



Exercise Effects in Parkinson's Disease

Madeleine E. Hackney, PhD

Associate Professor, Department of Medicine,
Division of Geriatrics and Gerontology, Emory
University School of Medicine

Research Health Scientist, Atlanta VAHCS Center
for Visual and Neurocognitive Rehabilitation

Muscular Weakness Correlates with Aging

- Decreased joint range of motion, strength, sensory processing, and sensorimotor integration
- Affects ability to move adaptively in complex environments (Rogers & Mille, 2003)
- Walking changes
- Reduced balance stability with increasing age



Muscular weakness increases with stage of Parkinson's and is greater than in adults without Parkinson's

TABLE 1 Hoehn and Yahr staging of Parkinson's disease²⁹

Stage I
Signs and symptoms on one side only
Symptoms mild
Symptoms inconvenient but not disabling
Usually presents with tremor of one limb
Friends have noticed changes in posture, locomotion, and facial expression
Stage II
Symptoms are bilateral
Minimal disability
Posture and gait affected
Stage III
Significant slowing of body movements
Early impairment of equilibrium on walking or standing
Generalized dysfunction that is moderately severe
Stage IV
Severe symptoms
Can still walk to a limited extent
Rigidity and bradykinesia
Stage V
Cachectic stage
Invalidism complete
Cannot stand or walk



- Ankle muscles for flexing and pointing weaker in Parkinson's (Mak et al., 2012)
- Leg extensor muscle strength and muscle power-associated with motor symptoms (SS Paul et al., 2012)
- Strength and activation deficits correlated strongly with UPDRS motor score (Stevens-Lapsley et al., 2012)

Solutions to Muscular Weakness

Exercise

Boxing

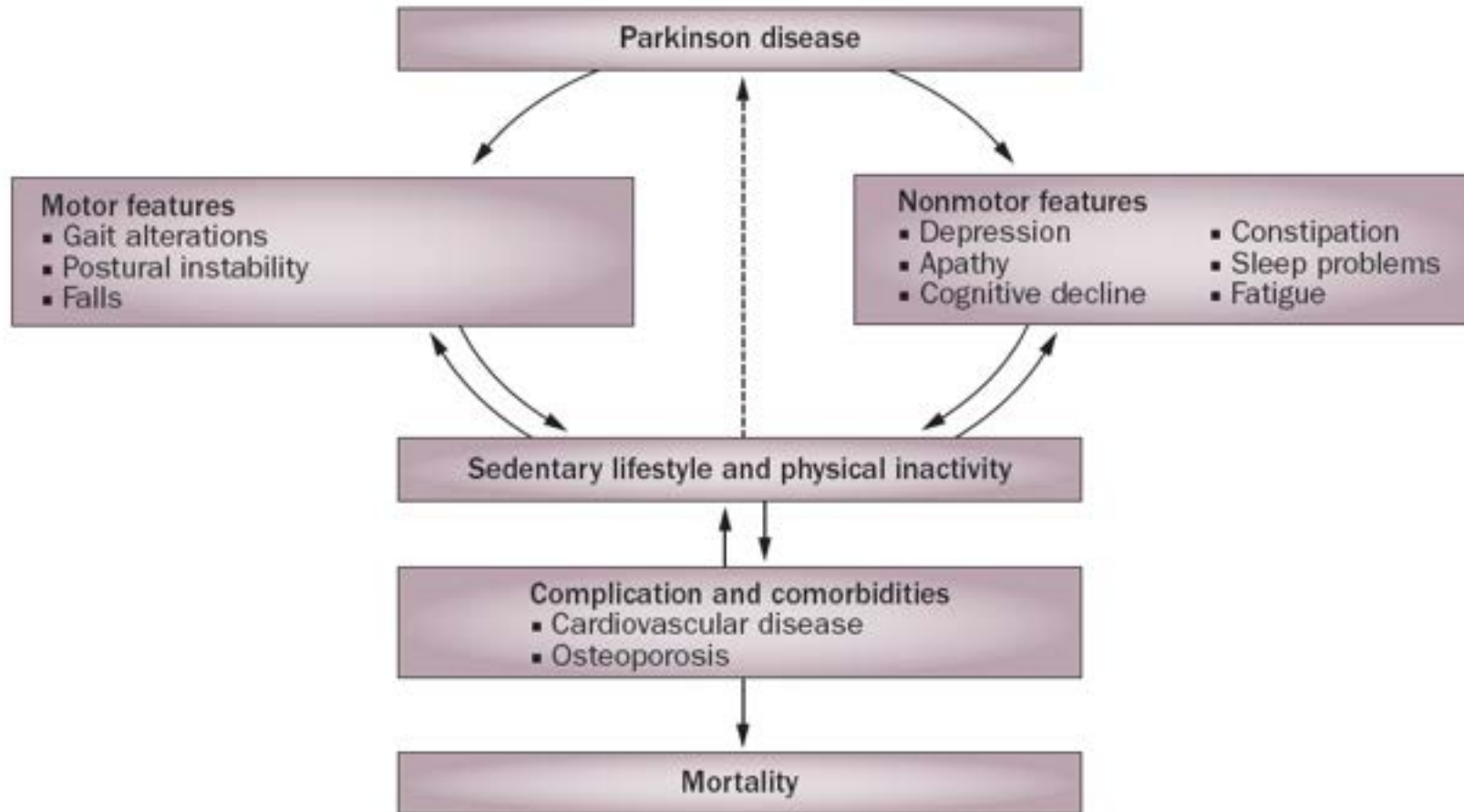
Walking

Resistance Training

Tango Dancing

Physical Inactivity in Parkinson's

(Speelman et al., 2011)



Exercise Benefits Everyone

- Improves strength
- Enhances balance
- Boosts morale and energy
- Fights off depression and elevates mood
- Enhances cognitive function
- Wards off diseases
 - Osteoporosis, heart disease, diabetes, fasciculations, paresthesias
- Expands social circle

Table 1. Key Benefits of Physical Exercise in Older Adults

System	Benefit
Inflammation	Chronic low grade systemic inflammation is a common manifestation of aging. Regularly performed exercise can reduce markers of systemic inflammation, even at relatively modest activity levels
Neurological	Faster nerve conduction; improved balance; improved memory, attention and reaction time; improved visual-spatial orientation and proprioception; improved sleep
Cardiovascular	Increased heart rate variability; lower blood pressure; better endothelial reactivity; lower inflammatory markers; reduced arterial stiffness, improved cardiac output; less atherosclerotic disease; enhanced microvasculature
Endocrine and Metabolic	Increased basal metabolic rate; improved lipid profiles; lower percentage body fat; improved insulin sensitivity and glucose homeostasis
Muscles	Increased muscle mass, strength, and power
Bones and Joints	Increased bone mass and flexibility
Ligaments and Tendons	Increased synthesis of collagen
Pulmonary	Improved gas exchange; stronger respiratory muscles



Participation in Exercise is Low in US

- **People start exercising but quickly stop**
- **65 years of age and older seniors should exercise at least 2.5 hours/week**
 - **<https://familydoctor.org/exercise-seniors/>**
- **Most older adults in US are not active enough**
 - **Parkinson's activity levels ~15-30% lower (Macera et al., 2005)**

Argentine Tango Adapted for Parkinson's target; Parkinson's Impairments

- **Bradykinesia**
- **Balance problems**
- **Shortened steps**
- **Turning and multitasking**
- **Backward walking**
- **Freezing of gait**
- **Internal generation of movement**



Endurance Exercise at 80% Power Improves Brain Activation During Sequence Learning

Motor sequence learning (MSL) effect in PD patients before and after aerobic training

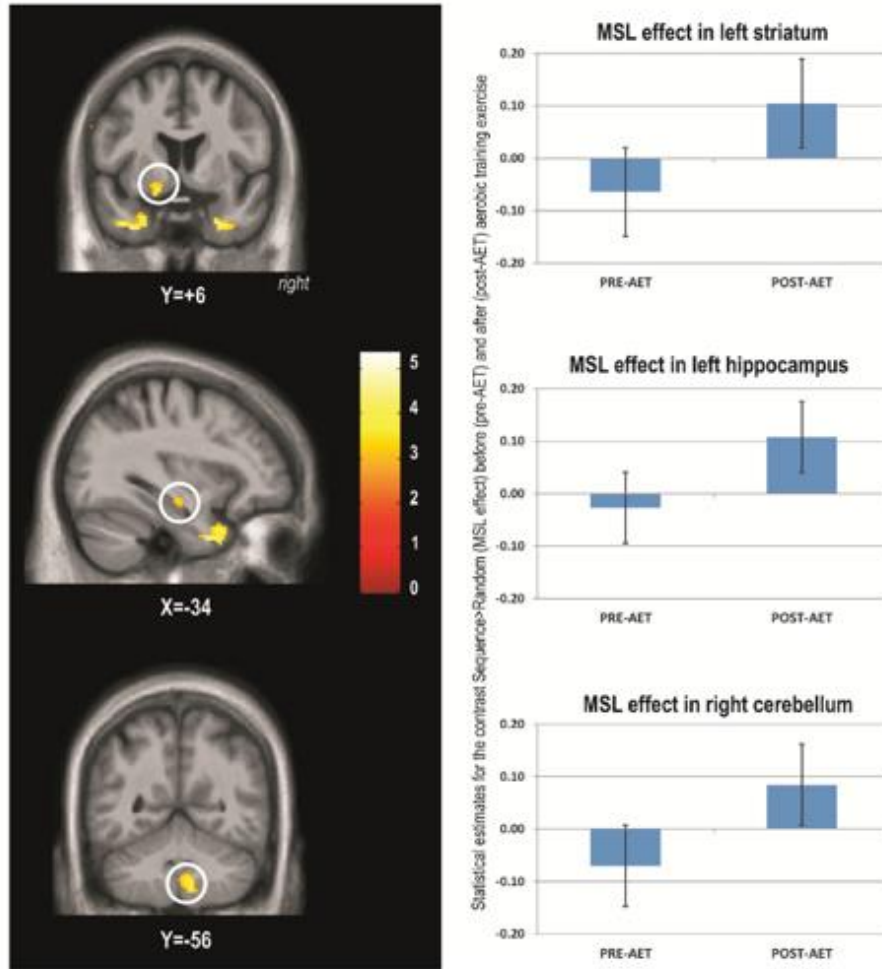
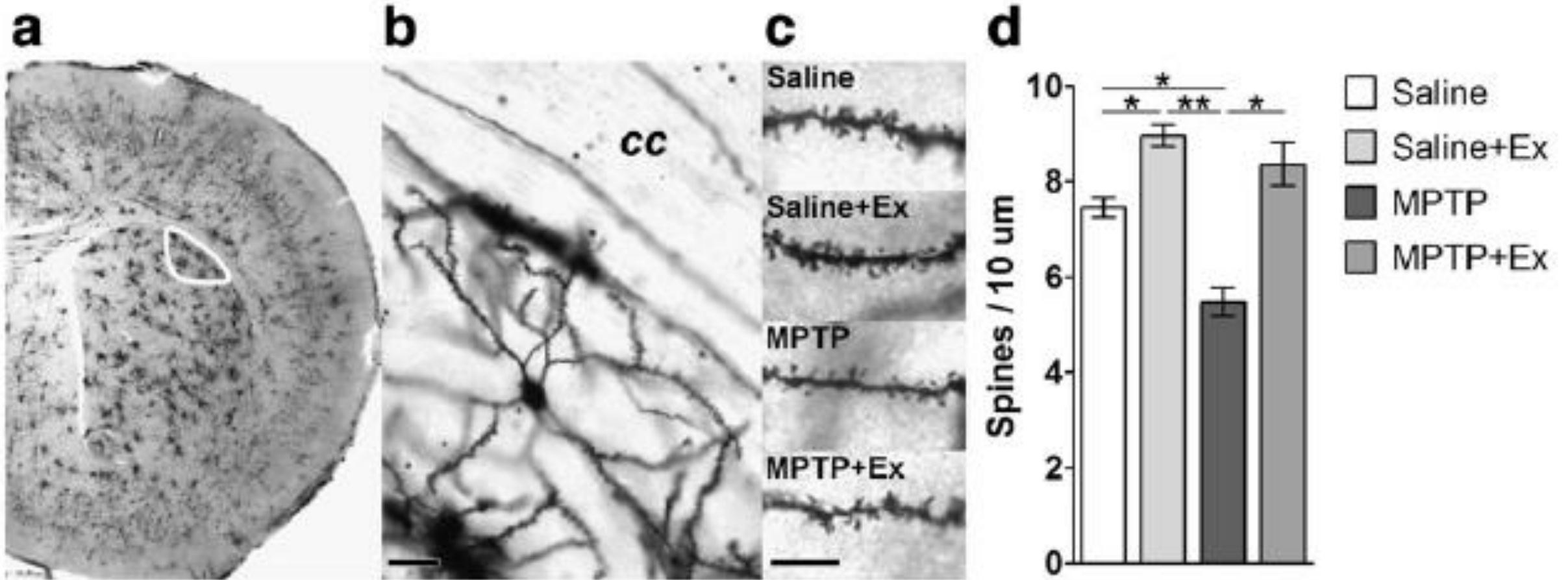


Fig. 1. Motor sequence learning (MSL) effect in PD patients before and after aerobic training.

Duchesne et al. Neuroimage Clinical 2016

Treadmill Exercise Reverses Dendritic Spine Loss in Medium Spiny Neurons



Endurance Exercise Increases Vascular Volume Fraction in Motor Cortex

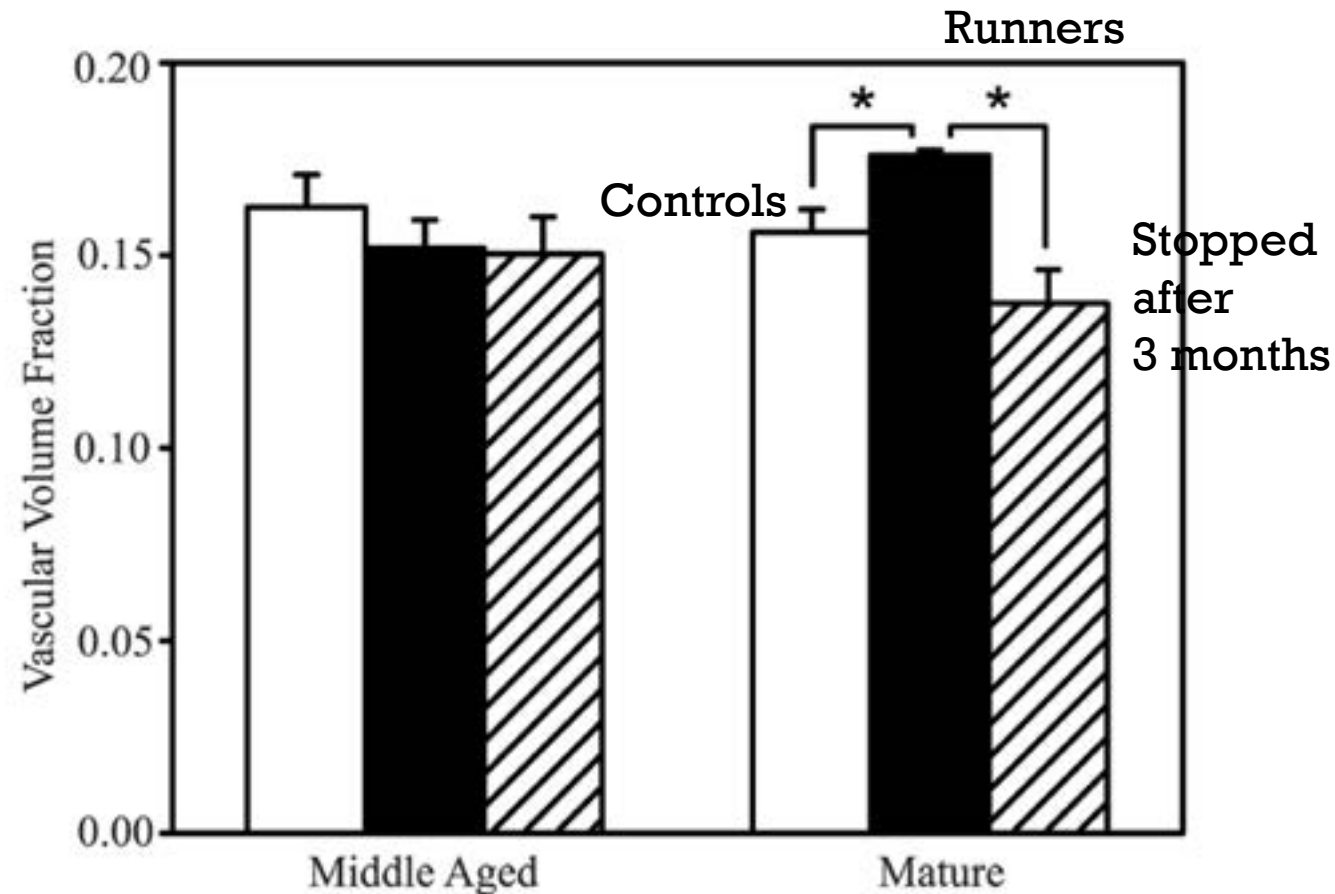


Figure 6.
Effects of exercise on volume fraction of CD31-immunostained vascular tissue in motor cortex of runners (solid bars), run-stops (striped bars) and controls (open bars). Asterisks indicate a significant difference between groups.

Rhyu et al Neuroscience 2010

Rationale for Endurance Exercise

- Increased dopamine metabolism
- Angiogenesis
- Neurogenesis
- Increase VO_2 max
- Possibly improve walking economy
- Neuroplasticity
- Anti-inflammatory effect
- Improve mitochondrial function and oxidative stress
- Increase brain connectivity
- Increase levels of neurotrophic factors such brain derived neurotrophic factor

Lamotte et al. Parkinson's Disease 2015



Three intense workouts a week could drastically delay Parkinson's symptoms, study finds

- High-intensity workouts slow the progression of the degenerative disease, according to a study from Northwestern University
- Light to moderate exercise, however, had no effect on symptoms
- Symptoms are slowed by 15 percent for at least six months when patients use a treadmill on an incline
- The new study proved that vigorous workouts were safe for Parkinson's patients, even though most are over 60

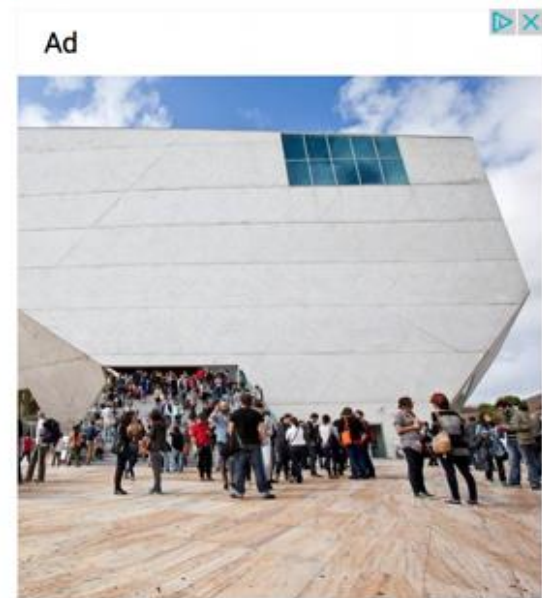
By NATALIE RAHHAL FOR DAILYMAIL.COM

PUBLISHED: 16:00, 11 December 2017 | UPDATED: 20:31, 11 December 2017

Share

263 shares
 5 View comments

Site Web Enter your search



Management of Parkinson's



Exercise/Physical Therapy



Diagnosis



**Neuroprotective therapy
when available**



Symptomatic Therapy



- Dopamine agonists
- Levodopa

Wearing Off



Complex Motor Fluctuations



Surgery



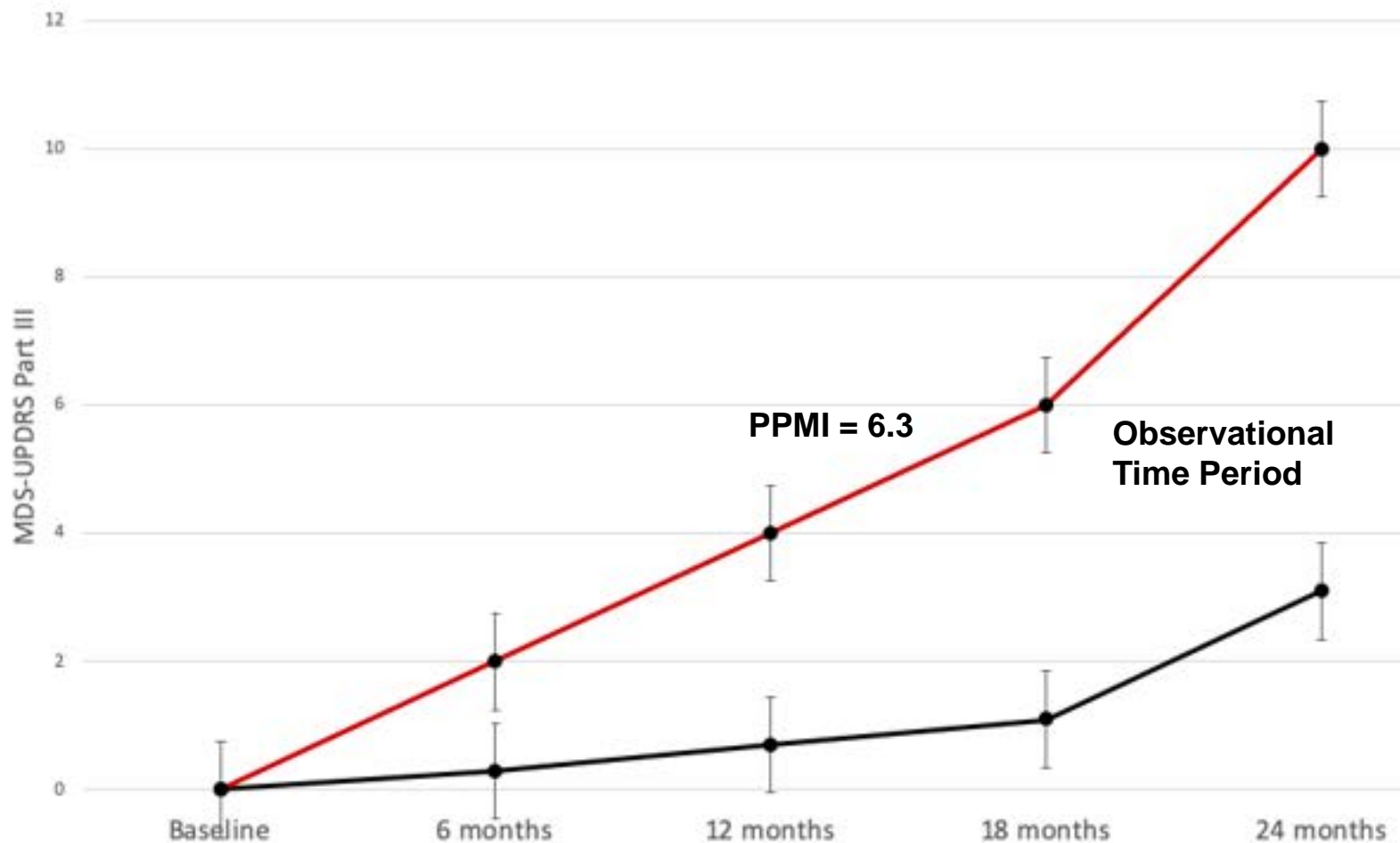
End-Stage Disease



Natural course/management of Parkinson's

SPARX3: Updated Design

Effects of Endurance Exercise Over 18 Months with 6 Months Follow-Up



Aerobic Exercise

“Vigorous exercise should be encouraged as potential strategy for a more favorable disease course.”

Ahlskog, 2011

“Regular aerobic-type exercise tending to lead to fitness is the single strategy with compelling evidence for slowing Parkinson disease progression. All patients with Parkinson disease should be encouraged to engage in regular such exercise.”

Ahlskog, 2017



Aerobic Training: Bike

2016 study on impact of aerobic training on bike showed improvements in:

- Cardiovascular capacity
- Executive function
- Motor learning
- Cadence and walking speed

12 weeks, 3x/week
40 minutes at **80% intensity**
Speed maintained at **60 RPM**



Nadeau et al., 2016

Benefits of Tai Chi

- Improved balance in older and younger people
- Decreased fall risk
- Decreased blood pressure; improved cardiorespiratory function
- Improved posture
- Lower levels of body chemicals indicating stress





Dance

- Dance naturally combines cueing, spatial awareness, balance, strength and flexibility, and physical activity.
- Dance is also enjoyable and stimulates social engagement and peer support.
- Significant improvements in balance, gait, and endurance when comparing tango, waltz, and fox-trot with traditional exercise.

Agility Training

Sports drills
Lateral shuffle
Tire course
Agility ladder
Grapevine
stepping

- Functional movement requires the ability to navigate efficiently in a wide variety of environments and situations
 - Coordination of complex sequences
 - Quickly switch between motor programs, directions, speeds
 - Manipulate visual information and surfaces
 - Dual tasks



Circuit Training

- ▶ Incorporate equipment, be creative, individualize exercises
- ▶ Impairments addressed:
 - ▶ Posture
 - ▶ Flexibility
 - ▶ Coordination
 - ▶ Strength
 - ▶ Balance



Cycling

- Indoor stationary (recumbent vs. upright), outdoor adapted, tandem
- Can be safer alternative to walking/treadmill
- Incorporate music, strengthen training, cognitive challenges in group classes



Aquatics

- 2017 study - aquatic exercise showed similar improvements to land-based exercise
 - Safe and enjoyable
- Benefits of water-based exercise:
 - Can reduce rigidity, stiffness, and pain
 - Buoyancy aids those with impaired balance to perform tasks not possible on land
 - Water resistance can build strength, endurance



Aerobic Training: Bike

- Two studies found that pairing cognitive tasks with cycling may improve cognitive and motor performance

- ✓ Say “Go” when you see a blue star
- ✓ Say “Pa” as many times as you can in 10 seconds
- ✓ Name the color of a set of “Xs”
- ✓ Repeat and memorize six letters
- ✓ Simple math problems
- ✓ Repeat numbers in reverse

Hazamy et al., 2017 and Altmann et al., 2015

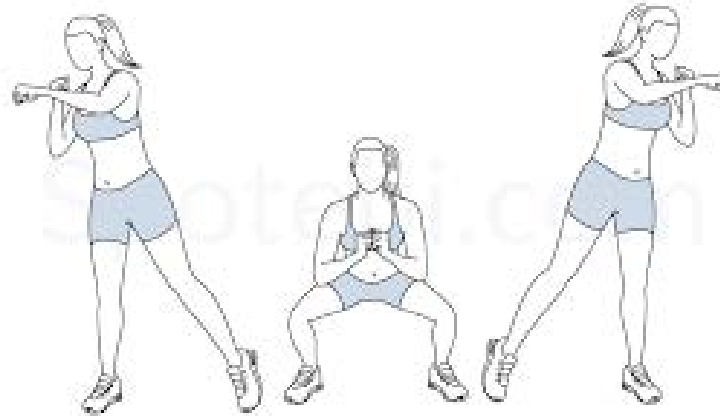
Strength Training

- Muscle strength and power reduced in people with Parkinson's
- Moderate intensity progressive resistance training resulted in significant strength, balance and motor symptoms gains (but not quality of walking) in people with early to mod Parkinson's

But, instead of this...



Do this...



Chung et al. 2016

Exercise Helps Balance Problems

▶ To improve balance problems, exercise must include:

- Practicing losing and regaining balance while taking steps
- Continually adjusting to changing demands of environment
 - Hu & Woollacott, 1994
 - Hirsch et al., 2003



Exercise Principles



To improve balance and to practice multifaceted exercises and adjustments to environment



Cues (auditory, visual, tactile) can improve various movements



Attention to movement may be key to achieving the right "size"



Lots of different types of exercises work; find one you enjoy!



High volume or high intensity may help, but regular exercise is key

Decreasing Exercise- Related Risks

Classes should be of a manageable size

- New instructors should have fewer clients/participants
- The ideal number depends on who is in the class and how mobile they are

Greater risks in older clients

- Lower intensity, more rest breaks
- Standing exercise done with support or with partner
 - Can use a gait belt
 - Recruit volunteers to assist in the class
- Provide increased feedback on form - participants may have poor awareness
- More repetition
- Simpler movements

Look for Exercise Classes with These Strategies:



INTEGRATE SALIENT
MUSIC THAT MATCHES
CADENCE OF THE
EXERCISE



EXPLAIN THE PURPOSE
OF THE EXERCISES



MODIFY EXERCISES AS
NEEDED TO MEET A
SPECIFIC PERSON'S
NEEDS



ENCOURAGE SOCIAL
ASPECT OF THE CLASS



INVITE CARE PARTNERS
TO JOIN CLASS



PROVIDE LOTS OF
DIRECT FEEDBACK AND
ENCOURAGEMENT

Look for Classes with These Teaching Strategies

Break down	Complex movements are broken down
Pacing	Pace allows you to focus on on deliberate completion of each part
Cues	Simple verbal instructions are given to help you follow along
Clarity	Participants are engaged to ensure they understand

Online/Virtual/Remote Classes **MUSTS**



Safety first! If there are too many participants for you to feel seen, it may not be a safe option for you.



Visibility! YOU can help your instructor by making sure your camera and lighting allow your whole body and environment to be seen.



Listen up! Make sure you can hear your instructor and they can hear you when needed.

Online/Virtual/Remote Classes: MUSTS



Socialization: Look for classes that allow conversation at the beginning of class and perhaps during short breaks



Frequent participant check-ins: “Hi, give me a thumbs up if you can hear and see me and are feeling good”



More than one class leader supporting participants with technology and movement.



Clear instructions for how to join and what you need to be successful in the class.

When to See a Physical or Occupational Therapist

- Go to see a physical therapist if you experience any of the following:
 - Unsafe ambulation
 - Poor awareness of deficits
 - Sudden decline in balance, cognition, walking, etc.
 - Increased falls
 - Coughing while eating or drinking
 - Unexplained weight loss
 - Care partner stress
 - Signs of unsafe driving

Thank you!

- Questions?
- **Contact me at
mehackn@emory.edu**

Acknowledgements

- Career Development Award Level-1, E7108M and Level-II (N0870-W), Department of Veterans Affairs, R&D service
- American Parkinson Disease Association
- Marian Chace Foundation/American Dance Therapy Association, National Parkinson Foundation
- National Institutes of Health (K01 HD-048437)
- Movement Science Program, Washington U
- GA State/GA Tech CABI
- Tango Under the Tent foundation, Inc.
- Dan and Merrie Boone Foundation
- Emory Center for Injury Control
- Emory Center for Health in Aging
- Emory School of Medicine Discovery Program
- ACTSI CRN
- Clairmont Oaks, Clairmont Place, Wesley Woods Senior living communities
- Gammon Earhart, Ph.D., PT, Steven Wolf, PT, Ph.D., Daniel Corcos, Ph.D., Courtney Hall, PT, Ph.D., Katharina Echt, Ph.D., Ted Johnson, MD, Krish Sathian, MD, Ph.D., Bruce Crosson, Ph.D., Kate Pirog Revill, PhD, Lena Ting, PhD
- Emory & Washington University Volunteers, Participants



Thank you, Team



Coordinators

- Allison Bay, MSPH
- Ariyana Bozorg, MS
- Ariel Hart



Collaborators

- Whitney Wharton, PhD
- Molly Perkins, PhD, MA
- Lena Ting, PhD
- J. Lucas McKay, PhD, MSCR
- Ihab Hajjar, MD
- Marian Evatt, MD
- Katharina Echt, PhD



Mentors

- Krishnankutty Sathian, PhD
- Steven Wolf, PhD
- Bruce Crosson, PhD
- Daniel Corcos, PhD
- Gammon Earhart, PT, PhD



Funding:

- Department of Veterans Affairs Career Development Award N0870W
- Parkinson's Foundation
- National Science Foundation
- National Institutes of Health
- Georgia CTSA



Post docs

- Amit Abraham, PhD, MAPhty (Musculoskeletal), BPT
- Jonathan Drucker, PhD



Graduate Students

- Allison Bay (MPH)
- Morgane Prime (MS)
- Chaejin Kim (MPH)
- Amrit Kashyap (PhD)
- Xuan Zhang (PhD)



Undergraduate Students

- Hayley Silverstein
- Ruhee Patel
- Hannah Lally
- Nicole Schindler
- Smrithi Ramachandra
- Isaac Andrade

