

Research Symposium Update on Exercise in Parkinson Disease

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Boston University



5/25/2017

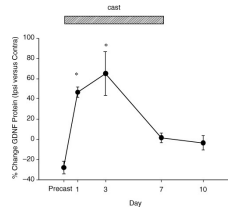
Exercise Goals

- Slow Progression of Disease?
- Slow Progression of Disability
- Optimize independence and participation in home, work and leisure activities
- Optimize independence and safety in performing function tasks (gait, balance, sit to stand, bed mobility, ADL's)
- Preserve or improve physical capacity (cardiovascular endurance, strength and flexibility)
- Prevent falls – reduce fall risk

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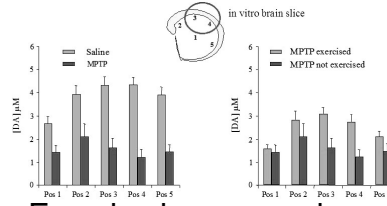
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Could Exercise Be Neuroprotective?



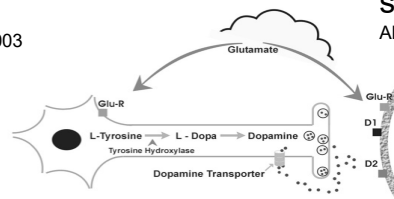
Increase in Striatal GDNF levels

Cohen et al. 2003



Exercise increases dopamine release in dorsolateral striatum

Akopian et al. 2008



Exercise suppresses expression of dopamine transporter

Fisher et al. 2004

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Exercise-induced neuroplasticity in human PD

PLASTICITY MARKER	PD N	EXERCISE/ACTIVITY
Decrease in corticomotor excitability with TMS	30	24 sessions over 8 weeks of high intensity treadmill training; 3.0 MET level &/or 75% MHR for 45 minutes
Increase in DA-D2r expression	4	SAME
Change in gray matter volume	47	6 training sessions of balance exercise over 6 weeks
Increase in BDNF	12	24 cycling sessions over 8 weeks; 60-75% MHR for 60 minutes
Increase in BDNF	11	24 cycling sessions over 8 weeks; 60-75% MHR for 60 minutes
Increase in BDNF	25	80 therapy/exercise sessions: aerobic exercise; stretching; balance & gait training; treadmill training

(Hirsch et al., 2016)

Regular exercise matters in Parkinson's disease

- Analysis of registry data including 2252 persons with Parkinson disease
- Regular exercise (> 150 mins/week) at baseline were associated with better
 - Quality of life
 - Mobility
 - Physical function
 - Cognition

And less

- disease progression

One year later.....

Oguh O et al. Parkinsonism and Related Disorders (2014) 1-5.

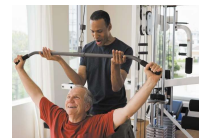
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Smart Exercise: Designing the program that is best for you!

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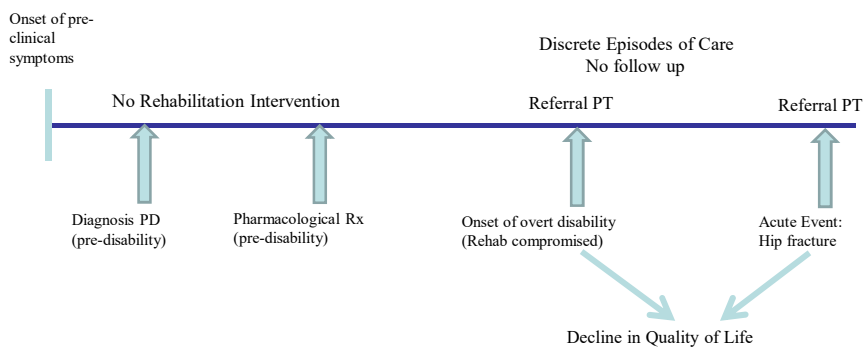
Q. What kind of exercise is best for people with Parkinson Disease?

A. Exercise that is tailored to your needs, preferences and goals will result in the best outcome...



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Traditional Model of Rehabilitation in Parkinson Disease



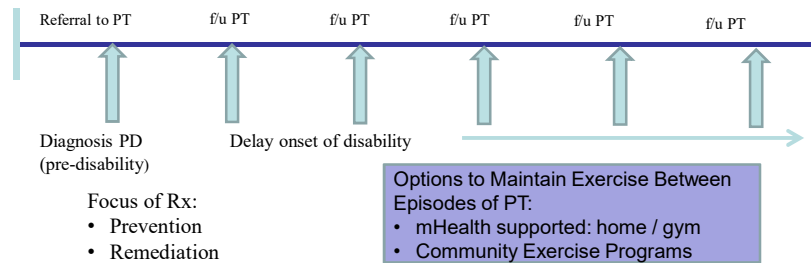
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Dental Model of Care (Secondary Prevention)

Onset of pre-clinical symptoms

Rehabilitation provided at regular intervals over disease continuum

- Standardized outcome measures administered at each f/u visit
- Exercise prescription tailored to meet the needs of each individual patient



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How do you choose what's best for you?

Exercise Category	Examples
Aerobic Exercise	Treadmill Walking overground Biking Boxing
Strength Training	Weight training machines, dumbbells, theraband, weighted vests, body weight
Balance Training	Balance Training Tai Chi class Dancing
Stretching	Flexibility exercises Yoga
Task Specific Training / Movement Strategy Training	Walking; Cueing with Music

Aerobic Exercise



+ Motor Skill Training



+ Strengthening

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Benefits of aerobic exercise:

Assessment	Participants, No	Mean Change (SE)	Within-Person Percentage Change	P value
6MWT				
HIT	22	77 (31.1)	6.3 (2.5)	.07
LIT	19	161 (51)	11.6 (3.7)	.001
S-R	19	107 (47.8)	9.1 (5.5)	.019
10-m Fast pace, s				
HIT	23	-0.4 (0.2)	-4.6 (1.9)	.049
LIT	22	-0.48 (0.3)	-6.2 (3.5)	.02
S-R	22	-0.1 (0.2)	-1.2 (2.3)	.63
Cardiovascular Assessment Peak VO₂, mL/kg/min				
HIT	23	1.54 (0.4)	8.1 (2.1)	.003
LIT	22	1.53 (0.7)	6.7 (2.7)	.004
S-R	21	-0.052 (0.4)	-0.2 (1.7)	.92

Shulman et al. 2013

Aerobic Walking Exercise in PD

- Walking 3x per week for 45 minutes
- Community Setting
- Mean HR = 70% HR max (HR = 107.8)

Outcome	Adjusted for levodopa equivalent
VO2 max (max O2 uptake; mL/min/kg)	1.66 ± 2.90 (<0.001)
7-m walk (seconds)	-0.62 ± 1.05 (<0.001)
UPDRS Motor	-2.75 ± 7.12 (0.002)
UPDRS Mental	-0.52 ± 1.58 (0.025)
Flanker task – (% increase score)	-3.70 ± 8.17 (0.005)
Fatigue Severity Scale	-0.52 ± 1.13 (0.002)
Geriatric Depression Scale	-0.77 ± 2.58 (0.043)
PDQUALIF, total (quality of life)	-1.14 ± 4.21 (0.064)

Uc et al. 2014

Contemporary Clinical Trials 36 (2013) 90-98

Contents lists available at ScienceDirect

Contemporary Clinical Trials

journal homepage: www.elsevier.com/locate/conclintrial

Study in Parkinson Disease of Exercise (SPARX): Translating high-intensity exercise from animals to humans

Charity G. Moore^{a,*}, Margaret Schenkman^b, Wendy M. Kohrt^c, Anthony Delitto^d, Deborah A. Hall^e, Daniel Corcos^f

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graph TD
    Baseline[Baseline] -- "(Randomization)" --> Usual[Usual Care]
    Baseline -- "(Randomization)" --> Mod[Moderate-Intensity Exercise]
    Baseline -- "(Randomization)" --> High[High-Intensity Exercise]
    Usual --> Usual3[3 months]
    Mod --> Mod3[3 months]
    High --> High3[3 months]
    Usual3 --> Usual6[6 months]
    Mod3 --> Mod6[6 months]
    High3 --> High6[6 months]
    Mod6 -- "(Randomization)" --> Mod6_2[Moderate-Intensity Exercise]
    High6 -- "(Randomization)" --> High6_2[High-Intensity Exercise]
    Usual6 --> Usual12[12 months]
    Mod6_2 --> Mod12[12 months]
    High6_2 --> High12[12 months]
  
```

N = 126

Mod Intensity = Exercise 4 days per week
60-65% Hrmax

High Intensity = Exercise 4 days per week
80-85% HRmax

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Strengthening Exercises



+ Balance Training

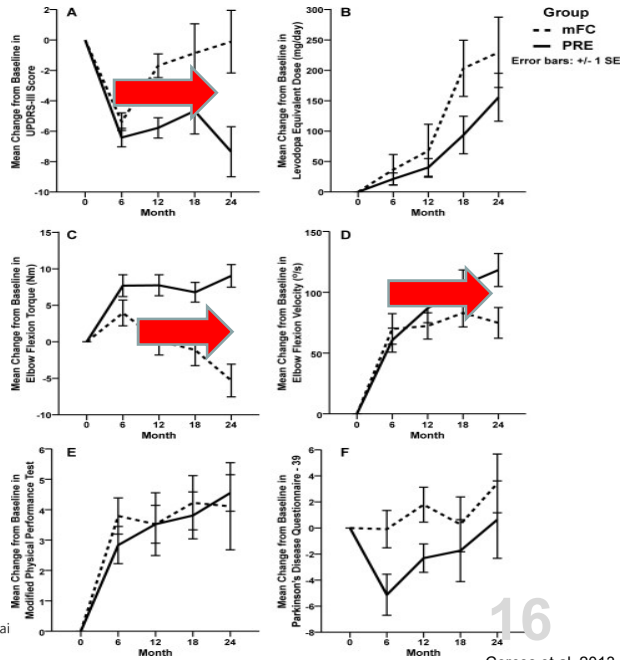


2-year (2x/wk)
RCT
Progressive
Resistance
Exercise in PD

Significant improvements:

- Motor UPDRS (off meds)
- Strength
- Movement Speed

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Targeting Strength

Enhance Postural Extension

- Hip Extensors
- Hip Abductors
- Knee Extensors
- Gastroc Soleus
- Trunk Extensors

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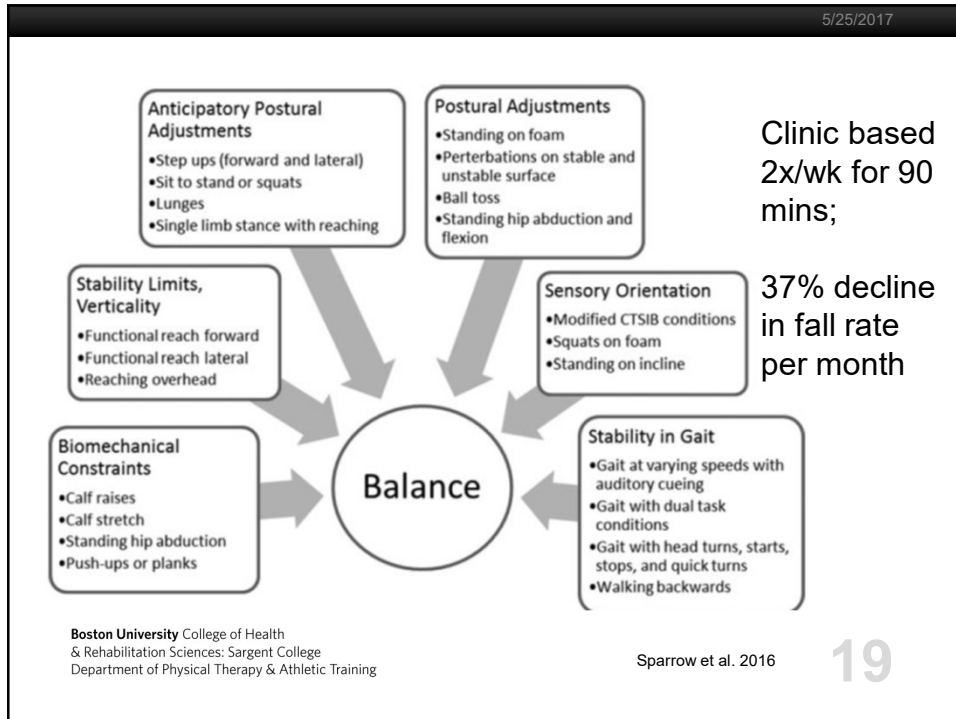
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Balance Exercises



+ Cognitive Training

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Predicting Falls

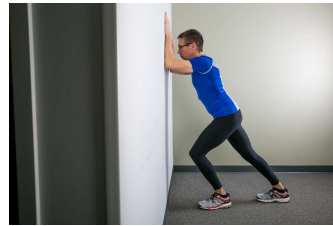
1. Have you fallen in past 12 months?
2. Have you experienced freezing of gait in the past month?
3. Timed 4 meter walk test

Total Score: Probability of Falling in next 6 months

Stretching Exercises



+ **Balance
Training**



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Targeting Flexibility & ROM

- Flexibility
 - Gastroc / soleus
 - Hamstrings
 - Hip flexors
 - Pectoralis major and minor
 - Elbow flexors
 - Finger flexors
- ROM
 - Cervical rotation
 - Axial extension
 - Trunk rotation
 - Trunk extension
 - Pelvis – anterior tilt

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Exercise + Socialization

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How much Exercise is Recommended?

Exercise Type	American College Sports Medicine Guidelines
Cardiorespiratory Exercise	<ul style="list-style-type: none"> • 150 minutes (2.5 hours) of moderate intensity per week
Resistance Exercise	<ul style="list-style-type: none"> • 2-3 days per week • 2 sets, 8-12 repetitions
Flexibility Exercise	<ul style="list-style-type: none"> • At least 2-3 days per week • Hold for 30 seconds • Repeat 2-4 times • Perform when muscles are warm (after exercise)
Balance / Neuromotor Exercise	<ul style="list-style-type: none"> • 2-3 days per week • 30 minutes

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TABLE 1. Practice variables important for evoking activity-dependent neuroplasticity- examples in brain injury (PD, stroke, spinal cord injury)

Practice variable	Animal study	Human study
Intensity	Petzinger et al., 2007 ²⁰ ; Tillerson et al., 2001 ²¹	Liepert, 2006 ¹³ ; Liepert et al., 2000 ¹⁴
Specificity	Fisher et al., 2004 ¹⁹ ; De Leon et al., 1999 ¹⁸ ; Tillakaratne, 2002 ¹⁷	Forrester et al., 2006 ¹² ; Dobkin et al., 2004 ¹¹
Difficulty	Friel and Nudo, 1998 ¹⁶	Wittenberg et al., 2003 ¹⁰ ; Johansen-Berg et al., 2002 ⁹
Complexity	Jones et al., 1999 ¹⁵	Winstein et al., 1997 ⁸

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Petzinger et al. 2010

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What do people with PD really want from their Treatment?

- Of 10 domains of functioning, patients with PD rated the following in order of importance:
 - **Walking**
 - **Slowness**
 - **ADL**
 - **Fatigue**
 - **Stiffness**
 - **Sleep**
 - **Thinking**
 - **Tremor**
 - **Emotional distress**
 - **Pain**
- Gait Disturbance most important to patients with PD
- Considered least likely to improve (low outcome expectations)
- L-dopa has limited therapeutic effects on gait
- Gait disturbance is a known strong predictor of disability and health related quality of life

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Nisenzon et al. 2011

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Using Music to Improve Walking....

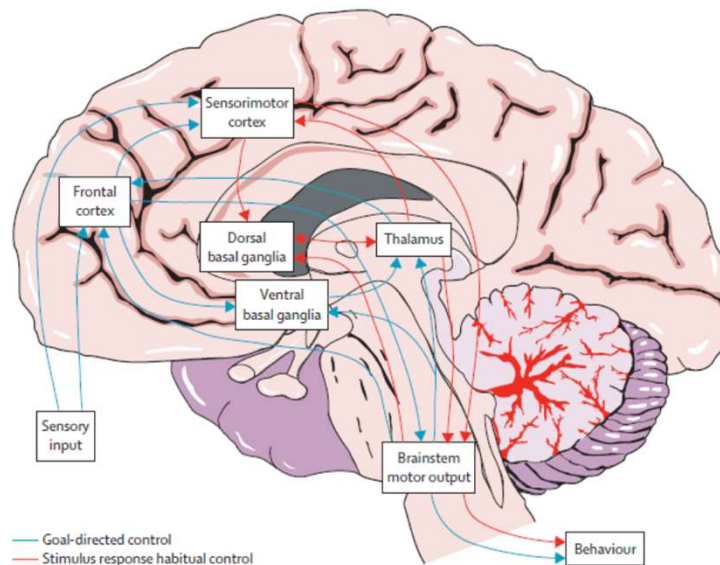
- 80 steps / min
- I'm a Believer by Neil Diamond
<https://www.youtube.com/watch?v=sWQv0dkVzVU>

- 100 steps / min
- Jack & Diane by John Mellencamp
<https://www.youtube.com/watch?v=zjMwrXGk4xU>

- 126 steps / min
- September by Earth, Wind & Fire
https://www.youtube.com/watch?v=ter0p_ilylk

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Petzing 2013

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Step Activity Classification Adults

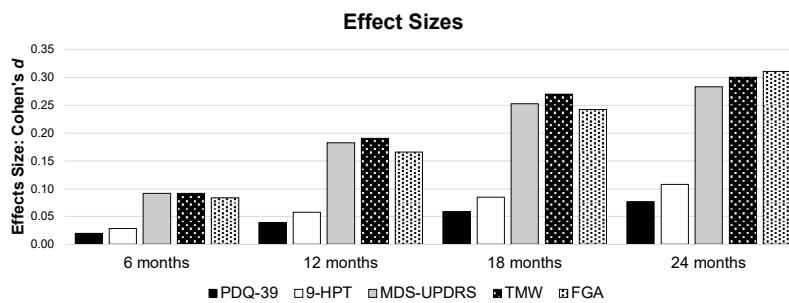
Physical Activity Level	Criterion (steps / day)
Basal Activity	< 2,500
Limited Activity	2,500-4,999
Low Active	5,000-7,499
Somewhat Active	7,500-9,999
Active	10,000-12,499
Highly Active	>12,500

Sedentary

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Adapted from Tudor-Locke et al. (2011) - Color added

Progression of Disability in PD



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Ellis et al. 2016 Parkinsonism & Related Disorders

Changes in Walking in Persons with Parkinson Disease over 1-year

Variable	% change / effect size
Steps*	-12 / 0.28
Moderate intensity minutes*	-40 / 0.30

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Cavanaugh, Ellis, Earhart, Ford, Foreman, Dibble, 2012

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Barriers to Exercise

Physical Therapy
Journal of the American Physical Therapy Association



Barriers to Exercise in People With Parkinson Disease
Terry Ellis, Jennifer K. Boudreau, Tamara R. DeAngelis,
Lisa E. Brown, James T. Cavanaugh, Gammon M.
Earhart, Matthew P. Ford, K. Bo Foreman and Leland E.
Dibble
PHYS THER. Published online January 3, 2013
doi: 10.2522/ptj.20120279

- Most Common Barriers to Exercise in Persons with PD:
 - **Low outcome expectation**
 - Fear of falling
 - Lack of time

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Ellis, 2013

What are the Factors Associated with Exercise Behavior in PD?

Physical Therapy
Journal of the American Physical Therapy Association



Factors Associated With Exercise Behavior in People With Parkinson Disease
Terry Ellis, James T. Cavanaugh, Gammon M. Earhart, Matthew P. Ford, K. Bo Foreman, Lisa Fredman, Jennifer K. Boudreau and Leland E. Dibble
PHYS THER. 2011; 91:1838-1848.
Originally published online October 14, 2011
doi: 10.2522/ptj.20100390

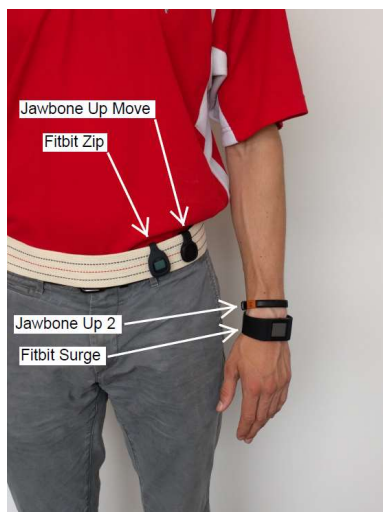
Most Robust Factors Associate with Exercise in PD:

Self-Efficacy: the measure of one ability to exercise successfully

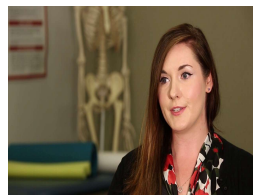
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Ellis et al. 2011

Accuracy of Activity Trackers

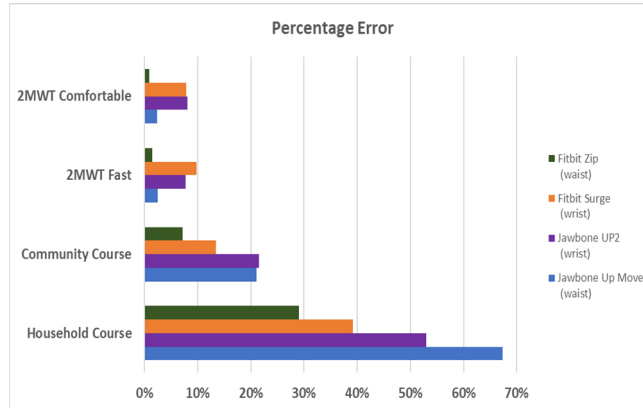


- Fitbit Zip
- Fitbit Surge
- Jawbone UP2
- Jawbone Up Move



Accuracy of Activity Trackers

- **Fitbit Zip**
- **Fitbit Surge**
- **Jawbone UP2**
- **Jawbone Up Move**



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Peer Coaching Program

Peer Coach Training



Peer Interaction



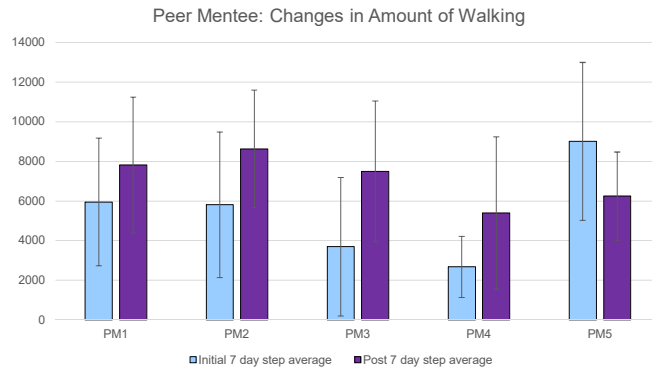
Physical Activity Levels & Post-Intervention Measurements



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Peer Coaching Program



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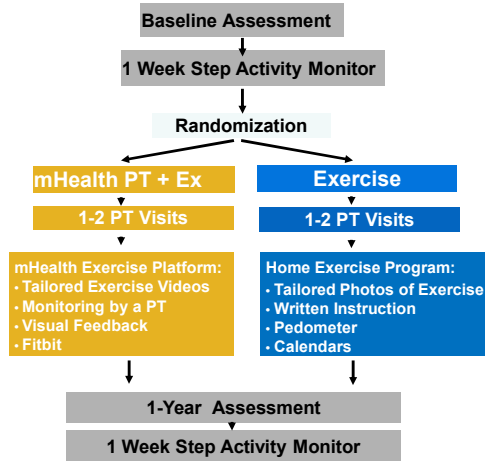
Steps per day increased by
31% from 5,428 to 7115 steps.

Mobile Health Technology to Promote Physical Activity in Persons with Parkinson Disease



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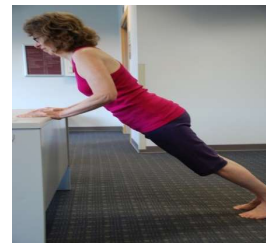
Study Design



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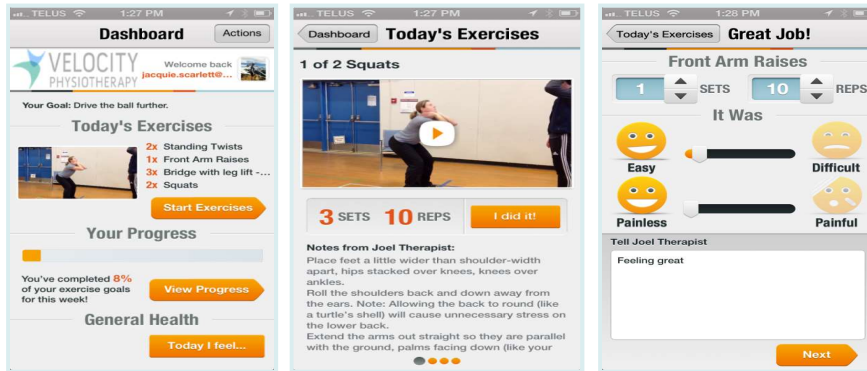
Exercise Intervention

- Walking with pedometer
- Strengthening



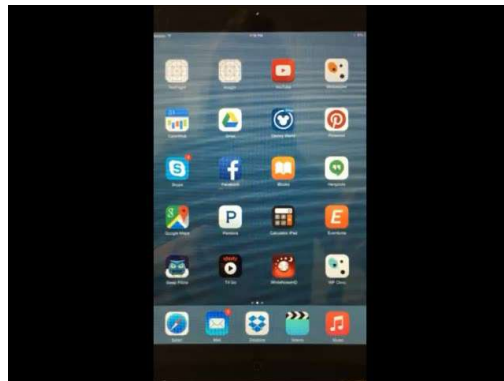
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Mobile Health Technology



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Wellpepper App: User Version



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Promoting Exercise

Theoretical Approach	Intervention Components						
	Tailored Exercise Videos	Adaptations to Exercise Program over time by PT	Monitoring by a PT	Progress Towards Goals: Visual Feedback	Adherence Graphs	Motivational content (videos)	Automated Reminders and Rewards
Self-efficacy	√	√	√	√	√	√	√
Outcome expectations			√	√		√	
Motivation		√	√	√	√	√	√
Knowledge	√	√	√			√	
Social Persuasion			√			√	

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Outcomes

- Feasibility, safety, acceptability and adherence
- Physical Activity: measured during a one-week period following the baseline and 12-month assessment sessions using the StepWatch™ Activity Monitor (SAM)
- HRQOL, walking endurance, balance
- Self-Efficacy, outcome expectation



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Satisfaction & Safety

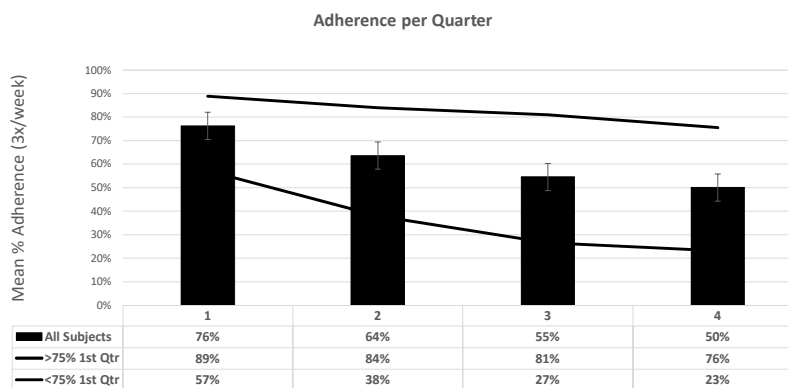
Survey	mHealth	Active Control
Satisfaction Rating (mean, SD) (0=Not satisfied - 10=Highly satisfied)	8.7 (+/- 1.3)	8.5 (+/- 1.6)
“Would you like to continue doing the program?”	85% Yes	75% Yes
“Would you recommend this program?”	100% Yes	100% Yes

Safety: No serious adverse events related to the intervention

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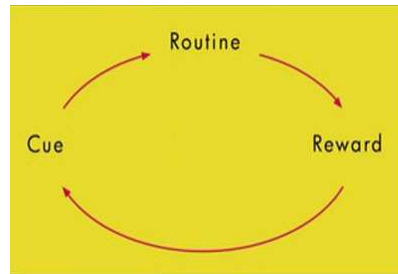
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Making Exercise a Habit

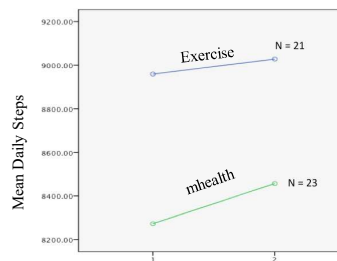
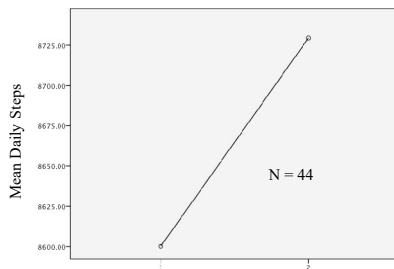


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THE HARDEST THING ABOUT EXERCISE IS TO **START** DOING IT. ONCE YOU ARE DOING **EXERCISE REGULARLY**, THE HARDEST THING IS TO **STOP**

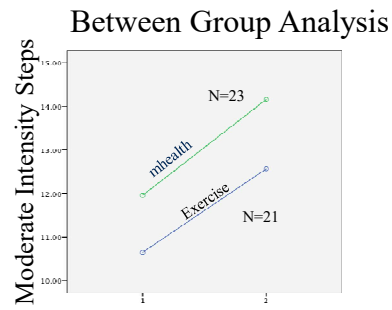
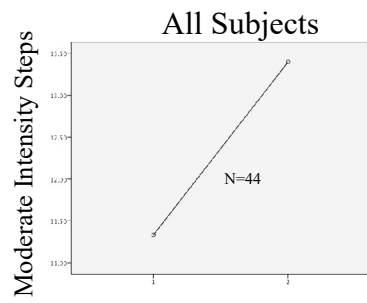


Mean Daily Steps



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Moderate-intensity Minutes*



* # minutes in which 100 steps or more were accumulated

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Changes in Walking in Persons with Parkinson Disease over 1-year

Variable	% change / effect size
Steps*	-12 / 0.28
Moderate intensity minutes*	-40 / 0.30

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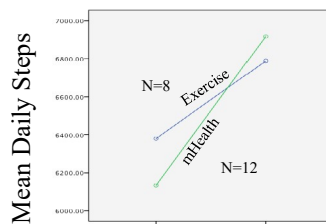
Cavanaugh, Ellis, Earhart, Ford, Foreman, Dibble, 2012

Steps

More noticeable (yet still non-significant) between-group differences over time were observed when the original dataset was divided according to the baseline level of physical activity.

✓ The suggestion is that the mobile health technology may have differentially benefitted less active participants.

“Low Active” (<7500)



mHealth: Increase in 5495 steps per week

Exercise: Increase in 2856 steps per week

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Moderate Intensity Minutes

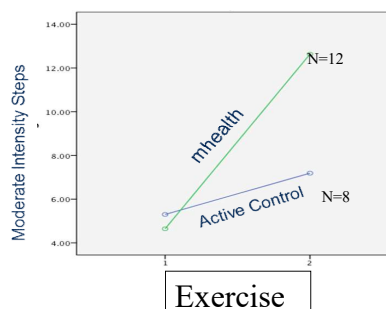
Results

✓ This result raises the possibility that the mHealth technology was differentially beneficial for less active participants.

mHealth: increase from **35 to 95 mod intensity minutes per week**

Control: increase from **35 to 49 mod intensity minutes per week**

Low Active (< 7500 per day)

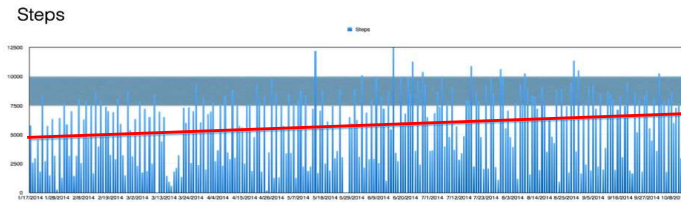


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Case Study:

MHEALTH011

Overall



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Case Study: Outcomes Measures Since Initial Diagnosis

Functional Outcome Measure	2011	2012	2013	2014	2015
PDQ-39	8	8	12	16	12
MOCA	27/30	27/30	25/30	25/30	23/30
MDS-UPDRS Part I	2	1	3	6	9
MDS-UPDRS Part II	18	15	15	13	13
MDS-UPDRS Part III	34	32	32	34	31
5 times sit to stand	9.5	7.6	10.2	10.0	13.4
MiniBEST test	26/28	26/28	27/28	27/28	24/28
FGA	28/30	28/30	28/30	27/30	27/30
10 meter: Comfortable	1.5 m/s	1.5 m/s	1.6 m/s	1.4 m/s	1.4 m/s
10 meter: Fast	2.0 m/s	2.0 m/s	1.8 m/s	1.8 m/s	1.7 m/s
6 MWT	529m	570m	567m	553m	554m
9 Hole Peg Test	R 30 L 23	R 27 L 22	R 28 L 24	R 30 L 28	R 31 L 27

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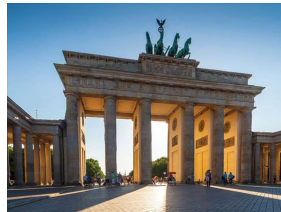
Thank You for Your.....



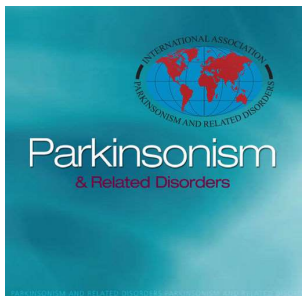
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National & International Presentations



Publications:



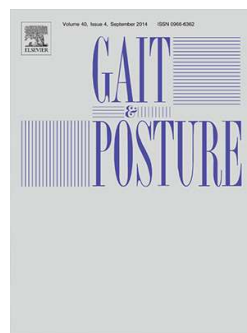
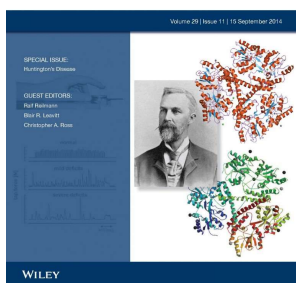
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Physical Therapy

Journal of the American Physical Therapy Association and

Official Journal of the International Parkinson and Movement Disorder Society
de Fysiotherapeut
Royal Dutch Society for Physical Therapy

Movement Disorders



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APTA Chattanooga Research Award

The award recognizes the most significant research paper contributing to the science and practice of physical therapy published in the Physical Therapy Journal (PTJ) in 2015.

Physical Therapy

Journal of the American Physical Therapy Association



Toward Understanding Ambulatory Activity Decline in Parkinson Disease
James T. Cavanaugh, Terry D. Ellis, Gammon M. Earhart, Matthew P. Ford, K. Bo Foreman and Leland E. Dibble
PHYS THER. 2015; 95:1142-1150.
Originally published online April 9, 2015
doi: 10.2522/ptj.20140498

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How can You Help Us?

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Research Study at Boston University



Effort and Motivation Study in Persons with Parkinson Disease

You are invited to join a research study in which you would participate in a series of tasks on the computer, walk for a brief period, and answer some questions about your thoughts and behaviors.



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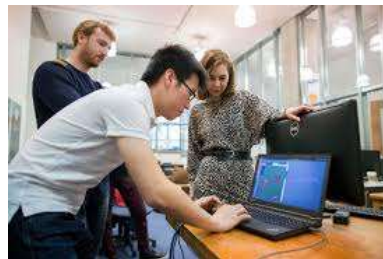
Evaluating Capacity vs Performance during Outpatient Physical Therapy



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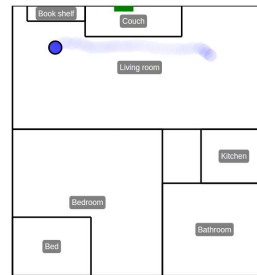


- Emerald was developed by MIT's Computer Science & Artificial Intelligence Lab (CSAIL)
 - Dina Katabi
 - Chen-Yu Hsu



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- Uses wireless signal to detect motion in a home
 - Example: Walking in the living room



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Presented at [White House Demo Day!](#)

5/25/2017

Community Wellness Program Training for Professionals



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Training Students....Future Experts in PD



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Physical Therapy Faculty Training



Upcoming Training Dates:
July 10 - July 13
Center for Neurorehabilitation at
Boston University
Faculty: Terry Ellis, P.T., Ph.D., N.C.S.

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Center for Neurorehabilitation

ABOUT US SERVICES RESEARCH STUDENT EXPERIENCES SUPPORT US APDA REHAB RESOURCE CENTER WELLBEING STRAINING

How You Can Help

Twitter

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Assistant Dean of Development &
Alumni Relations
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617-353-2286

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Our Team



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Thank You: Collaborators

BUMC: Parkinson's Disease & Movement Disorders Center
U of Utah, Wash U, U of Alabama, U of New England
Health & Disabilities Research Institute



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5/25/2017

APDA National Rehabilitation Resource Center at BU

- First of its kind...Parkinson's Exercise Helpline:
[1-888-606-1688](tel:1-888-606-1688)
- E-mail: rehab@bu.edu




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Questions

To Make an Appointment for Physical Therapy or to Participate in a Study, Please call Leslie Caiola at 617-353-7525.

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