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The Impact of Physical Activity and Exercise on Cognition in Older Adults

Fang Yu, PhD, RN
Assistant Professor
University of Minnesota School of Nursing

Outline

- Background about professional interest in physical activity, exercise, and cognition
- Research evidence on the impact of physical activity and exercise on cognition in older adults with and without dementia
- Biological mechanisms for the effect of exercise on cognition
- Current research of aerobic exercise in older adults with dementia
- Exercise recommendations for older adults

Dementia the Most Feared Disease by Older Adults

Time Period	Millions of people
Present	~4.5
Est by 2050	~13.5

- Life expectancy of 8–10 years after symptoms begin
- Some live up to 20 years

The Emerging Benefit of Rehabilitation

	Cognitively intact group	Cognitively impaired group	<i>p</i>
Functional gain	3.5 ± 4.48	4.55 ± 5.37	.63
Rehabilitation efficiency	0.32 ± 0.44	0.40 ± 0.48	.66
Days of services	11.38 ± 5.56	11.64 ± 4.51	.83


- Yu, F., Evans, L. K., & Sullivan-Marx, E. M. (2005). Functional outcomes for elders with cognitive impairment in a comprehensive outpatient rehabilitation facility. *Journal of the American Geriatrics Society*, 53, 1599-1606.

A Myth About Rehabilitation Benefit

- Why could older adults with dementia benefit?
 - Physical therapy
 - Physical activity
 - Exercise
 - Occupational therapy
 - Skill training
 - Use of assistive devices
 - Social work
 - Attention
 - Social interaction


Physical Activity and Exercise

- Physical activities
 - Any form of muscular movement
 - Related to physical fitness
- Exercise
 - A subset of physical activity with the purpose of maintaining and improving physical fitness
 - Rigorous
 - Continuous
 - Rhythmic



Exercise Types

- **Endurance exercises:**
 - Increase breathing and heart rate for an extended period of time
- **Strength exercises:**
 - Build muscles
- **Balance exercises:**
 - Build up leg muscles
 - Prevent falls, a common problem in older adults
- **Flexibility exercises:**
 - Keep body limber by stretching your muscles and the tissues that hold your body's structures in place




Evidence on Whether Physical Activity Improves Cognition

- Well-designed:
 - Subjects are randomly assigned to the treatment or control group
 - Subjects in the treatment group exercise
 - Subjects in the control group did not exercise
- Enough power:
 - Thousands of subjects



Problem: poorly designed without enough power

- Solution through meta-analysis:
 - Combining data from smaller experimental studies




Exercise Enhances Cognition in Older Adults

- Meta-analysis by Colcombe & Kramer (2003):
 - 18 experimental studies in older adults (55 or older)
 - Gains in cognitive functioning after aerobic exercise is much larger for exercisers (ES = .478) than for non-exercisers (ES = .164)
 - Most striking increase in executive functioning
 - The exercise training:
 - Aerobic
 - Moderate intensity
 - 8 weeks vs 12 weeks


Exercise Enhances Cognition in Older Adults with Dementia

- Meta-analysis by Heyn (2004):
 - 30 experimental studies in older adults (55 years old or older)
 - Exercisers had better cognitive functioning than non-exercisers (N = 2,020, ES = .62)
 - The exercise training:
 - Aerobic, strength, flexibility, and balance
 - An average of 23 weeks
 - 3.6 times per week
 - 45 min duration per session



Exercise Prevents Dementia Onset in Older Adults

- Large-scale observational longitudinal studies:
 - Larson (2006):
 - 1,740 people older than 65 from 1994 to 2003
 - In 1994, they had no signs of dementia
 - In 2003:
 - Among those who exercised 3 or more times per week:
 - » 13/1,000 person years developed dementia
 - Among those who did not exercise as much:
 - » 19.7/1,000 persons years for those exercising less




Exercise Prevents Dementia Onset in Older Adults (cont.)

- Large-scale observational longitudinal studies:
 - Physical activity earlier in life was associated with less dementia and AD later on
 - Fratiglioni et al. (2004): 6 of 9 studies on aging (sample sizes ranged from 469 to 4,615)
 - Physical activity at least twice a week at midlife is related to reduced risk of dementia (odds ratio = .48) and AD (odds ratio = .38) 21 years later
 - Rovio (2005): 1,449 persons, ages 65-79 years

Insights from Basic Science


- Mice that ran voluntarily experience structural changes in the brain:
 - Stimulated expression of genes
 - Neuron regeneration
 - Production of neurotransmitters
 - More synapses and synaptic plasticity
 - More capillaries
 - Brain-derived neurotrophic factor (BDNF), insulin growth factor I, and nerve growth factor
 - Increasing cerebral blood supply
 - Changes in hippocampus



Humans and mouse share 97.5% of Genetic Structure

Insights from Basic Science (cont.)

- Mice that ran voluntarily:
 - Functional changes in the brain:
 - Improved function of neurotransmitters
 - Improved memory and learning
- Transgenic mice that ran voluntarily:
 - Reduced β -amyloid deposits
 - Improved memory and learning




Insights from Human Science

- Structural changes in the brain:
 - People who juggled 3 months or bicycled around London for 2 years in attempt to memorize street routes:
 - Gray matter in the hippocampus was enlarged compared to white matter
 - Draganski et al., 2004
 - People who engaged in aerobic exercise:
 - Spared brain tissue loss
 - Increased cerebral vasculature
 - Increased blood flow in frontal, parietal, and temporal cortices
 - Kramer et al., 2004.

The FIT-AD Study

- Purposes:
 - Feasibility of engaging older adults with mild Alzheimer's disease in aerobic exercise training
 - Any changes in cognition after the training
- Place:
 - the exercise training lab at the University of Minnesota

The FIT-AD Study (cont.)



- The training program:
 - In pairs with an exercise trainer
 - Warm-up exercises
 - Cycling on a stationary bicycle
 - 65% - 70% of heart rate reserve
 - Cool-down exercises
 - Three times a week for 18 weeks

Exercise Recommendations

- National Institute of Aging (NIA):
 - In the long term, older adults in all age groups hurt their health far more by not exercising than by exercising.
 - Rule of thumb:
 - Older adults should stay as physically active as they can.
- There are extensive evidence supporting that the relationship between exercise and cognitive functioning is **BIOLOGICALLY PLAUSIBLE**.

Getting Started

- Checking with your doctor if you have:
 - chest pain
 - irregular, rapid, or fluttery heart beat
 - severe shortness of breath
 - significant, ongoing weight loss that hasn't been diagnosed
 - infections, such as pneumonia, accompanied by fever
 - fever, which can cause dehydration and a rapid heart beat
 - acute deep-vein thrombosis (blood clot)
 - a hernia that is causing symptoms
 - foot or ankle sores that won't heal
 - joint swelling
 - persistent pain or a problem walking after you have fallen
 - certain eye conditions, such as bleeding in the retina or detached retina
 - new procedures

Aerobic Exercise

- **Build up your endurance gradually**
 - Start low and increase slowly
- **Eventually** work your way up to a moderate-to-vigorous level
 - Level 13 on the Borg scale
- Then **> 10 minutes at a time** or a total of a minimum of 30 minutes at the end of the day
- Goal: a **minimum of 30 minutes of endurance exercise on most or all days of the week**

Least effort	
6	
7	very, very light
8	
9	very light
10	
11	fairly light
12	
13	somewhat hard
14	
15	hard
16	
17	very hard
18	
19	very, very hard
20	
Maximum effort	

Different Aerobic Exercises

- **Moderate:**
 - Swimming
 - Bicycling
 - Cycling on a stationary bicycle
 - Gardening (mowing, raking)
 - Walking briskly on a level surface
 - Mopping or scrubbing floor
 - Golf, without a cart
 - Tennis (doubles)
 - Volleyball
 - Rowing
 - Dancing
- **Vigorous:**
 - Climbing stairs or hills
 - Shoveling snow
 - Brisk bicycling up hills
 - Tennis (singles)
 - Swimming laps
 - Cross-country skiing
 - Downhill skiing
 - Hiking
 - Jogging

Strength Exercise

- Do strength exercises for all of your major muscle groups **at least twice a week:**
 - No strength exercises of the same muscle group 2 days in a row
 - Start with no weight, 1 or 2 pounds of weight
 - Gradually add weight over weeks to a challenging amount
 - 8 to 15 repetitions in a row
 - Take **3 seconds to lift or push a weight** into place; **hold the position for 1 second**, and take **another 3 seconds to lower the weight**
 - Target goal: between hard and very hard (15 to 17 on the Borg scale)

Stretch Exercise

- Stretch when your muscles are warmed up
 - If stretching exercises are the only exercise you can do, do them > 3 times a week, up to every day
- Do each exercise 3 to 5 times at each session
- Hold the stretched position for 10 to 30 seconds
- Total session should last 15 to 30 minutes
 - Move slowly into position
 - Never jerk into position
 - Stretching may cause mild discomfort, but not pain

Balance Exercise

- Add modifications to regular lower-body strength exercises
 - Don't do extra strength exercises if adding balance modifications to lower body strength exercises
- "Anytime, anywhere" strategy
 - Balance on one foot, then the other, while waiting for a bus



Useful Resources

- http://www.nia.nih.gov/NR/rdonlvres/25C76114-D120-4960-946A-3F576B528BBD/0/NIA_Exercise_Guide_906.pdf
- http://www.acsm.org/Content/NavigationMenu/Research/Roundtables_Specialty_Conf/PastRoundtables/Exercise_for_Older_Adults.htm
- Fang Yu, PhD, RN
 - (Mail) 5-160 WDH 1331, 308 Harvard St SE, Minneapolis, MN 55455
 - (Phone) (612) 624-5435;
 - (Fax) (612) 625-7180;
 - (Email) yuxxx244@umn.edu