Parkinson’s disease (FS-21)

Gammon Earhart (United States of America)
Colleen Canning (Australia)
Lee Dibble (United States of America)
Lynn Rochester (United Kingdom)
Terry Ellis (United States of America)
Rehabilitation and Parkinson’s Disease: Exercise is as Important as Medication

World Confederation of Physical Therapy
May 2015
Background

- Parkinson’s disease (PD) is a common neurodegenerative disorder
- Biggest risk factor is increasing age
- Growing evidence supports key role of exercise
- Physiotherapists have a key role in PD care

Objectives

• Discuss the latest evidence regarding the effectiveness of exercise in the management of Parkinson disease

• Identify various evidence-based exercise approaches for individuals with Parkinson disease

• Explain to patients, caregivers, and other professionals the importance of exercise and physical activity for people with Parkinson disease
Introductions

• Gammon Earhart, PT, PhD
• Colleen Canning, MAPA, PhD
• Lee Dibble, PT, PhD, ATC
• Lynn Rochester, PhD, Grad Dip Phys
• Terry Ellis, PT, PhD, NCS
Exercise is as Important as Medication

Adherence

Motivation

Social Support

Cohesion

Group Exercise

O'Brien et al., *Disabil Rehabil*, 2008
Group Exercise Approaches

- Traditional
- Tai Chi
- Dance
Tai Chi and Postural Stability in Patients with Parkinson’s Disease

Fuzhong Li, Ph.D., Peter Harmer, Ph.D., M.P.H., Kathleen Fitzgerald, M.D.,
Elizabeth Eckstrom, M.D., M.P.H., Ronald Stock, M.D., Johnny Galver, P.T.,
Gianni Maddalozzo, Ph.D., and Sara S. Batya, M.D.

A Randomized Controlled Trial of Patient-Reported Outcomes
With Tai Chi Exercise in Parkinson’s Disease

Fuzhong Li, PhD,1* Peter Harmer, PhD, MPH,2 Yu Liu, PhD,3 Elizabeth Eckstrom, MD, MPH,4 Kathleen Fitzgerald, MD,5
Ronald Stock, MD,4 and Li-Shan Chou, PhD6
Randomized Controlled Trial of Community-Based Dancing to Modify Disease Progression in Parkinson Disease

Ryan P. Duncan, MPT\textsuperscript{1} and Gammon M. Earhart, PhD\textsuperscript{1}

• One year study

• Tango vs. no exercise

• Periodic assessments OFF medication
Acknowledgments

• Participants & Volunteers

• American Parkinson Disease Association

• Parkinson’s Disease Foundation

• National Institutes of Health (R01 NS077959)
Balance

Duncan & Earhart, Neurorehab Neural Repair, 2012
Disease Severity

Duncan & Earhart, Neurorehab Neural Repair, 2012
Are the Effects of Community-Based Dance on Parkinson Disease Severity, Balance, and Functional Mobility Reduced with Time? A 2-Year Prospective Pilot Study

Ryan P. Duncan, PT, DPT\textsuperscript{1} and Gammon M. Earhart, PhD, PT\textsuperscript{1-3}

Duncan & Earhart, J Comp Alt Med, 2014
Dance as an intervention for people with Parkinson’s disease: A systematic review and meta-analysis

Kathryn Sharp*, Jonathan Hewitt

Department of Geriatric Medicine, School of Medicine, Cardiff University, Academic Centre, Llandough Hospital, Penarth CF64 2XX, United Kingdom

PDQ-39 – Final Outcome

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Dance</th>
<th>Exercise</th>
<th>Mean Difference Mean, SD</th>
<th>Total</th>
<th>Mean, SD</th>
<th>Total</th>
<th>Weight</th>
<th>IV, Fixed, 95% CI</th>
<th>IV, Fixed, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hackney and Earhart 2009a</td>
<td>21, 5.37</td>
<td>31, 24.66</td>
<td>5.37</td>
<td>13</td>
<td>81.1%</td>
<td>-3.66</td>
<td>[-7.14, -0.18]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volpe et al 2013</td>
<td>22.16, 10.18</td>
<td>12, 27.61</td>
<td>7.67</td>
<td>12</td>
<td>18.9%</td>
<td>-5.45</td>
<td>[-12.66, 1.76]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td></td>
<td></td>
<td></td>
<td>43</td>
<td>100.0%</td>
<td>-4.00</td>
<td>[-7.13, -0.87]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: Chi² = 0.19, df = 1 (P = 0.66); I² = 0%
Test for overall effect: Z = 2.50 (P = 0.01)
RESEARCH ARTICLE

The Effects of Adapted Tango on Spatial Cognition and Disease Severity in Parkinson’s Disease

Kathleen E. McKee¹, Madeleine E. Hackney²,³

Is Irish set dancing feasible for people with Parkinson's disease in Ireland? ∗

Joanne Shanahan a, *, Meg E. Morris b, Orfhlaith Ni Bhriain c, Daniele Volpe d, Margaret Richardson e, Amanda M. Clifford a
Implementation into the Community

- Enjoyable
- Convenient – facility, schedule
- Staffing
- Session structure
- Assessment
- Sustainability
Establishing Community-Based Exercise

- Needs of community
- Partnerships with established organizations
- Collaboration with other professionals

A health promotion service delivery model that attempts to bridge the gap between rehabilitation & community based health promotion settings.

Rimmer: www.ncpad.org
Exercise is as Important as Medication

- Multiple evidence-based approaches
- Settings from clinic to community
- Physiotherapists poised to be on front lines
- ACT on Exercise - Advocate, Coordinate, Track

Rehabilitation and Parkinson’s disease: exercise is as important as medicine

Exercise for prevention of falls: one size does not fit all

Colleen Canning
Faculty of Health Sciences
Falls in PD

- Falls – each year
  - Up to 70% of people with PD fall
    - over 60% fall recurrently
    - 20% fall ≥ 10 times

- Multi-system neurodegenerative disease
  - Motor and non-motor impairments

- Independent fall risk factors
  - Freezing of gait
  - Poor balance
  - Reduced lower limb muscle strength
Meta-analysis

Balance and Falls in Parkinson’s Disease: A Meta-analysis of the Effect of Exercise and Motor Training

Natalie E. Allen, PhD,1* Catherine Sherrington, PhD,2 Serene S. Paul, BAppScPhty(Hons),1 and Colleen G. Canning, PhD1

1Neurological Rehabilitation Research Group, Faculty of Health Sciences, University of Sydney, Sydney, Australia
2Musculoskeletal Division, George Institute for Global Health, University of Sydney, Sydney, Australia

Effect on falls (n = 250)

Ashburn, 2007
Nieuwboer, 2007

Randomised controlled trials (exercise and/or motor training)

- PD participants
- Large scale randomized controlled trials
  - Published 2010 - current; N>100 participants;
- Falls as primary or secondary outcome
  - not when monitored for safety/adverse events
- Analysis of rate of falls

4 trials – exercise interventions
(766 participants)
An exercise intervention to prevent falls in people with Parkinson’s disease: a pragmatic randomised controlled trial

Victoria A Goodwin,1 Suzanne H Richards,1 William Henley,2 Paul Ewings,3 Adrian H Taylor,4 John L Campbell4

A Randomized Controlled Trial to Reduce Falls in People With Parkinson’s Disease

Meg E. Morris, PhD1, Hylton B. Menz, PhD1, Jennifer L. McGinley, PhD2, Jennifer J. Watts, MComm (Ec)3, Frances E. Huxham, PhD3, Anna T. Murphy, PhD4, Mary E. Danoudis, MPT1, and Robert Iansek, PhD14

Exercise for falls prevention in Parkinson disease

A randomized controlled trial

Colleen G. Canning, PhD
Catherine Sherrington, PhD
Stephen R. Lord, PhD
Jacqueline C.T. Close, MD

ABSTRACT

Objective: To determine whether falls can be prevented with minimally supervised exercise targeting potentially remediable fall risk factors, i.e., poor balance, reduced leg muscle strength, and freezing of gait, in people with Parkinson disease.

Methods: Two hundred thirty-one people with Parkinson disease were randomized into exercise or usual care control groups. Exercise was practised for 15 to 60 minutes, 3 times weekly for 6

Tai Chi and Postural Stability in Patients with Parkinson’s Disease

Fuzhong Li, Ph.D., Peter Harmer, Ph.D., M.P.H., Kathleen Fitzgerald, M.D., Elizabeth Eckstrom, M.D., M.P.H., Ronald Stock, M.D., Johnny Galver, P.T., Gianni Maddalozzo, Ph.D., and Sara S. Batya, M.D.

Li (2012) NEJM 366(6):511

Goodwin (2011) JNNP 32:1232


## Reduction in fall rates

<table>
<thead>
<tr>
<th>Trial</th>
<th>Comparisons</th>
<th>IRR (95% CI)</th>
</tr>
</thead>
</table>
| **Goodwin**  
(n=130) | Balance and strength ex vs control | 0.68 (0.43 to 1.07), p = 0.10 (during intervention)  
0.74 (0.41 to 1.33), p = 0.31 (during follow-up) |
| **Li**  
(n=195) | Tai Chi vs stretch            | 0.33 (0.16 to 0.71), p = **0.005** (during intervention)  
0.31 (0.14 to 0.67), p = **0.003** (during follow-up) |
| **Morris**  
(n=210) | Strength vs control           | 0.15 (0.07 to 0.32) (during follow-up)                                    |
|         | Move Strategy vs control      | **0.39 (0.18 to 0.81)** (during follow-up)                                  |
| **Canning**  
(n=231) | Balance, strength, cueing vs control | 0.73 (0.45 to 1.17), p = 0.18 (during intervention)  |
## Participants

<table>
<thead>
<tr>
<th>Trial</th>
<th>IRR (95% CI)</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Goodwin</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Balance and strength ex vs control</td>
<td>0.68 (0.43 to 1.07), <em>p</em> = 0.10 (during intervention)</td>
<td>≥ 2 falls in past yr</td>
</tr>
<tr>
<td></td>
<td>0.74 (0.41 to 1.33), <em>p</em> = 0.31 (during follow-up)</td>
<td></td>
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<tr>
<td><strong>Li</strong></td>
<td></td>
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<td><strong>Morris</strong></td>
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<tr>
<td><strong>Canning</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Balance, strength, cueing vs control</td>
<td>0.73 (0.45 to 1.17), <em>p</em> = 0.18 (during intervention)</td>
<td>≥ 1 fall in past yr or at risk of falls</td>
</tr>
</tbody>
</table>
## Exercise delivery

<table>
<thead>
<tr>
<th>Trial</th>
<th>IRR (95% CI)</th>
<th>Exercise delivery</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Goodwin</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Balance and strength ex vs control</td>
<td>0.68 (0.43 to 1.07), <em>p</em> = 0.10 (during intervention)</td>
<td>1 x class/wk</td>
</tr>
<tr>
<td></td>
<td>0.74 (0.41 to 1.33), <em>p</em> = 0.31 (during follow-up)</td>
<td>2 x home exs/wk</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10 wks</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>33% supervision</strong></td>
</tr>
<tr>
<td><strong>Li</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tai Chi vs stretch</td>
<td><strong>0.33 (0.16 to 0.71), <em>p</em> = 0.005</strong> (during intervention)</td>
<td>2 x classes/wk</td>
</tr>
<tr>
<td></td>
<td><strong>0.31 (0.14 to 0.67), <em>p</em> = 0.003</strong> (during follow-up)</td>
<td>24 wks</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>100% supervision</strong></td>
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<tr>
<td><strong>Morris</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resistance vs control</td>
<td><strong>0.15 (0.07 to 0.32)</strong> (during follow-up)</td>
<td>1 x class/wk</td>
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<tr>
<td></td>
<td></td>
<td>1 x home exs/wk</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8 wks</td>
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<tr>
<td>MovStrategy vs control</td>
<td><strong>0.39 (0.18 to 0.81)</strong> (during follow-up)</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td><strong>50% supervision</strong></td>
</tr>
<tr>
<td><strong>Canning</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Balance, strength, cueing vs control</td>
<td>0.73 (0.45 to 1.17), <em>p</em> = 0.18 (during intervention)</td>
<td>1 x class/month</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 x home exs/wk</td>
</tr>
<tr>
<td></td>
<td></td>
<td>26 wks</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>13% supervision</strong></td>
</tr>
</tbody>
</table>
## Reduction in fall rates – sub group analysis

<table>
<thead>
<tr>
<th>Trial</th>
<th>Comparisons</th>
<th>IRR (95% CI)</th>
</tr>
</thead>
</table>
| **Goodwin** *(n=130)* | Balance and strength exs vs control | 0.68 (0.43 to 1.07), *p* = 0.10 (during intervention)  
0.74 (0.41 to 1.33), *p* = 0.31 (during follow-up) |
| **Li** *(n=195)*       | Tai Chi vs stretch            | 0.33 (0.16 to 0.71), *p* = 0.005 (during intervention)  
0.31 (0.14 to 0.67), *p* = 0.003 (during follow-up) |
| **Morris** *(n=210)*   | Resistance vs control         | 0.15 (0.07 to 0.32) (during follow-up)                                        |
|                         | Move Strategy vs control      | 0.39 (0.18 to 0.81) (during follow-up)                                        |
| **Canning** *(n=231)*  | Balance, strength, cueing vs control | 0.73 (0.45 to 1.17), *p* = 0.18 (during intervention)  
**Low disease severity**  
0.31 (0.16 to 0.61), *p* = 0.0007  
**High disease severity**  
1.61 (0.87 to 3.00), *p* = 0.13 |

Exercise is more effective and cost-saving compared to usual care.
Prevention of Falls Network Europe project (ProFANE)

Interventions for preventing falls

- Exercises
- Medication
- Surgery
- Fluid or nutrition therapy
- Psychological
- Knowledge
- Environmental/assistive technology
- Management of urinary incontinence
- Other

Randomised controlled trials (all other interventions)

- PD participants
- Large scale randomized controlled trials
  - Published 2010 - current, N>100 participants;
- Falls as primary or secondary outcome
  - not when monitored for safety/adverse events
- Analysis of rate of falls

0 trials
Randomised controlled trials - medications

**Effects of a central cholinesterase inhibitor on reducing falls in Parkinson disease**

Kathryn A. Chung, MD
Brenna M. Lobb, MS
John G. Nurr, MD
Fay B. Horak, PT, PhD

**ABSTRACT**

**Objective:** To investigate if a central cholinesterase inhibitor will reduce falling frequency in subjects with Parkinson disease (PD) with advanced postural instability.

**Background:** Falling due to postural instability is a significant problem in advanced PD, and in

**Chung (2010)**
Neurology 75:1263

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**Once-weekly risedronate for prevention of hip fracture in women with Parkinson’s disease: a randomised controlled trial**

Yoshihiro Sato,1 Jun Iwamoto,2 Yoshiaki Honda1

**Research Report**

**Sato (2011)**
JNNP 82:1390

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**Droxidopa in Patients with Neurogenic Orthostatic Hypotension Associated with Parkinson’s Disease (NOH306A)**

Robert A. Hauser4,* , L. Arthur Hewitt5 and Stuart Isaacson6
4University of South Florida, Tampa, FL, USA
5Chelsea Therapeutics, Inc., Charlotte, NC, USA
6Parkinson’s Disease and Movement Disorders Center of Boca Raton, Boca Raton, FL, USA

**Hauser (2014)**
J Parkinson Dis 4:57
## Medications

<table>
<thead>
<tr>
<th>Trial</th>
<th>Result</th>
<th>PD participants</th>
<th>H&amp;Y 1-4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Chung</strong> <em>(N=23)</em></td>
<td>Falls/day (over 6 wk intervention)</td>
<td>≥ 2 falls or near falls/week</td>
<td>No freezing of gait</td>
</tr>
<tr>
<td>Central cholinesterase inhibitor</td>
<td>Donepizil = 0.13 (0.03 SE) &lt;br&gt;Placebo = 0.25 (0.08 SE)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Between group difference = 0.12 (-0.09 to 0.33)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Sato</strong> <em>(N=272)</em></td>
<td>Falls (over 24 mth intervention)</td>
<td>Women</td>
<td></td>
</tr>
<tr>
<td>Bisphosphonates</td>
<td>No significant difference between groups</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Hip fractures: risedronate group = 3</strong> &lt;br&gt;<strong>placebo group = 15</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Hauser</strong> <em>(N=51)</em></td>
<td>Falls (over 8 wk intervention)</td>
<td>Neurogenic orthostatic hypotension</td>
<td></td>
</tr>
<tr>
<td>Drixodopa</td>
<td>Proportion of fallers: droidopa = 54% &lt;br&gt;placebo = 59%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Number of falls: droidopa = 79 &lt;br&gt;placebo = 192</td>
<td></td>
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</tr>
</tbody>
</table>
Prevention of Falls Network Europe project (ProFANE)

Interventions for preventing falls

- Exercises
- Medication
- Surgery
- Fluid or nutrition therapy
- Psychological
- Knowledge
- Environmental/assistive technology
- Management of urinary incontinence
- Other

https://www.healthtap.com/topics/actonel-vs-fosamax
## Fall risk factors in PD

<table>
<thead>
<tr>
<th>Generic</th>
<th>PD-specific</th>
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</thead>
<tbody>
<tr>
<td>Age - older</td>
<td>Fall history</td>
</tr>
<tr>
<td>Gender - female</td>
<td>Disease severity</td>
</tr>
<tr>
<td>Medication – chronic use of sedatives</td>
<td>PD medication</td>
</tr>
<tr>
<td>Polypharmacy</td>
<td>↓ mobility</td>
</tr>
<tr>
<td>Postural hypotension</td>
<td>Shuffling and short stepped gait</td>
</tr>
<tr>
<td>Cardiac arrhythmia</td>
<td>Freezing of gait</td>
</tr>
<tr>
<td>Arthrosis</td>
<td>Flexed posture</td>
</tr>
<tr>
<td>Use of assistive device</td>
<td>Postural instability</td>
</tr>
<tr>
<td>Fear of falling</td>
<td>Transfers</td>
</tr>
<tr>
<td>Muscle weakness</td>
<td>Cognitive impairment</td>
</tr>
<tr>
<td>Visual impairment</td>
<td>Axial rigidity</td>
</tr>
<tr>
<td>Daily use of alcohol</td>
<td>Dyskinesia</td>
</tr>
<tr>
<td>Environmental hazards</td>
<td>Deep Brain Stimulation</td>
</tr>
<tr>
<td>Co-morbidities</td>
<td>Dual tasking</td>
</tr>
<tr>
<td>Depression</td>
<td>Urinary incontinence</td>
</tr>
<tr>
<td>Osteoporosis</td>
<td></td>
</tr>
</tbody>
</table>

Van der Marck et al (2014)  Park Rel Disord 20:360
Attentional impulsivity as a risk factor

- Prospective cohort study of people with PD
- N = 388
- 6 mth follow-up period
- Non-fallers (n=237) compared to recurrent fallers (>1 fall, n=78)
- Attentional impulsivity* — tendency to be more sensitive to distraction
- Attentional impulsivity is an independent risk factor for falls (when gender, disease severity, medication, cognition, postural instability are accounted for)


Predicting falls
A simple three step clinical prediction tool (AUC = 0.80)

externally validated in US sample (n=171)
AUC = 0.83 (95% CI 0.76-0.89)

Duncan et al (under review) Park Rel Disord

FIG. 1. The 3-step clinical prediction tool for assessing the probability of falling in people with Parkinson’s disease.
Implications for assessment and intervention

Establish risk of falls

Recommended by the European Guidelines for Physiotherapy (2014)
http://parkinsonnet.info/guidelines/european-guidelines

**FIG. 1.** The 3-step clinical prediction tool for assessing the probability of falling in people with Parkinson’s disease.
Implications for assessment and intervention

High Risk

— Assessment
  — fall history
  — medical review
  — assessment of potentially remediable fall risk factors (FOG, anticipatory and reactive balance, muscle strength, cognition, fear of falling, impulsiveness)

— Intervention
  — Avoidance of high-risk activities and address environmental hazards
  — Targeted single interventions (introduced sequentially) addressing remediable fall risk factors

*Canning, Paul & Nieuwboer (2014) Neurodegenerative Disease Management 4:203*
Implications for assessment and intervention

Low Risk

Assessment

– Key risk factors to be targeted

– Intervention

– Group or minimally-supervised exercise program including challenging balance exercises and progressive strengthening exercises

Large scale exercise/motor training trials underway

Mirelman et al. BMC Neurology 2013, 13:15
http://www.biomedcentral.com/1471-2377/13/15

STUDY PROTOCOL

V-TIME: a treadmill training program augmented by virtual reality to decrease fall risk in older adults: study design of a randomized controlled trial

Anat Mirelman^1,2,*, Lynn Rochester^3, Miriam Reelick^4, Freek Nieuwhof^4, Elisa Pelosi^5, Giovanni Abbruzzese^5, Kim Dockx^6, Alice Nieuwboer^6 and Jeffrey M Hausdorff^1,2,7

– Multi-centre RCT
– Motor (treadmill) versus motor+cognitive (treadmill+VR)
– N = 300
– Healthy fallers; PD fallers; MCI fallers
Large scale exercise/motor training trials underway

PDSAFE

- Multi-centre RCT
- N = 600
- Context and task-specific evaluation of falls risk
- Personalised task-specific movement strategy training, strengthening and balance training
- Home-based, tailor-made to the individual and supported by technology to optimize adherence.

Ashburn et al (2013) ISRCTN48152791
Cochrane systematic review underway

Interventions for preventing falls in Parkinson’s disease
(Protocol)

Canning CG, Allen NE, Bloem BR, Keus SHJ, Munneke M, Nieuwboer A, Sherrington C,
Verheyden GSAF

Exercise is as important as medication, but, one size does not fit all

Evidence of efficacy of exercise for falls prevention in PD

- Challenging balance exercises
- Progressive resistance exercises
- Movement strategy training (including cueing)

- Minimally-supervised exercise for those with lower disease severity or risk
- Consider multifactorial interventions and more closely supervised exercise for those with higher disease severity or risk
Acknowledgments

– Participants

– Collaborators

  – Cathie Sherrington, Inez Farag, Stephen Lord, Jacqueline Close, Victor Fung, Mark Latt, Kirsten Howard, Gillian Heller, Stephane Heritier, Alison Hayes, Natalie Allen, Susan Murray, Serene Paul, Sandra O’Rourke, Jooeun Song

– Funding

  – Australian National Health and Medical Research Council

  – Harry Secomb Foundation
Implications for assessment and intervention

Moderate Risk

— Assessment

1. Brief fall history to identify evidence of multiple falls, injurious falls or falls associated with dizziness or syncope

2. Brief screening for evidence of key significant risk factors (FOG, impaired cognition, impaired balance, impulsiveness)

— Intervention

— If evidence of 1 or 2 above, approach intervention as high risk
— If no evidence of 1 or 2 above, approach intervention as low risk

*Canning, Paul & Nieuwboer (2014) Neurodegenerative Disease Management 4:203*
Training the Periphery to Benefit the Brain: Aerobic and Resistance Training Effects

Lee Dibble, PhD, PT
University of Utah
Department of Physical Therapy
Acknowledgements

• **Participants**
  – Bo Foreman
  – Jim Ballard
  – David Shprecher
  – Paul House
  – Lauren Schrock
  – Kevin Duff
  – Mark Lester
  – Lorinda Smith
  – Heather Hayes
  – Serene Paul

• **Utah Collaborators**
  – Jim Cavanaugh
  – Gammon Earhart
  – Terry Ellis
  – Colleen Canning
A Triple Threat: Age, PD, and Physical Inactivity

Speelman et al, 2011
Physical Activity Progressively Declines in People with PD

Dibble, Cavanaugh, Earhart, Ellis, Ford, Foreman (Unpublished data); Cavanaugh et al., 2015
An Ideal Prescription?

Exercise!!!
Broad Spectrum Benefits of Physical Activity

- Heart disease
- High Blood Pressure
- Stroke
- Metabolic Syndrome / Diabetes
- Cancer (Breast / Colon)

Reductions in all causes of illness and death

- Muscle blood flow
- Muscle cell size
- Blood sugar usage
- Bone strength
- Inflammation
But What About Benefits in PD?

• Cardiovascular / Musculoskeletal
  – Improved aerobic fitness / muscle size and strength

• Neurologic?
  – Reduced disease severity / medication need
  – Cognition
Walking Economy in PD

Christiansen et al., 2009
Aerobic Exercise Benefits

Review

Effects of Endurance Exercise Training on The Motor and Non-Motor Features of Parkinson’s Disease: A Review

Five studies investigated VO2 outcomes in response to aerobic training and all 5 showed significant improvements as a result of training.

Lamotte et al., 2015
Aerobic Exercise Benefits

\[ \dot{V_O}_2 \text{ (mL/min/kg)} \]

- Baseline
- 4 mo
- 10 mo
- 16 mo

Walking Speed (mph)

Schenkman et al., 2012
Muscle Structure Benefits

Kelly et al, 2014; Dibble et al., 2006
Muscle Force Benefits

Hirsch et al., 2003; Dibble et al., 2006, 2009, 2015; Falvo et al., 2008; Hass et al., 2007, 2010; Allen et al., 2010; Paul et al., 2014; Schilling et al., 2010; Troche et al., 2010; Pitts et al., 2009; Corcos et al., 2013
# Reduced Disease Severity via Aerobic Exercise

**Lamotte et al., 2015**

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>UPDRS-III pre-exercise</th>
<th>UPDRS-III post-exercise</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Total</td>
</tr>
<tr>
<td>Fisher 2008</td>
<td>27.6</td>
<td>10.3</td>
<td>10</td>
</tr>
<tr>
<td>Ridgel FE 2009</td>
<td>48.4</td>
<td>12.66</td>
<td>5</td>
</tr>
<tr>
<td>Ridgel VE 2009</td>
<td>49</td>
<td>15.44</td>
<td>5</td>
</tr>
<tr>
<td>Sage 2009</td>
<td>22.2</td>
<td>8.1</td>
<td>13</td>
</tr>
<tr>
<td>Schenkman 2012</td>
<td>24.4</td>
<td>9.1</td>
<td>41</td>
</tr>
<tr>
<td>Shulman HIT 2013</td>
<td>30.3</td>
<td>9.59</td>
<td>23</td>
</tr>
<tr>
<td>Shulman LIT 2013</td>
<td>31.6</td>
<td>9.38</td>
<td>22</td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td>119</td>
<td></td>
<td>108</td>
</tr>
</tbody>
</table>

Heterogeneity: Chi² = 8.05, df = 6 (P = 0.23); I² = 25%

Test for overall effect: Z = 1.77 (P = 0.08)
Reduced Medication Need via Aerobic Exercise

Frazzitta G et al., 2014
Reduced Disease Severity and Medication Need via Resistance Exercise

Corcos et al., 2013
The effects of exercise on cognition in Parkinson’s disease: a systematic review

Danielle K Murray¹, Matthew A Sacheli¹, Janice J Eng² and A Jon Stoessl¹

<table>
<thead>
<tr>
<th>Study</th>
<th>Can exercise improve a marker of cognitive function?</th>
<th>Quality of evidence²</th>
<th>Strength of recommendation³</th>
</tr>
</thead>
<tbody>
<tr>
<td>McKee et al. 2013 [29]</td>
<td>Yes</td>
<td>Moderate</td>
<td>Strong</td>
</tr>
<tr>
<td>Cruise et al. 2011 [26]</td>
<td>Yes</td>
<td>Moderate</td>
<td>Strong</td>
</tr>
<tr>
<td>Ridgel et al. 2011 [28]</td>
<td>Yes</td>
<td>Moderate</td>
<td>Strong</td>
</tr>
<tr>
<td>Tanaka et al. 2009 [27]</td>
<td>Yes</td>
<td>Moderate</td>
<td>Strong</td>
</tr>
</tbody>
</table>
Benefits for the Brain

Summary: Benefits >> Side Effects

- Heart disease
- High Blood Pressure
- Stroke
- Metabolic Syndrome / Diabetes
- Cancer (Breast / Colon)

↑ Blood flow / vessel formation
↑ Activation of brain centers
↑ Nerve growth / growth factors
↑ Nerve cell connections
↓ Loss of nerve cells

⇒ Reductions in all causes of illness and death

The only prescription with unlimited refills.

- Muscle blood flow
- Muscle cell size
- Blood sugar usage
- Bone strength
- Inflammation
The role of cognition in gait and clinical implications for therapy in PD

Lynn Rochester PhD MCSP
Professor of Human Movement Science
http://research.ncl.ac.uk/hmst/

Rehabilitation and Parkinson’s Disease: Exercise is as important as Medication
Independence and falls risk

Aims

- Role of cognition in gait
- Changes in approaches to gait rehabilitation
Historical and patient perspective

"Walking becomes a task which cannot be performed without considerable attention. The legs are not raised to the height, or with that promptitude which the will directs, so that the utmost care is necessary to prevent frequent falls."

James Parkinson, 1817

Walking and talking

- Leg starting to drag (H&Y 1.5)
- Talking getting faster (H&Y 3)
- Possible outside not inside (H&Y 3)

Spouses’ insights

- Cup down before answering (2.5)
- Stopped doing 2 things at once (H&Y 4)
- Possible link to falls (H&Y 4)

Multi-tasking

- Linked to freezing (H&Y 3)

Jones et al., 2008
Cognition

- At diagnosis: MCI > 40% using level 2 criteria

Yarnall et al., 2013
Manifestation

- Continuous gait disturbance
- Episodic

Methods to detect

- Association
- Dual-task protocols
Association

- Executive function and attention are associated with gait speed and variability
- More advanced PD

- Early relationship of gait and cognition
- Limits of cognitive compensation

Amboni et al., 2013; Rochester et al., 2008; Lord et al., 2010; Lord et al., 2011

Lord et al., 2014
Dual-task

**Purpose of dual-task studies**
- Demonstrate in real-time
  - Attention/working memory as a compensatory feature
  - Ability to prioritise task (EF)
  - Limits of compensation
- Moderate to advanced PD
- Gait performance worse on multiple variables

- Interference equal (PD and controls)
- EXCEPT FOR gait-related postural control
- Early training of dynamic postural control

*Amboni et al., 2013* 
*Rochester et al., 2014*
Characterizing Freezing of Gait in Parkinson’s Disease: Models of an Episodic Phenomenon

Alice Nieuwboer, PhD,* and Nir Gladis, MD²
¹Department of Rehabilitation Sciences, KU Leuven, Leuven, Belgium
²Movement Disorders Unit, Department of Neurology, Tel Aviv Medical Center, Sackler School of Medicine, Sackler School of Neuroscience, Tel-Aviv University, Tel-Aviv, Israel

<table>
<thead>
<tr>
<th>Models of FOG</th>
<th>Principle</th>
<th>Prediction of FOG-episodes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Threshold⁶³</td>
<td>Accumulation of motor deficits until threshold is reached and freeze occurs</td>
<td>Increase motor cycle frequency decrease amplitude increase coordination complexity</td>
</tr>
<tr>
<td>Interference⁷⁵</td>
<td>Competition for common central processing resources induces breakdown</td>
<td>Increase number concurrent tasks increase difficulty level tasks increase load of external input</td>
</tr>
<tr>
<td>Cognitive⁸²</td>
<td>Deterioration in processing of response conflict induces block</td>
<td>Increase incongruency level increase response speed increase load on executive function</td>
</tr>
<tr>
<td>Decoupling⁹⁰</td>
<td>Decoupling between motor programs and motor response induces block</td>
<td>Increase strength startle stimuli increase frequency of motor task increase postural instability</td>
</tr>
</tbody>
</table>

NEUROLOGY AND PRECLINICAL NEUROLOGICAL STUDIES - REVIEW ARTICLE

Cognitive aspects of freezing of gait in Parkinson’s disease: a challenge for rehabilitation


Nieuwboer et al., 2013  Heremans et al., 2013

Role of cognition
Exercise interventions targeting cognitive control

Capacity/reserve
Control
Capacity (External Cueing)

- Auditory cues

Spaulding et al., 2012; Rochester et al., 2008; 2010
Attentional control (Task prioritisation)

- If attention directed to a task - performance $\uparrow$
- Conversely if not – performance $\downarrow$
- Consider clinically when giving instructions

Yogev-Seligmann et al., 2012; Kelly et al., 2012
Dual task gait can be trained

Effect of cognitive impairment?
Multi modal intervention

Q? Is complex cognitive-motor training more effective to reduce falls than motor training alone?
Cognitive Impairment

Gait impairments

Dementia

Falls/immobility

Intervention

Integrated Risk assessment
Testing in the clinic

TUG
10m test

Motor

Cognitive

- Saturday, Friday, Thursday...
- 97, 94, 91......
- 99, 92, 85....

- Time
- Speed
- Step length
- % difference
- FOG episodes

Cognition
**Clinical messages**

<table>
<thead>
<tr>
<th>Should we train cognitive control (dual tasking)?</th>
</tr>
</thead>
<tbody>
<tr>
<td>➢ Yes – evidence supports this</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>When?</th>
</tr>
</thead>
<tbody>
<tr>
<td>➢ Start early</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Who?</th>
</tr>
</thead>
<tbody>
<tr>
<td>➢ Cognitive intact</td>
</tr>
<tr>
<td>➢ Care with MCI/dementia/FOG</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>How?</th>
</tr>
</thead>
<tbody>
<tr>
<td>➢ Cues or attentional strategies</td>
</tr>
<tr>
<td>➢ Component practice + whole practice + dual/multi-practice</td>
</tr>
<tr>
<td>➢ Complex cognitive – motor training</td>
</tr>
</tbody>
</table>
Acknowledgements

Human Movement Science Team:
- Lynn Rochester
- Sue Lord
- Brook Galna
- Alan Godfrey
- Carol Shields
- Silvia Del-Din
- Lisa Alcock
- Gillian Barry
- Sam Stuart
- Rosie Morris
- Elizabeth Hill
- Aodhan Hickey
- Phillip Brown
- Heather Hunter
- Katherine Baker

NIHR Biomedical Research Unit for Lewy Body Dementia award to the Newcastle upon Tyne Hospitals NHS Foundation Trust
Clinical Implications

- Evaluate interference
- Address gait impairment much earlier
- Target postural control during complex activity
- Encourage more complex motor/cognitive training
Cognitive training in Parkinson disease
Cognition-specific vs nonspecific computer training

ABSTRACT

Objective: In this study, we compared a cognition-specific computer-based cognitive training program with a motion-controlled computer sports game that is not cognition-specific for their ability to enhance cognitive performance in various cognitive domains in patients with Parkinson disease (PD).

Methods: Patients with PD were cognition (CogniPlus, 19 patients) and nonspecific training (Nintendo Wii, 20 patients). The effects of cognitive training on cognition-specific (CogniPlus) and nonspecific (Nintendo Wii) training were assessed using the neuropsychological evaluation, neurological assessment, and psychiatric self-rating scales at baseline, training (4 weeks), and post-training follow-up.

Table 2: Cognitive tests at baseline and follow-up and change scores

<table>
<thead>
<tr>
<th>Test</th>
<th>Baseline CogniPlus, median (IQR)</th>
<th>Baseline Wii, median (IQR)</th>
<th>p Value, Wilcoxon rank-sum test</th>
<th>After intervention CogniPlus, median (IQR)</th>
<th>After intervention Wii, median (IQR)</th>
<th>p Value, CogniPlus, mean (SD)</th>
<th>p Value, mean (SD)</th>
<th>p Value, perm. test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alertness, RT</td>
<td>272 (246.5, 291)</td>
<td>291 (274, 339)</td>
<td>0.094</td>
<td>266 (248, 300)</td>
<td>275 (229, 324)</td>
<td>-0.3 (1.2)</td>
<td>0.5 (0.8)</td>
<td>0.024</td>
</tr>
<tr>
<td>Working memory</td>
<td>-0.16 (-0.49, 0.87)</td>
<td>-0.05 (-0.42, 0.3)</td>
<td>0.828</td>
<td>-0.14 (-0.78, 0.32)</td>
<td>-0.16 (-0.54, 0.41)</td>
<td>0.4 (0.9)</td>
<td>0.1 (0.9)</td>
<td>0.431</td>
</tr>
<tr>
<td>Executive functions</td>
<td>23 (1.92, 2.91)</td>
<td>21.7 (17.7, 2.41)</td>
<td>0.369</td>
<td>2.44 (2.08, 2.74)</td>
<td>2.37 (2.01, 2.85)</td>
<td>0.1 (0.9)</td>
<td>-0.2 (1.1)</td>
<td>0.462</td>
</tr>
<tr>
<td>Visuoconstruction</td>
<td>23 (21, 29.5)</td>
<td>24.5 (18.75, 28.25)</td>
<td>0.832</td>
<td>22 (17.5, 31)</td>
<td>26.5 (20, 34)</td>
<td>-0.2 (0.7)</td>
<td>0.3 (0.8)</td>
<td>0.055</td>
</tr>
<tr>
<td>Episodic memory</td>
<td>45 (37, 48.5)</td>
<td>48 (40, 50.25)</td>
<td>0.076</td>
<td>51.5 (49, 57.75)</td>
<td>64.5 (54.5, 75.5)</td>
<td>0.8 (0.7)</td>
<td>1.3 (0.9)</td>
<td>0.093</td>
</tr>
</tbody>
</table>

Mean difference (CI): Alertness, RT = -0.9 (-1.49 to -0.11), p = 0.024; Working memory = 0.3 (-0.35 to 0.81), p = 0.431; Executive functions = 0.3 (-0.44 to 0.94), p = 0.462; Visuoconstruction = -0.5 (-0.97 to 0.01), p = 0.055; Episodic memory = -0.5 (-0.96 to 0.08), p = 0.093.
Effects of a central cholinesterase inhibitor on reducing falls in Parkinson disease

ABSTRACT

Objectives: To investigate if a central cholinesterase inhibitor will reduce falling frequency in subjects with Parkinson disease (PD) with advanced postural instability.

Background: Falls due to postural instability is a significant problem in advanced PD, and is

<table>
<thead>
<tr>
<th>Table</th>
<th>Outcomes during donepezil and placebo phases*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Treatment phase</td>
</tr>
<tr>
<td></td>
<td>Donepezil</td>
</tr>
<tr>
<td>Fall frequency (falls/day)</td>
<td>0.13 (0.13)</td>
</tr>
<tr>
<td>Near fall frequency (near falls/day)</td>
<td>2.50 (4.1)</td>
</tr>
<tr>
<td>Global Impression of change</td>
<td>3.07 (0.32)</td>
</tr>
<tr>
<td>Change in ABC Scale, %</td>
<td>3.6 (0.04)</td>
</tr>
<tr>
<td>Change in Berg Balance</td>
<td>1.65 (1.37)</td>
</tr>
<tr>
<td>Change in UPDRS</td>
<td>1.06 (0.96)</td>
</tr>
<tr>
<td>Change in Folstein MMSE</td>
<td>0.17 (0.86)</td>
</tr>
<tr>
<td>DBS group (fall frequency) (n = 6)</td>
<td>0.10 (0.03)</td>
</tr>
</tbody>
</table>

STUDY PROTOCOL

The ReSPonD trial - rivastigmine to stabilise gait in Parkinson’s disease a phase II, randomised, double blind, placebo controlled trial to evaluate the effect of rivastigmine on gait in patients with Parkinson’s disease who have fallen

Emily J Henderson*, Stephen R Lord, Jacqueline CT Close, Andrew D Lawrence, Alan Whone and Yoav Ben-Shlomo

Cheung et al., Neurology, 2010

Henderson et al., BMC Neurology, 2013
Emerging but limited evidence to support exercise to improve cognitive function

Executive function

No agreement on type, intensity, dose

More work needed
Attention: Visual
Dual tasks

Un Cued

Cued
USE OF MOBILE HEALTH TECHNOLOGY TO FACILITATE LONG-TERM ENGAGEMENT IN EXERCISE IN PERSONS WITH PARKINSON’S DISEASE

TERRY ELLIS, PHD, PT, NCS
DIRECTOR: CENTER FOR NEUROREHABILITATION
BOSTON UNIVERSITY, BOSTON, MA, USA
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
## Changes in Walking in Persons with Parkinson Disease over 1-year

<table>
<thead>
<tr>
<th>Variable</th>
<th>% change / effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steps*</td>
<td>-12 / 0.28</td>
</tr>
<tr>
<td>Moderate intensity minutes*</td>
<td>-40 / 0.30</td>
</tr>
</tbody>
</table>

Cavanaugh JT, Ellis T, Earhart GM, Ford MP, Foreman KB, Dibble LE. Capturing Ambulatory Activity Decline in PD. JNPT;2012:36:51
**WHAT ARE THE FACTORS ASSOCIATED WITH EXERCISE BEHAVIOR IN PD?**

<table>
<thead>
<tr>
<th>Variable</th>
<th>p</th>
<th>Exp (B)</th>
<th>95.0% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BODY STRUCTURE &amp; FUNCTIONS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UPDRS Motor Score</td>
<td>0.22</td>
<td>1.49</td>
<td>0.79-2.80</td>
</tr>
<tr>
<td>Co-morbidities (No.)</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>GDS total score</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td><strong>ACTIVITY</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fall history</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>6 MWT</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td><strong>PARTICIPATION</strong></td>
<td></td>
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<tr>
<td>PDQ mobility score</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td><strong>ENVIRONMENTAL FACTORS</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Social support</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td><strong>PERSONAL FACTORS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>0.02</td>
<td>1.04</td>
<td>1.01-1.08</td>
</tr>
<tr>
<td>Gender</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Education</td>
<td>0.01</td>
<td>2.30</td>
<td>1.29-4.11</td>
</tr>
<tr>
<td>Employment status</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Household income</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Self Efficacy</td>
<td>0.01</td>
<td>2.34</td>
<td>1.30-4.23</td>
</tr>
</tbody>
</table>

Most Common Barriers to Exercise in Persons with PD:

- Low outcome expectation
- Fear of falling
- Lack of time
BANDURA’S SOCIAL COGNITIVE THEORY

Model of the direct and indirect relationships between self-efficacy and behaviors such as physical activity based on Bandura [2004].

Self-efficacy functions as an important proximal determinant of human motivation and action.
Self-efficacy has been repeatedly shown to predict physical activity behavior in healthy adults (Kaewthummanukul & Brown, 2006; Rovniak, Anderson, Winett, & Stephens, 2002; Sharma & Sargent, 2005).

Predictive of both the adoption, and the maintenance, of physical activity (Sallis et al., 1986; Sallis, Hovell, & Hofstetter, 1992; Strachan, Woodgate, Brawley, & Tse, 2005).

Changes in self-efficacy can mediate the effects of behavior change interventions on increases in objective measured physical activity behaviour (Darker, French, Eves, & Sniehotta, 2010).
# DESIGN OF PARKFIT STUDY

<table>
<thead>
<tr>
<th>Study Elements</th>
<th>ParkFit n=299</th>
<th>Park Safe n=287</th>
</tr>
</thead>
<tbody>
<tr>
<td>35 Total Treatment Sessions (per yr x 2):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical Therapy</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Personal Activity Coach</td>
<td>✔️</td>
<td></td>
</tr>
<tr>
<td>Brochure</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Bi-Annual Newsletter</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Goal Setting</td>
<td>✔️</td>
<td></td>
</tr>
<tr>
<td>Ambulatory Activity Monitor</td>
<td>✔️</td>
<td></td>
</tr>
</tbody>
</table>
# EFFECT OF INTERVENTION

<table>
<thead>
<tr>
<th>Outcome 24 months</th>
<th>ParkFit</th>
<th>ParkSafe</th>
<th>Estimated Difference (95% CI)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physical Activity - LASA</strong>&lt;br&gt;(median hours/week)</td>
<td>273</td>
<td>12.5 (6.3-18.4)</td>
<td>267</td>
<td>12.0 (7.0-18.3)</td>
</tr>
<tr>
<td><strong>Activity Diary</strong>&lt;br&gt;(median hours/week)</td>
<td>275</td>
<td>1.3</td>
<td>273</td>
<td>0.5</td>
</tr>
<tr>
<td><strong>Activity monitor</strong>&lt;br&gt;(median kcal/day)</td>
<td>254</td>
<td>38.7</td>
<td>258</td>
<td>-14.2</td>
</tr>
<tr>
<td><strong>Physical fitness</strong>&lt;br&gt;(mean meters walked)</td>
<td>255</td>
<td>8.4</td>
<td>253</td>
<td>-1.6</td>
</tr>
</tbody>
</table>
PD VIRTUAL EXERCISE COACH

30% of subjects were in the “contemplation” stage of exercise

70% in the “preparation” stage of exercise
 RESULTS

- 100% retention rate
- 70% very satisfied and 30% moderately satisfied with the virtual exercise coach
- On average, subjects had 22 conversations with the virtual coach over a 28 day period
- Mean adherence to daily walking was 85%
- No adverse events

<table>
<thead>
<tr>
<th>Variables</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value (DF)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>PDQ_Mobility</td>
<td>20</td>
<td>-3.38</td>
<td>9.78</td>
<td>-1.54(19)</td>
<td>0.14</td>
</tr>
<tr>
<td>TenMeter_comfortable</td>
<td>20</td>
<td>-0.5</td>
<td>0.82</td>
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MOBILE HEALTH TECHNOLOGY TO PROMOTE PHYSICAL ACTIVITY IN PERSONS WITH PARKINSON DISEASE
Study Design

Baseline Assessment

1 Week Step Activity Monitor

Randomization

mHealth PT

1-2 In-person PT Visits

mHealth Exercise Platform:
• Tailored Exercise Videos
• Monitoring by a PT
• Visual Feedback

Usual PT Care

1-2 In-person PT Visits

Home Exercise Program:
• Photos of Exercise
• Written Instruction

1-Year Assessment

1 Week Step Activity Monitor

1-Year Assessment

1 Week Step Activity Monitor
EXERCISE INTERVENTION

- Walking with pedometer
- Strengthening
MOBILE HEALTH TECHNOLOGY

Dashboard

Welcome back
jacquie.scarlett@...

Your Goal: Drive the ball further.

Today's Exercises

2x Standing Twists
1x Front Arm Raises
3x Bridge with leg lift...
2x Squats

Start Exercises

Your Progress

You've completed 8% of your exercise goals for this week!

View Progress

General Health

Today I feel...

Notes from Joel Therapist:
Place feet a little wider than shoulder-width apart, hips stacked over knees, knees over ankles.
Roll the shoulders back and down away from the ears. Note: Allowing the back to round (like a turtle’s shell) will cause unnecessary stress on the lower back.
Extend the arms out straight so they are parallel with the ground, palms facing down (like your

Today's Exercises

1 of 2 Squats

3 SETS 10 REPS

I did it!

Great Job!

Front Arm Raises

It Was

Easy

Difficult

Painless

Painful

Tell Joel Therapist

Feeling great

Next
Patient Version of Wellpepper App
PT/Clinic Version of Wellpepper App
### Theoretical Approach

<table>
<thead>
<tr>
<th>Intervention Components</th>
<th>Tailored Exercise Videos</th>
<th>Adaptations to Exercise Program over time by PT</th>
<th>Monitoring by a PT</th>
<th>Progress Towards Goals: Visual Feedback</th>
<th>Adherence Graphs</th>
<th>Motivational content (videos)</th>
<th>Automated Reminders and Rewards</th>
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**PROMOTING BEHAVIORAL CHANGE**
% Adherence to 3 days per week of exercise over 6 months
GODIN LEISURE-TIME EXERCISE QUESTIONNAIRE

**mHealth Group**
- Baseline: 15% Mild, 40% Moderate, 45% Strenuous
- 6 month: 8% Mild, 73% Moderate, 19% Strenuous

**Active Control**
- Baseline: 5% Mild, 64% Moderate, 32% Strenuous
- 6 month: 1% Mild, 86% Moderate, 13% Strenuous
CURRENT MODEL OF REHABILITATION IN PARKINSON DISEASE

Onset of pre-clinical symptoms

- No Rehabilitation Intervention
- Diagnosis PD (pre-disability)
- Pharmacological Rx (pre-disability)

Discrete Episodes of Care
- Onset of overt disability (Rehab compromised)
- Acute Event: Hip fracture

Referral PT
- Decline in Quality of Life
- No follow up
PARADIGM SHIFT
SECONDARY PREVENTION MODEL OF CARE

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

Referral to PT  f/u PT  f/u PT  f/u PT  f/u PT  f/u PT

Diagnosis PD (pre-disability)  Delay onset of disability

Focus of Rx:
- Prevention
- Remediation

Options to Maintain Exercise Between Episodes of PT:
- mHealth supported: home / gym
- Community Exercise Programs
THANK YOU: COLLABORATORS

BUMC: Parkinson’s Disease & Movement Disorders Center
U of Utah, Wash U, U of Alabama, U of New England
Braintree Rehabilitation Hospital
Health & Disabilities Research Institute
VA Boston