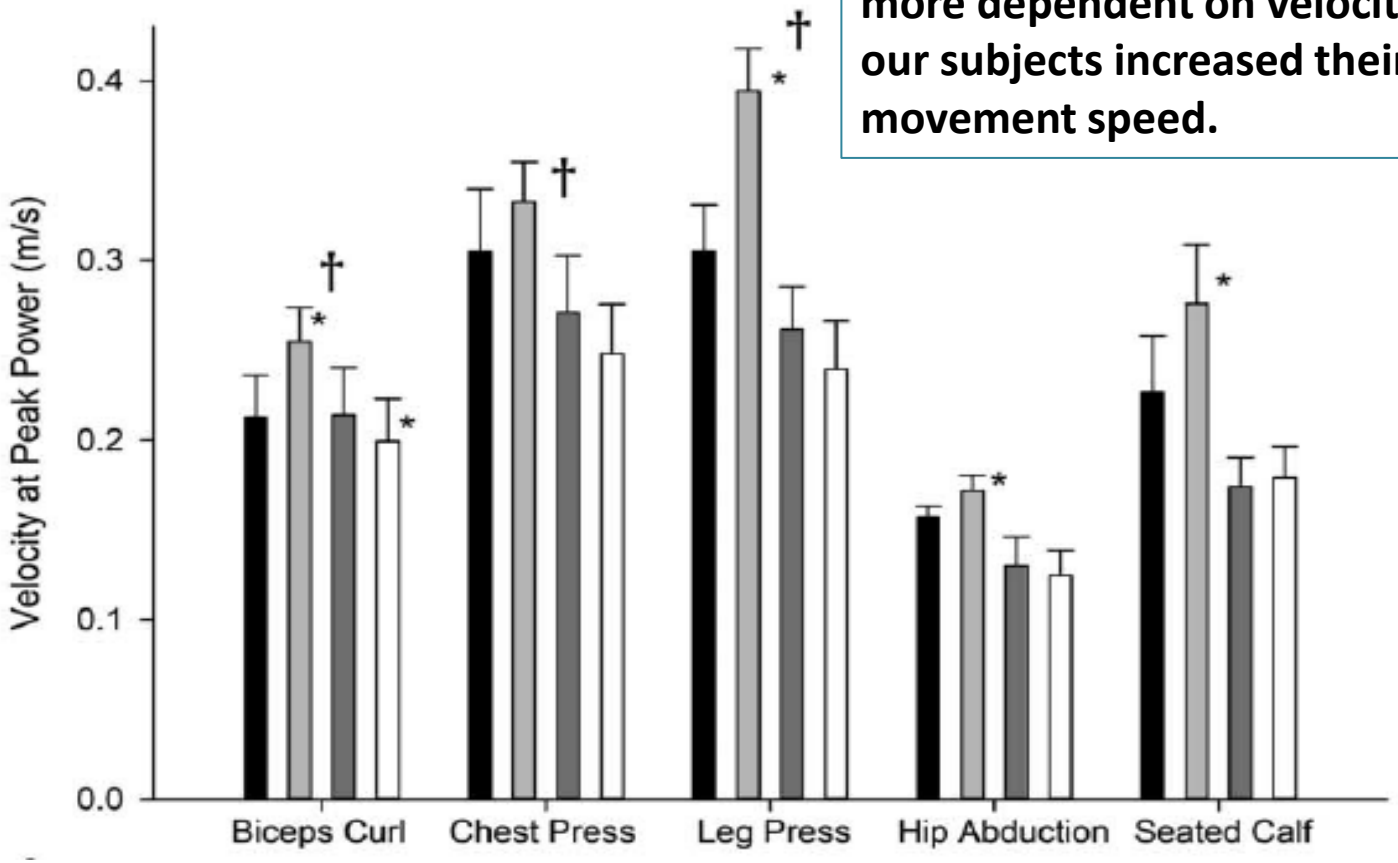




…and POWER changes were evident in every muscle group but the biceps.

Results:

This indicates POWER became more dependent on velocity as our subjects increased their movement speed.



Velocity at the peak power before and after 3-month training. *Significantly different from pretest, †significant change difference between groups. Power training pretest (black bars) and posttest (light gray bars); Control pretest (dark gray bars) and posttest (white bars). Bars represent mean and SE.

Conclusion:

The patterns of change in L-V and L-P relationships provide evidence for the unique responses of the specific muscle groups and joints to the exercises evaluated and offer a framework for more exacting exercise prescriptions in patients with PD.

POWER AND STRENGTH TRAINING PRODUCE SIMILAR IMPROVEMENTS IN STRENGTH, POWER, BALANCE AND FUNCTIONAL MOVEMENT IN PERSONS WITH PARKINSON'S DISEASE

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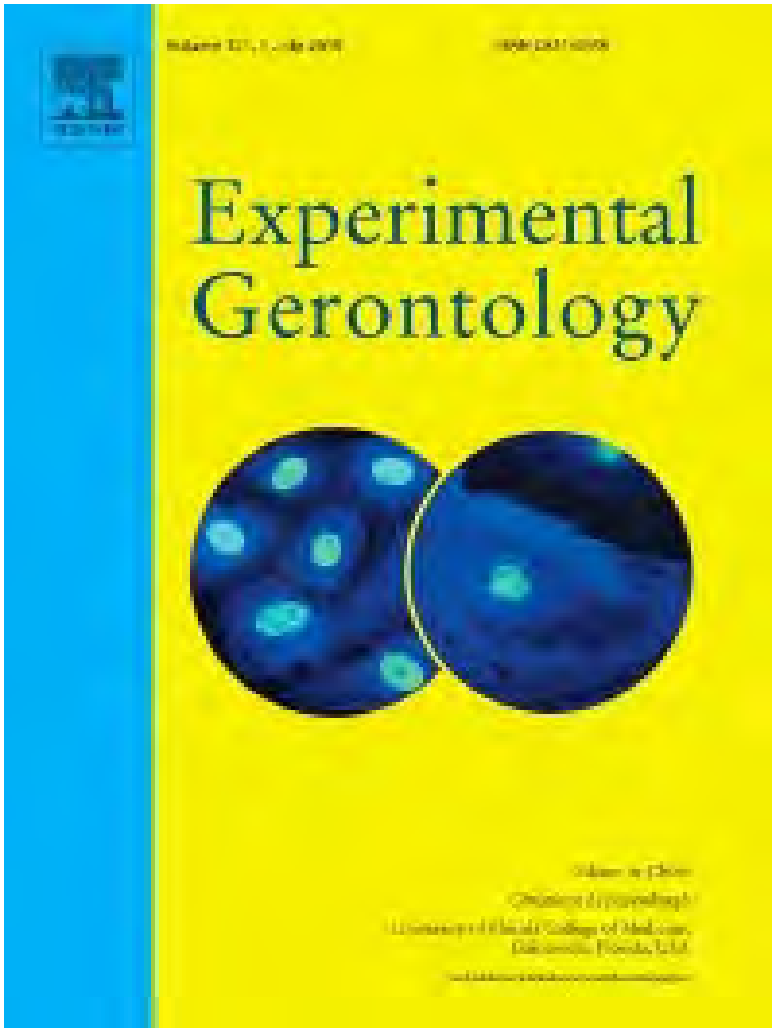
Keri L. Strand
Kirk B. Roberson
Emma R. Michiels
Jessica E. Kuhn
Francisco A. Lopez
Joseph F. Signorile

Exp Gerontol. 2019



Objective:

To compare the effects of ST and PT on measures of strength, power, balance and functional movement in persons with PD.

Hypothesis:

We hypothesized that PT would produce greater power increases and functional improvement; while ST would induce greater strength gains.

Participants:

Table 1
Baseline characteristics of study participants.

Characteristics	Strength (n = 18)	Power (n = 17)
Age (y)	69.3 ± 10.5	73.0 ± 6.8
Sex (male/female)	13/5	10/7
Height (cm)	167.6 ± 7.7	169.0 ± 11.1
Weight (kg)	75.8 ± 29.3	73.3 ± 19.0
MMSE	29.0 ± 1.5	28.3 ± 1.7
Hoehn and Yahr Stage	1–3	1–3
UPDRS Part III	28.6 ± 16.2	32.8 ± 11.6

Values are ± SD; MMSE = Mini Mental State Exam; UPDRS = Unified Parkinson's Disease Rating Scale; no significant differences at baseline.

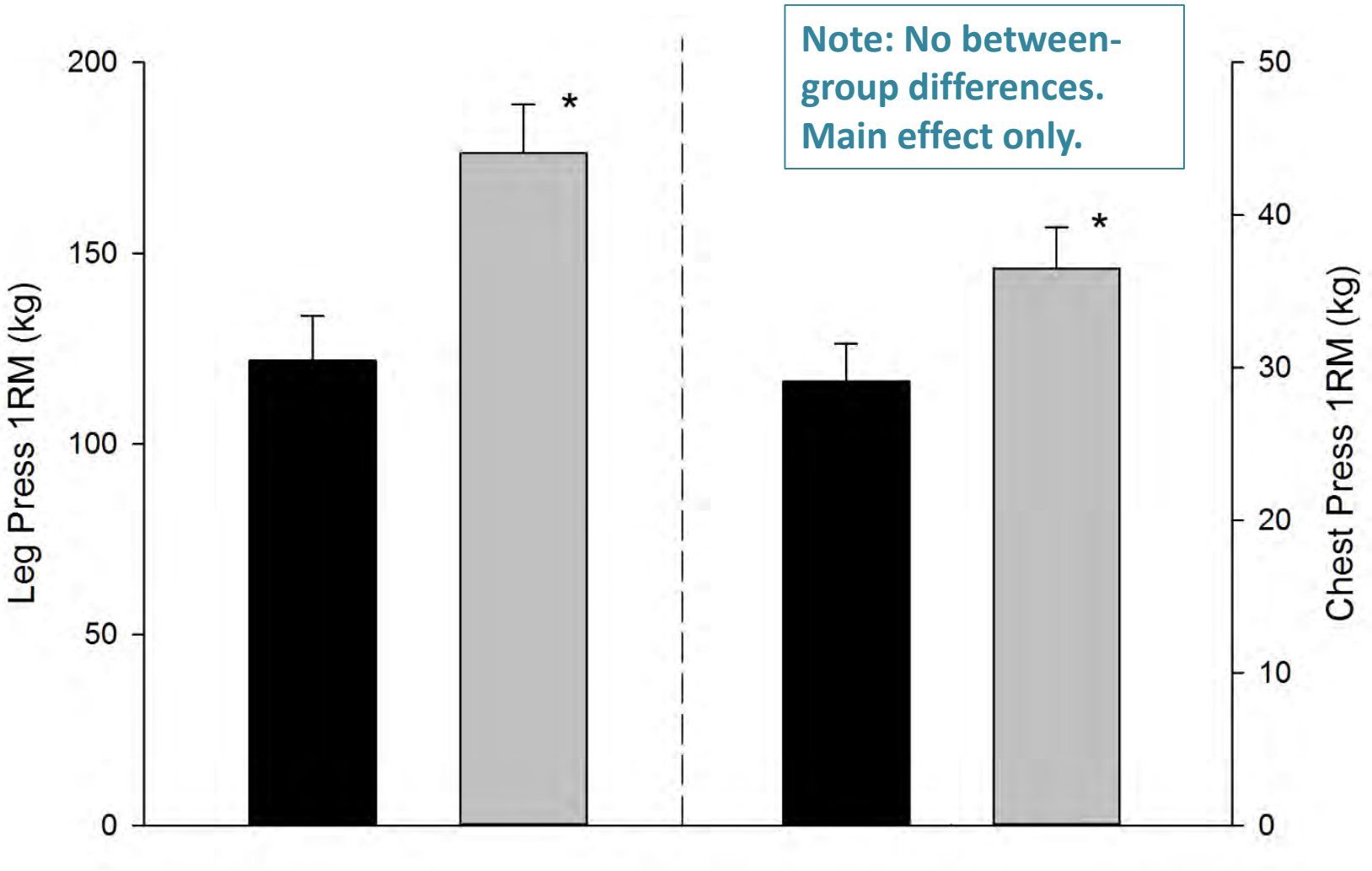
Strength training group

- Familiarization: 30–40% 1RM increasing to 70% by the end of 2 weeks.
- Three sets, 10 repetitions
- Rest periods between sets were 1.5 to 2 min.
- 2 – 3s controlled concentric and eccentric velocity.
- Verbal cues to maintain lifting tempo.
- After 2 weeks, training to volitional failure with load increases based on successful completion of ten repetitions without excessive discomfort.
- Typical load progression involved a 5% for upper body and 10% for lower body exercises.
- Criteria were modified when necessary due to the manifestations of patient-specific PD symptoms or excessive fatigue.
- Exercise order was randomized during each session and upper and lower body exercises were alternated whenever possible.

Power training group

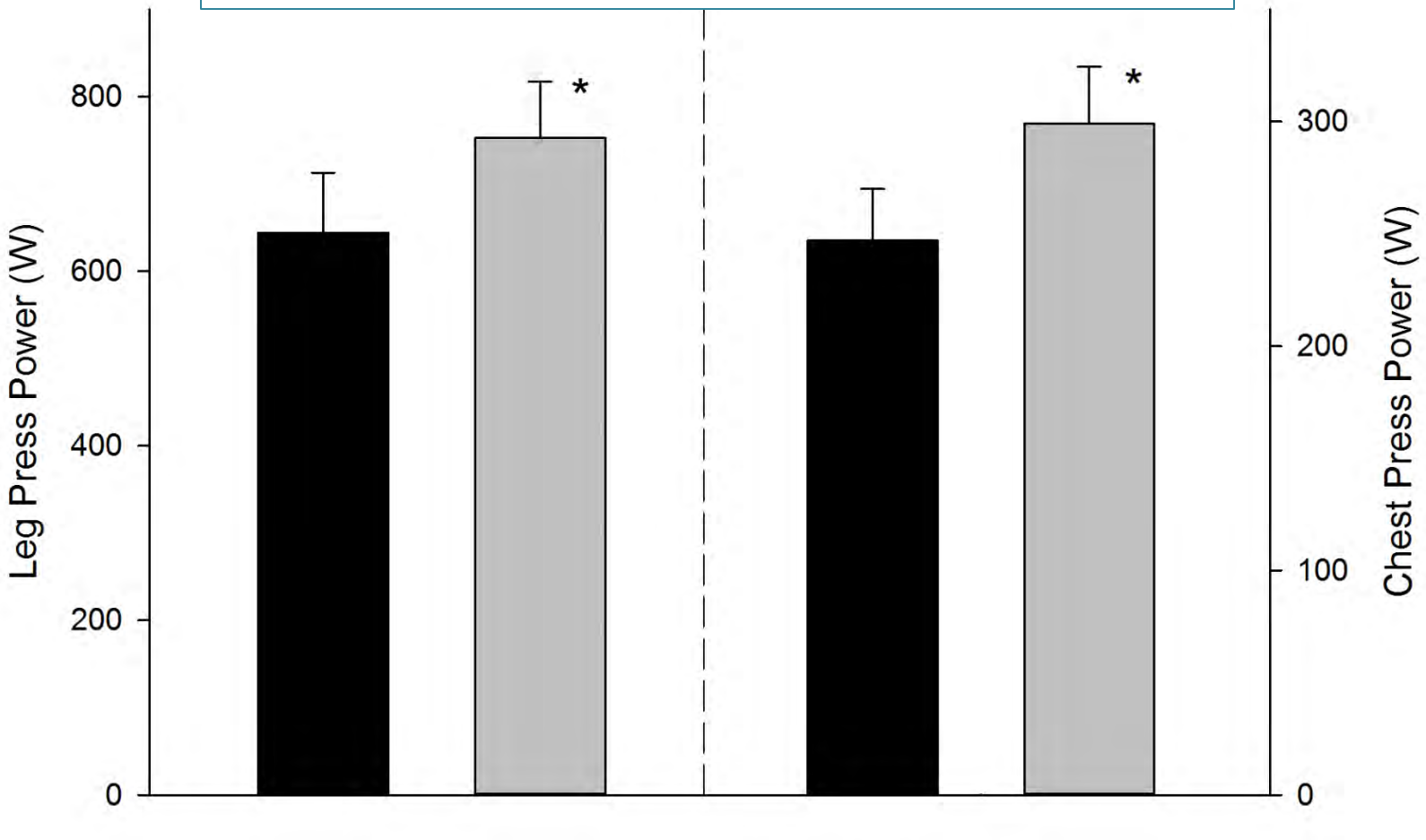
- Familiarization phase at 30% 1RM increased to 50% by the end of 2 weeks.
- Three sets, each consisting of 10 repetitions
- Rest periods between sets were 1.5 to 2 min.
- Explosive motion at maximal velocity during the concentric phase and controlled eccentric phase for 2 to 3 s.
- Participants were provided verbal cues to maintain lifting tempo.
- Load progression criteria based on loads producing the highest power output for any given repetition measured across all 3 sets.
- Typical load progression involved a 5% increase for upper body and a 10% increase for lower body exercises.
- Criteria were modified when necessary due to the manifestations of patient-specific PD symptoms or excessive fatigue.
- Exercise order was randomized during each session and upper and lower body exercises were alternated whenever possible.

Results: Strength



Results: Power

Note: No between-group differences. Main effect only.



Results:

Note: No between-group differences. Main effects only.

Table 3: Means, standard deviations, mean differences and effect sizes for balance and functional movement within the sample

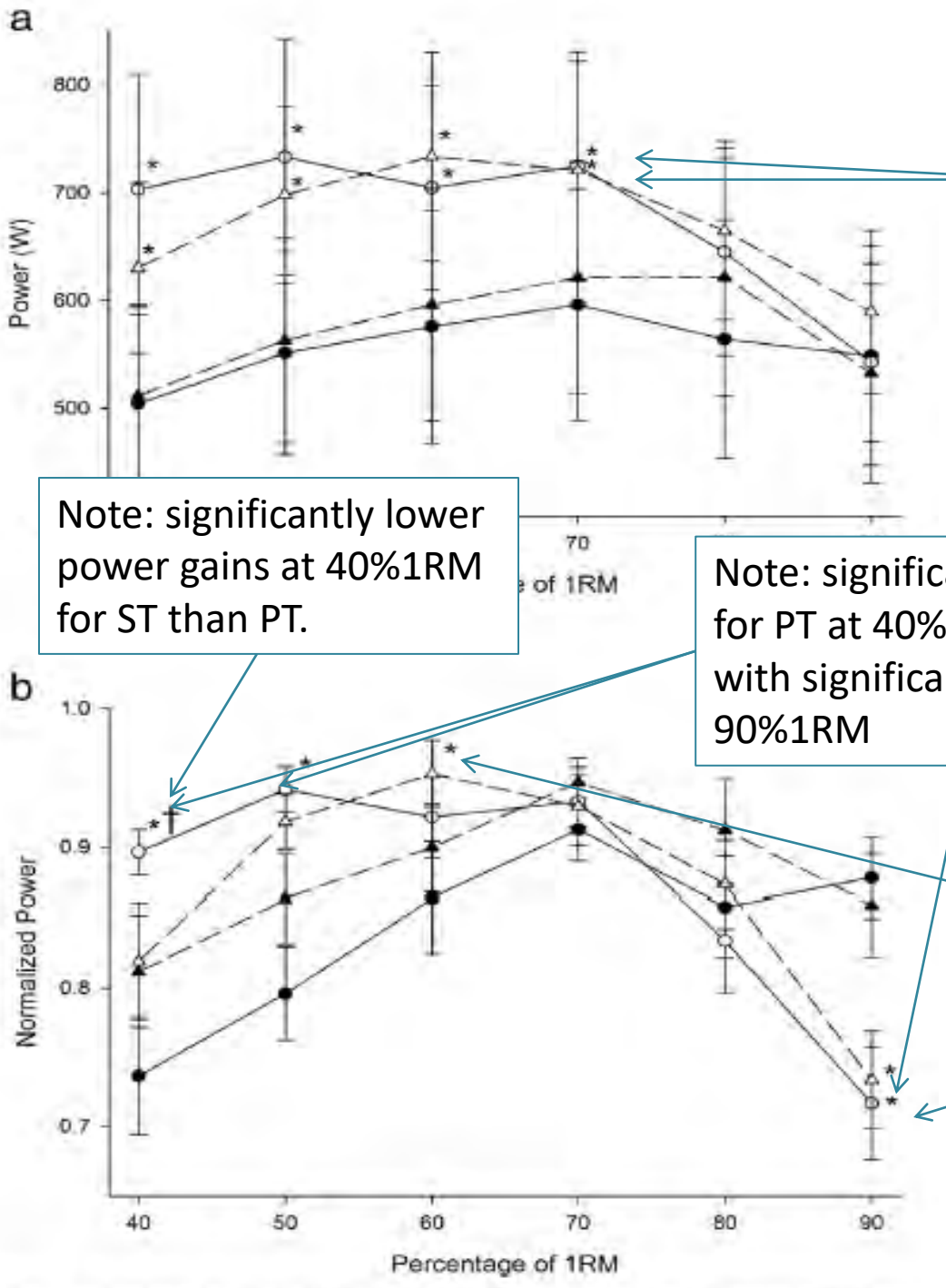
	Baseline Mean (SD)	12 wks Mean (SD)	Mean Diff (95% CI)	*p*	Effect Size Cohen's *d*
BBA	50.9 (6.3)	49.2 (6.9)	1.7 (.5, 2.9)	.007	.48
DMA	979.0 (163.6)	942.3 (128.2)	-36.7 (-86.9, 13.6)	.15	.25
TIME			3.1 (-2.6, 8.8)	.28	.18
TUG			-.84 (-4.3, 2.7)	.63	.13
Falls Efficacy	8.3 (1.9)	8.0 (2.1)	-.26 (-.6, .1)	.14	.25

TUG for Normal Mobility ≤10s

FES Fall Risk >10

BBA=berg balance assessment; DMA=dynamic motion analysis score; TUG=timed up-and-go. Absolute within-sample differences, *p* values and 95% confidence interval (CI) are derived from a paired sample T-test. Effect size of *d*=0.80 or greater is considered large, 0.50 to 0.79 is considered medium, and 0.20 to 0.49 is considered small.

Results: Power-Velocity



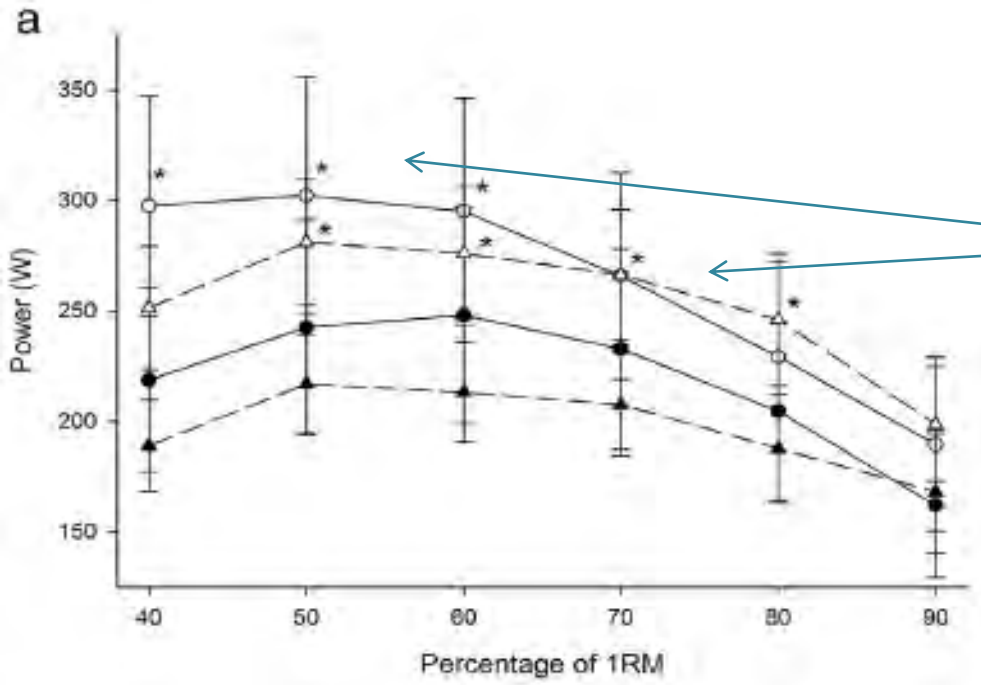
Note: significant increases in power at the same loads for ST and PT

Note: significantly lower power gains at 40%1RM for ST than PT.

Note: significant increases for PT at 40% and 50%1RM with significant decrease at 90%1RM

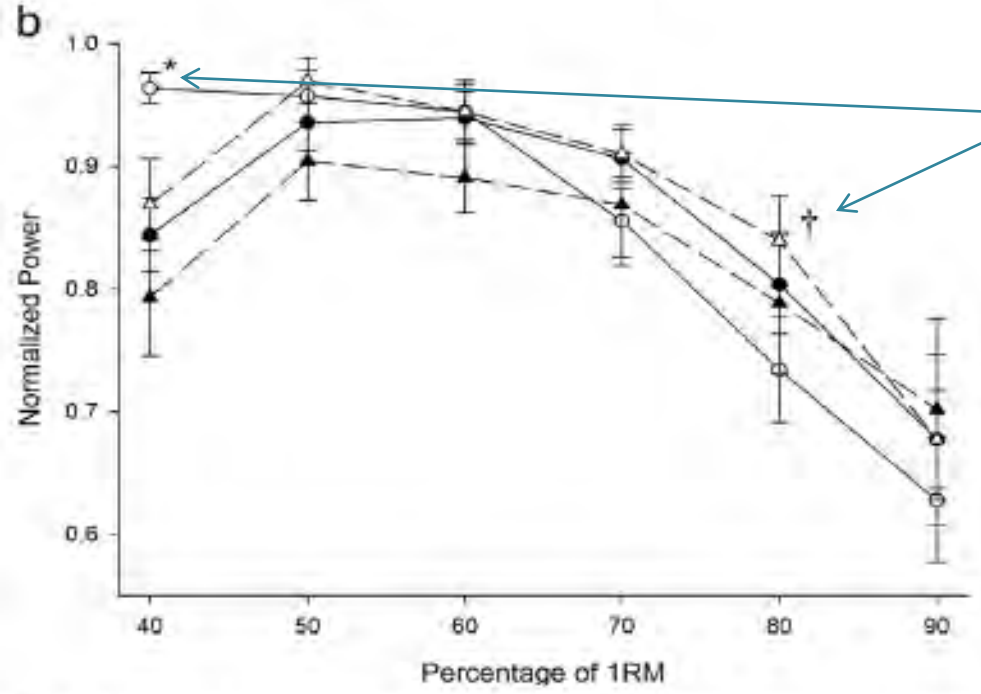
Note: significant increases for ST at 60% and significant decrease at 90%1RM

Fig. 4. Absolute (a) and normalized (b) power curves for leg press across relative loads based on percentage of subjects' maximal single repetition performance (1RM). Values are Mean ± SE. ● Power training group pretest, ○ power training group post-test, ▲ strength training group pretest, Δ strength training group post-test; *indicates significantly different from pretest values at $p \leq .05$. †indicates significant difference between groups.



Note: significant increases in power for PT at 40-60%1RM; but for ST at 50-80%1RM

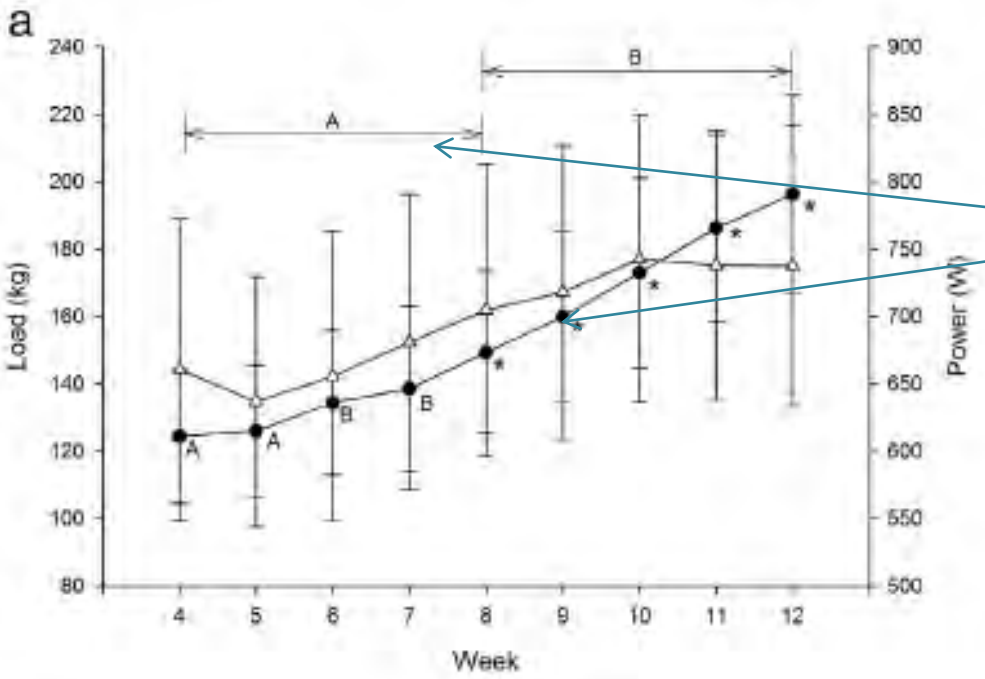
Results: Power-Velocity



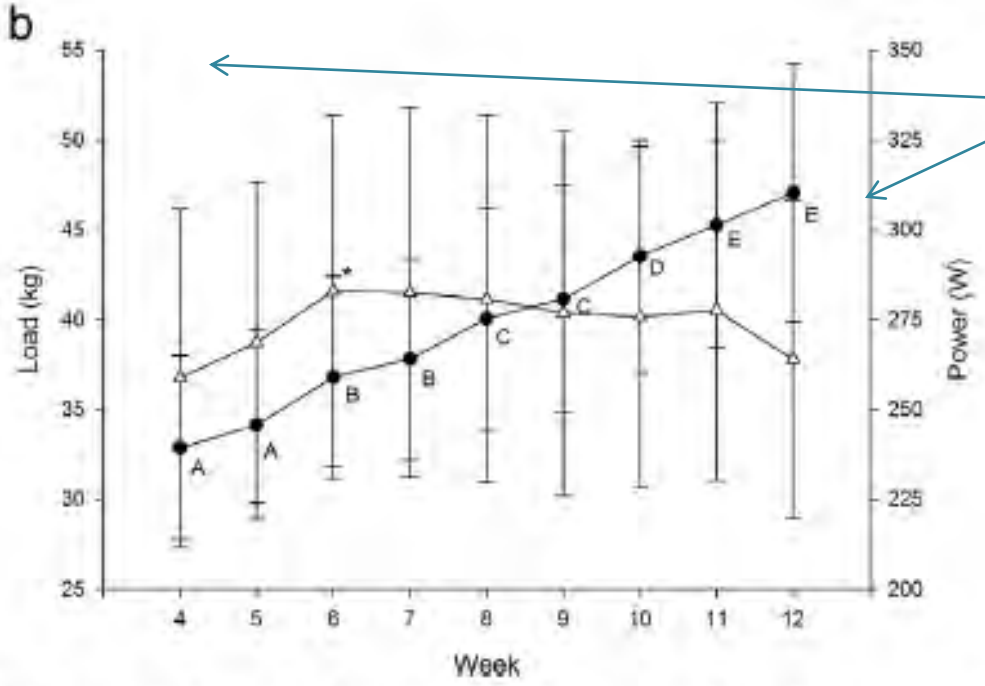
Note: significant increases for PT at 40% alone, and higher power for ST than PT at 80%1RM

Fig. 5. Absolute (a) and normalized (b) power curves chest press across relative loads based on percentage of subjects' maximal single repetition performance (1RM). Values are Mean ± SE. ● Power training group pretest, ○ power training group post-test, ▲strength training group pretest, Δ strength training group post-test; *indicates significantly different from pretest values at $p \leq .05$, †indicates significant difference between groups.

Results: Time-Course Power Changes



Note: For leg press, load increased throughout, power began to plateau at 8 weeks



Note: For chest press load increased throughout, power plateaued at 6 weeks

Fig. 6. Power changes for leg press (a) and chest press (b) across 9 weeks of training allowing for the two-week familiarization phase and a third week to stabilize loading patterns. Values are Mean ± SE; Time points with the same letter are not significantly different from each other. *significantly different from neighboring time points. ● load; Δ power. Significant level set at $p \leq .05$.

Conclusions:

- **Both ST and PT appear to be effective modalities for reducing the neuromuscular deficits associated with PD.**
- **Improvement differ for ST and PT by load, with more drastic differences for when power was normalized to peak power.**
- **Both PRT failed to improve functional performances likely due to the lack of movement-specific activities in the protocols or high baseline scores.**

PERIODIZED RESISTANCE TRAINING WITH AND WITHOUT FUNCTIONAL TRAINING IMPROVES FUNCTIONAL CAPACITY, BALANCE, AND STRENGTH IN PARKINSON'S DISEASE

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Matthew C. Totillo
Diana C. Castillo
Noah J. Gabor
Joseph F. Signorile

J Strength Cond Res. 2021

Objective:

To compare the effectiveness of 2 daily undulating periodization resistance training programs, strength, power, and hypertrophy training (SPH) and strength, power, and functional training (SP+Func), on measures of upper-body and lower-body functional performance, balance, muscular strength, motor symptoms, QoL, and FOG in persons with PD.

Participants:

Table 1

Characteristics of study subjects ($N = 35$) at baseline by group.*

Characteristic	SPH ($n = 17$)	SP + Func ($n = 18$)	p
Demographic			
Age (y)	70.19 ± 9.06	68.63 ± 10.54	0.65
Men/women (n)	9/8	11/7	0.63
Anthropometric			
Height (m)	1.65 ± 0.09	1.67 ± 0.15	0.25
Body mass (kg)	72.92 ± 15.86	74.13 ± 14.08	0.81
BMI ($kg \cdot m^{-2}$)	26.65 ± 5.10	26.97 ± 5.73	0.92
Clinical			
Hoehn and Yahr stage	2.00 ± 0.71	1.91 ± 0.63	0.21
Disease duration (y)	5.45 ± 4.11	5.83 ± 3.47	0.77
MMSE	28.44 ± 2.53	28.21 ± 2.04	0.79
Activity level ($h \cdot wk^{-1}$)	3.41 ± 2.94	3.73 ± 3.12	0.37
Antiparkinson medication (%)	82.4	83.3	0.94
Comorbidities			
Hypertension (%)	41.2	27.8	0.40
Dyslipidemia (%)	35.3	11.1	0.09
Depression (%)	52.9	44.4	0.62
Diabetes (%)	0.0	5.6	0.32

*SPH = strength, power, and hypertrophy group; SP + Func = strength, power, and functional group; BMI = body mass index; MMSE = Mini-Mental State Examination.

†Values are mean ± SD unless otherwise stated.

DUP Protocols

Table 2

Training intervention details for the SPH (strength, power, and hypertrophy) and SP + Func (strength, power, and functional) groups.*

	SPH group				SP + Func group			
Day	Protocol	Set × reps, loads	Tempo	Recovery	Protocol	Set × reps, loads	Tempo	Recovery
1	Strength	3 × 8 at 80% 1RM	2–3 second concentric and eccentric	90 s	Strength	3 × 8 at 80% 1RM	2–3s concentric and eccentric	90 s
2	Power	3 × 6 at 50% 1RM	Maximal concentric velocity, 1–2 second isometric hold, 2–3 second eccentric	120 s	Power	3 × 6 at 50% 1RM	Maximal concentric velocity, 1–2s isometric hold, 2–3s eccentric	120 s
3	Hypertrophy	3 × 12 at 70% 1RM	2–3s concentric and eccentric	60 s	Functional	Table 3		

*1RM = 1 repetition maximum.

Functional Training Cycle

Table 3

Functional training details.

Circuit	Focus	Exercise	Volume
1	Strength/mobility	Weighted walk	3 × 50 m
	Balance	Anterior-posterior go-stop	3 × 30 s
	Balance	Lateral go-stop	3 × 30 s
2	Strength/mobility	Sit-to-stand transfers	3 × 5 each direction
	Power	Standing medicine ball throw	3 × 10
3	Balance/mobility	Forward ladder drills	2 × 4 drills
	Balance	Medicine ball wood chops	2 × 5 each side
	Balance/mobility	Lateral ladder drills	2 × 4 drills
	Power	Lateral medicine ball throws	2 × 5 each side
4	Strength	Step-ups	2 × 10 each leg
	Power	Ball bounce pass and catch	2 × 10
	Strength/balance	Cone lunges	2 × 10 each leg

Results:

Table 4

Within-group and between-group outcomes after SPH and SP + Func exercise interventions.*

	SPH ($n = 13$)				SP + Func ($n = 15$)				Between groups		
Assessment	Baseline mean ± SD	12 wk mean ± SD	η^2‡	p	Baseline mean ± SD	12 wk mean ± SD	η^2‡	p	Adjusted mean diff (95% CI)	η^2‡	p
TUG (s)§	8.64 ± 2.95	7.76 ± 3.28	0.06	0.25	8.14 ± 3.18	7.24 ± 1.58	0.07	0.20	0.51 (−1.51 to 2.53)	0.01	0.61
30-s STS (reps)	12.08 ± 2.69	14.54 ± 4.63	0.19	0.02†	13.27 ± 4.46	15.47 ± 5.78	0.18	0.03†	−1.53 (−4.94 to 1.88)	0.02	0.51
GJST (s)§	11.36 ± 2.42	10.76 ± 2.51	0.04	0.29	11.10 ± 1.88	10.52 ± 2.36	0.05	0.28	0.25 (−1.35 to 1.85)	0.00	0.75
SMBT (m)	2.43 ± 0.96	2.74 ± 0.75	0.14	0.05†	2.49 ± 0.90	2.80 ± 0.97	0.16	0.04†	−1.34 (−8.28 to 5.60)	0.00	0.85
Mini-BESTest	22.42 ± 4.08	25.58 ± 2.35	0.31	0.003†	21.80 ± 3.39	25.07 ± 2.69	0.37	0.001†	0.57 (−1.60 to 2.74)	0.01	0.60
LP1RM (kg)	181.6 ± 81.7	206.4 ± 83.2	0.20	0.02†	197.6 ± 79.8	234.1 ± 85.8	0.38	0.001†	−21.9 (−84.8 to 41.0)	0.02	0.48
CP1RM (kg)	32.6 ± 14.3	37.7 ± 14.1	0.17	0.04†	35.2 ± 16.9	42.7 ± 22.5	0.32	0.003†	−3.8 (−17.8 to 0.2)	0.01	0.58
UPDRS-III§	28.85 ± 12.91	24.46 ± 10.81	0.09	0.11	25.07 ± 11.11	23.73 ± 11.13	0.01	0.60	2.25 (−5.86 to 10.37)	0.01	0.57
PDQ-39§	21.69 ± 14.20	18.80 ± 11.05	0.04	0.30	16.91 ± 8.64	14.57 ± 8.38	0.03	0.37	4.51 (−2.84 to 11.85)	0.06	0.22
FOG-Q§	6.62 ± 8.06	9.23 ± 9.44	0.09	0.11	7.40 ± 7.85	4.13 ± 6.89	0.16	0.04†	2.26 (−3.67 to 8.19)	0.02	0.46

*SPH = strength, power, and hypertrophy training group; SP + Func = strength, power, and functional training group; CI = confidence interval; TUG = timed up and go; 30-s STS = 30-second sit-to-stand; GJST = gallon-jug shelf-transfer; SMBT = seated medicine ball throw; Mini-BESTest = Mini-Balance Evaluation Systems Test; LP1RM = leg press 1 repetition maximum; CP1RM = chest press 1 repetition maximum; UPDRS-III = Unified Parkinson's Disease Rating Scale, motor score; PDQ-39 = Parkinson's Disease Questionnaire-39; FOG-Q = Freezing of Gait Questionnaire.

†Significant ($p \leq 0.05$).

‡η^2: eta-squared effect size interpreted as large (0.14), medium (0.06), and small (0.01).

§Lower score is better.

Conclusion:

- A 12-week DUP machine-based SPH program was equally effective as a SP+Func program for improving upper-body and lower-body functional ability, balance, and strength outcomes among individuals with mild-to-moderate PD.
- This study suggests that persons with PD should undertake a periodized PRT program incorporating strength and power training to offset age-related and disease-related neuromuscular and functional decline and that hypertrophy and functional training can be incorporated as dictated by motor symptoms and FOG, respectively.

VELOCITY BASED TRAINING AFFECTS FUNCTION, STRENGTH AND POWER IN PERSONS WITH PARKINSON'S DISEASE

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Manuscript in Prepartion

The Concept

Velocity-based training (VBT) is one of the newest training methodologies employed by athletes to improve power. We have used modifications of athletes' power training methods in the previous studies. Thanks to the HUR equipment providing immediate data on velocity and power thereby allowing us to employ this data-driven training method effectively, we are now able to test the impact of VBT in persons with PD.

Objective:

Since VBT targets velocity, where the greatest declines in performance are seen in people with PD. Given the shifts in the load-velocity spectrum demonstrated by Ni et al [12] with traditional power training, we hypothesized that VBT that incorporated a lower velocity loss threshold (10%) would produce greater shifts towards the velocity end of the load-velocity LV spectrum than a 30% velocity loss threshold.

Objective:

Further, we hypothesized that training at both VBT thresholds would positively affect maximal strength, power, and functional capability.

Participants:

	VD (n=7)	FD (n=9)
Age (y):	75.0 (6.7)	71.3 (5.2)
Height (m):	1.72 (0.1)	1.69 (0.07)
Weight (kg):	80.4 (14.7)	74.4 (11.5)
Sex:	6M, 1F	6M, 3F
Side mostly affected (%):		
Left	18.75	18.75
Right	18.75	31.25
Symmetric	6.25	6.25
UPDRS:		
Part III score	32.5 (13.4)	32.0 (15.6)
Hoehn & Yahr Stage	1.9 (.9)	1.8 (1.0)
Participants on medication (n):	7	9
Carbidopa	5	7
Levodopa	4	5

Values are mean (SD) Abbreviations: y = years; m = meters; kg = kilograms.

Results

Note: Main Effect for Time

Table 2. Pairwise comparisons for functional tests (n = 16).

Mean 12.6s for 70-79

Variable	Pretest	Post-test	MDiff (SE)	95% CI	p	d
Five Time Sit-To-Stand						
Performance Time (s)	9.53 (2.69)	8.06 (3.05)*	1.48 (0.45)	MCID = 2.3s	.005	0.51
Power (W)	321.7 (99.7)	395.8 (145.2)*	75.5 (22.7)	-124.2, -26.7	.005	0.59
Six-Meter Gait Speed						
Habitual Speed (s)	1.17 (0.21)	1.20 (0.25)	0.03 (0.40)	-0.04, 0.10	<.403	0.13
Maximum Speed (s)	1.77 (0.39)	1.99 (0.44)*	0.22 (0.04)	MCID = .10 m/s	<.001	0.53

Pretest and post-test scores are Mean (SD); *Significant difference from pretest to post-test.

MDiff (SE) = mean difference and standard error between pretest and post-test; 95% CI = 95% confidence interval of the difference; d= Cohen's d effect size.

Results

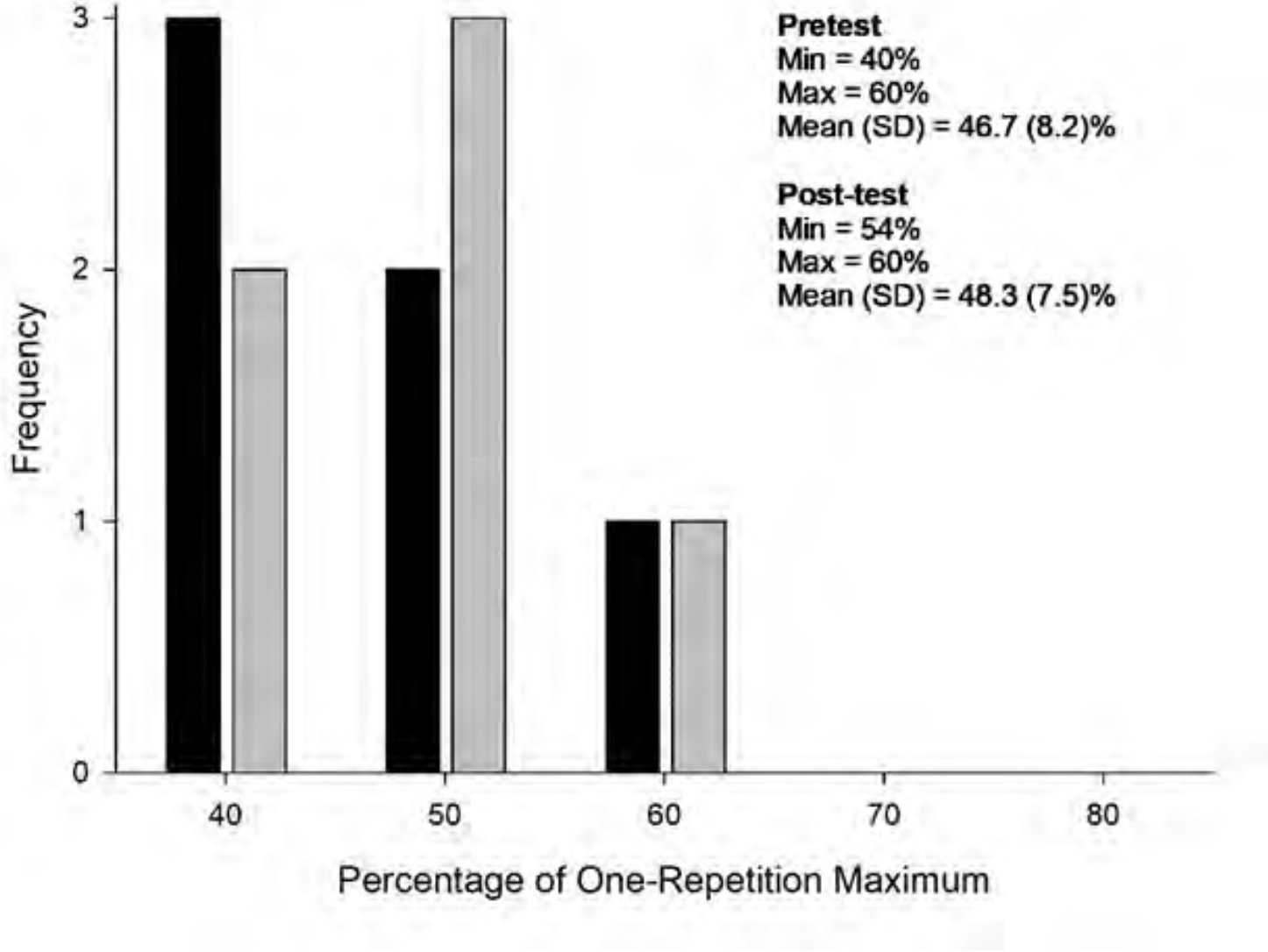
Note: Main Effect for Time

Table 3. Pairwise comparisons for neuromuscular tests.

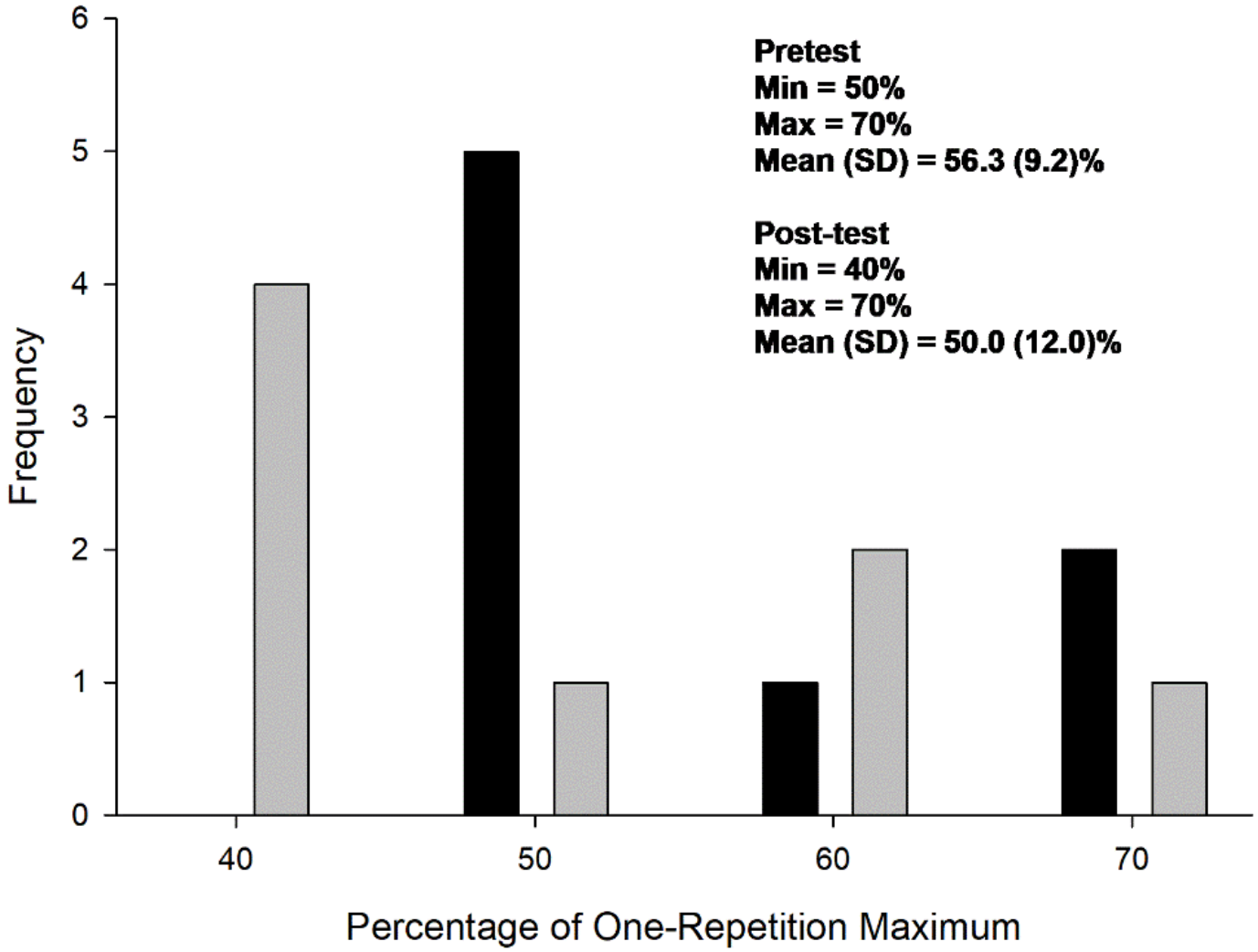
Variable	Pretest	Post-test	MDiff (SE)	95% CI	p	d
Chest Press (1RM) n = 16	26.3 (12.8)	31.4 (13.8)*	-5.1 (1.1)	-7.5, -2.7	<..001	0.39
Leg Press 1RM (kg) n = 16	321.7 (99.7)	395.8 (145.2)*	-12.6 (3.7)	-20.6, -4.6	.004	0.59
Relative Leg Press 1RM ($kg \cdot BWkg^{-1}$) n=16	1.39 (0.42)	1.58 (0.45)*	-0.19 (0.04)	-0.28, -0.09	<.001	0.44
Chest Press PP (W) n = 14	317.6 (173.5)	304.4 (195.6)	17.0 (31.4)	-51.3, 85.4	.597	0.07
Leg Press PP (W) n = 14	451.9 (185.1)	497.2 (195.2)*	-43.6 (13.2)	-72.3, -15.0	.006	0.24
Relative Leg Press PP ($W \cdot BWkg^{-1}$) n = 14	5.89 (2.23)	6.54 (2.38)*	-0.63 (0.19)	-1.05, -0.20	.007	0.28

Pretest and post-test scores are Mean (SD); *Significant difference from pretest to post-test. MDiff (SE) = mean difference and standard error between pretest and post-test; 95% CI = 95% confidence interval of the difference; d= Cohen's d effect size.

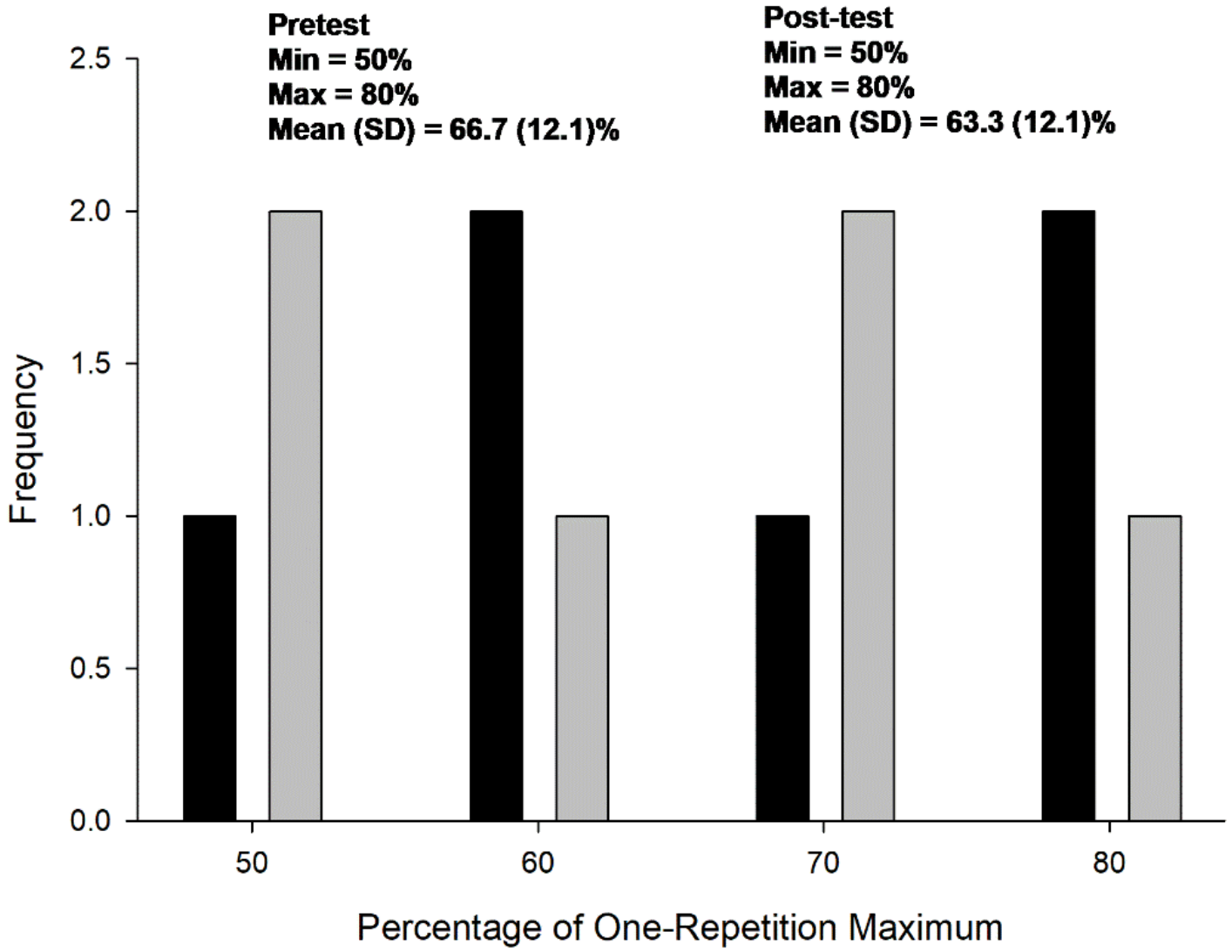
Load Velocity Shift 10% Deficit Chest Press



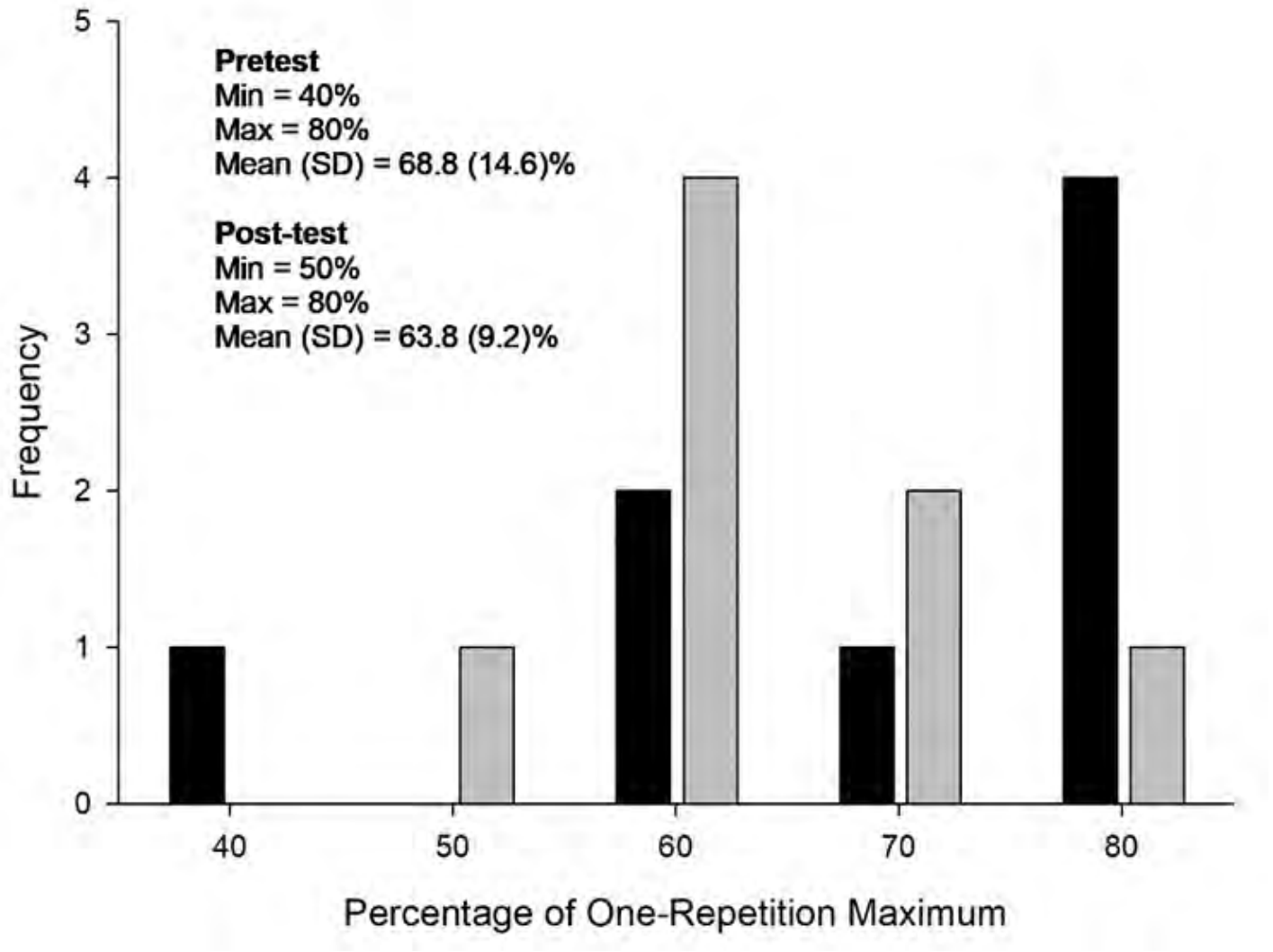
Load Velocity Shift 30% Deficit Chest Press



Load Velocity Shift 10% Deficit Leg Press



Load Velocity Shift 30% Deficit Leg Press



Conclusion:

- Both groups improved Chest press and Leg press power, as well as Leg press power relative to body weight
- Both VBT groups improved functional performance time and power in the 5xSTS
- Both groups improved six-meter gait speed at maximum effort; but not at habitual effort.
- Both groups demonstrated the ability to shift the load-velocity relationship toward the velocity end of the spectrum.

Our results suggest that VBT is a viable method for improving function in PD patients; however, a larger sample is required to support our findings.

Using data-based for progressions…a teaser

MEDICALFITNESS Association

Thank you for attending!
We appreciate your support.

Joseph Signorile, PhD
University of Miami