Physical Activity, Aging and Well-Being

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Lecture Overview

• Aging in America

• Aging, Function, and Physical Activity

• Physical Activity Effects on Physical, Mental, and Cognitive Health Status

• Does Yoga influence cognitive function and functional performance?
"For the rest of human history, there are going to be more old people than young..."

Joel Cohen, Professor of Population Sciences, Rockefeller and Columbia Universities
Worldwide Growth in Over 65s Due to Boomer Generation

Exhibit 5: The pace of aging will accelerate.

Population age 65 and over and age 85 and over, selected years 1900–2010 and projected 2020–2050

NOTE: These projections are based on Census 2000 and are not consistent with the 2010 Census results. Projections based on the 2010 Census will be released in late 2012.

Reference population: These data refer to the resident population.

Percentage of Medicare enrollees age 65 and over who are unable to perform certain physical functions, by sex, 1991 and 2009

NOTE: Rates for 1991 are age-adjusted to the 2009 population.
Reference population: These data refer to Medicare enrollees.
SOURCE: Centers for Medicare and Medicaid Services, Medicare Current Beneficiary Survey.
Percentage of population age 65 and over who are obese, by sex and age group, selected years, 1988–2010

NOTE: Data are based on measured height and weight. Height was measured without shoes. Obese is defined by a BMI of 30 kilograms/meter² or greater. The percentage of people who are obese is a subset of the percentage of those who are overweight. See data source for the definition of BMI.

Reference population: These data refer to the civilian noninstitutionalized population.

SOURCE: Centers for Disease Control and Prevention, National Center for Health Statistics, National Health and Nutrition Examination Survey.
Aging and Cognitive Function – Is it All Down Hill after 30?

Park et al., 2001

Salthouse et al., 2009
Cognitive Change Across Adulthood: Normative Stability in Midlife
Physical Activity
Percentage of people age 45 and over who reported participating in leisure-time aerobic and muscle-strengthening activities that meet the 2008 Federal physical activity guidelines, by age group, 1998–2010

NOTE: This measure of physical activity differs from previous editions of Older Americans. The measure reflects the 2008 Federal physical activity guidelines for Americans (available from: http://www.health.gov/PAGuidelines/). The 2008 Federal guidelines recommend that for substantial health benefits, adults perform at least 150 minutes (2 hours and 30 minutes) a week of moderate-intensity, or 75 minutes (1 hour and 15 minutes) a week of vigorous-intensity aerobic physical activity, or an equivalent combination of moderate- and vigorous-intensity aerobic activity. Aerobic activity should be performed in episodes of at least 10 minutes, and preferably, it should be spread throughout the week. The 2008 guidelines also recommend that adults perform muscle-strengthening activities that are moderate or high intensity and involve all major muscle groups on two or more days a week, because these activities provide additional health benefits. The measure shown here presents the percentage of people who fully met both the aerobic activity and muscle-strengthening guidelines.

Reference population: These data refer to the civilian noninstitutionalized population.

SOURCE: Centers for Disease Control and Prevention, National Center for Health Statistics, National Health Interview Survey.
Physical Activity and Aging

- Walking in the US population:
  - 34% walk regularly (30+ min/day, 5+ days/wk)
  - 46% walk occasionally
  - 20% never walk

Walking and Aging

Wyatt et al. (2005). MSSE
Trends in Overall No Leisure Time Physical Activity (BRFSS data)
Adults 65+ Reporting No Leisure Time Physical Activity (BRFSS data 2010)
• 8.3 million Americans aged 65 and older need assistance with some basic ADL
• Insufficient PA
• Living longer but not necessarily better lives
• Increased susceptibility to chronic health conditions
• Result is functional disability, reduced health status, depression, social isolation etc.
• Compromised Psychological Well-Being and Quality of Life
Physical Activity

Physical Function (Limitations, Disability, Performance, Body Comp.)

Psychosocial Function (Self-esteem, Self-efficacy, Affect)

Cognitive Function (Attention, Memory)

Physical Health Status

Mental Health Status

Quality of Life (Global well-being, Satisfaction with life)

McAuley & Morris, 2007
I. Physical Activity and Physical Health Status: Functional Performance

- Importance of regular physical activity for maintaining functional performance as we age

- Most exercise programs, RCTs, delivered at medical or university centers

- Are there alternative methods for extending our reach?
The Flexibility, Toning, and Balance Trial (FLEXTOBA©)

McAuley, et al. (2011). Contemporary Clinical Trials
Why is this timely?

Products and services segmentation (2012)

- 25% Yoga DVDs
- 15% Dance DVDs
- 15% Cardio & Taekwondo DVDs
- 15% Pilates DVDs
- 15% Toning DVDs
- 10% Walk DVDs
- 5% Other DVDs
Why is this timely?

Major market segmentation (2012)

- 35% Consumers aged 18 to 34
- 33% Consumers aged 35 to 54
- 20% Consumers aged 55 and up
- 8% Consumers aged 12 to 17
- 4% Consumers aged 6 to 11

Total $264.5m

Source: www.ibisworld.com
McAuley et al. (2013); Wojcicki et al., (2015) *Journals of Gerontology: Medical Sciences*

Gothe et al. (2015) *Journal of Behavioral Medicine*

- 307 older adults (M age = ~71 yrs), 83 communities, 5000 square miles of Central Illinois
- Randomized to FlexToBa or Healthy Aging DVD conditions
- Titrated telephone support calls
- Primary outcomes: Physical function, physical activity, well-being
FLEXTOBA EFFECTS ON FUNCTIONAL PERFORMANCE
Short Physical Performance Battery

![Bar chart showing performance comparison between FlexToBa and Control groups. The chart compares values before (Pre) and after (Post) intervention.](illinois.edu)
Arm Curls

![Bar chart showing Arm Curls pre and post for FlexToBa and Control groups.](chart.png)
Upper Body Flexibility

![Bar chart showing comparison of pre and post values for FlexToBa and Control groups.](image-url)
Lower Body Flexibility

FlexToBa

Control

Pre

Post
FLEXTOBA EFFECTS ON PHYSICAL ACTIVITY
Physical Activity: GLTEQ

Significant difference at month 6 when controlling for baseline and gender; $p < .01$
Physical Activity: Accelerometer

Significant difference at month 6 when controlling for baseline and gender; $p = .05$
FLEXTOBA EFFECTS ON WELL-BEING: SELF-ESTEEM
Self Esteem: Month 0 to Month 6

** (p<.01) time x group effect
The Flexibility, Toning, and Balance Trial (FLEXTOBA©)

• Support for DVD-delivered physical activity program for older adults improving physical and psychosocial function, as well as increasing physical activity

• Clinically significant improvement in SPPB

• Minimal contact involved; Safe; Well-tolerated; High levels of satisfaction

• Potential for broad reach and scalability
II. Physical Activity and Mental Health Status: Fatigue
Physical Activity and Mental Health Status: Fatigue in Diseased Populations

- Prevalence of Fatigue in:
  - Breast cancer (BC) – 70-99%
  - Multiple sclerosis (MS) – 75-99%

- Potential of physical activity to reduce fatigue via psychosocial pathways

- Depression
  - Related to both fatigue and physical activity

- Self-efficacy
  - Reciprocal relationship with physical activity behavior
  - Associated with both fatigue and depression independently

McAuley et al. (2010) *Psychosomatic Medicine*
Sample and Analyses

- **Study 1**: Cross-sectional sample of BCS (N=192)
  - Path analysis within covariance framework

- **Study 2**: 6 month longitudinal sample of persons with MS (N=292)
  - Panel analysis within covariance framework

McAuley et al. (2010) *Psychosomatic Medicine*
Results: Breast Cancer

\[ \chi^2 = 1.48, \ df = 2, \ p = .45; \ SRMR = 0.03, \ CFI = 1.00 \]

McAuley et al. (2010) *Psychosomatic Medicine*
Results: Multiple Sclerosis

\[ \chi^2 = 25.86, \ df = 18, \ p = .10; \ SRMR = 0.01, \ CFI = .99 \]

McAuley et al. (2010) *Psychosomatic Medicine*
Phillips & McAuley (2013) *Cancer Epidemiology, Biomarkers, and Prevention*

- **National sample, n=1,527 women completed majority of survey at baseline**
  - Accelerometer Data: 3 valid days at both time points n= 370

- **Demographics:**
  - Age: 56.2 ± 9.4
  - BMI: 26.6 ± 5.7
  - 97.0% White
  - 67% > College education and 86% > $40,000 annual income

- **Disease Specific Characteristics:**
  - 7.2 ± 6.0 years since diagnosis
  - 83.6% stage 0, I, II
  - 97.4% post-treatment
    - 99.3% Surgery
    - 59.0% Chemotherapy
    - 67.7% Radiation Therapy
Phillips & McAuley (2013) *Cancer Epidemiology, Biomarkers, and Prevention*

\[ \chi^2 = 667.22, \text{ df} = 110, p < 0.001; \text{ CFI} = 0.96; \text{ SRMR} = 0.02 \]
Implications

- Preliminary evidence for a psychosocial model of the PA-Fatigue association
- Importance of the primary “active agent” (self-efficacy) being modifiable
- Potential for disease-related fatigue being reduced by promoting physical activity
- Roles played by other correlates of fatigue (Cortisol, CRP, T-cell levels, body composition)?
III. Relationships Among Physical Activity, and Cognitive Health Status
Physical Activity and Cognitive Function

• Physical activity and fitness have been implicated in improved cognitive function

• In humans, effects appear greater for particular types of function

• Executive control – planning, scheduling, interference control, working memory, etc.

Exercise training improves cognitive function in older adults

Colcombe & Kramer, 2003 Psychological Science
Fitness Training and Attentional Control

Colcombe et al. (2004). *Proceedings of the National Academy of Sciences*
But What About Yoga?
Two Yoga Studies

• Yoga Effects on Cognition and Functional Performance in Older Adults

• A meta-analysis of acute and chronic yoga effects on cognition
Yoga and Cognition Studies

• Few yoga interventions examining this relationship
• Finding are equivocal
• Most studies limited by methodological issues, ceiling effects, low exercise dose, no active controls, high drop-out rates
Study I: Purpose of the Study

• To investigate the effects of an 8-week yoga intervention on cognition (executive functions, attention and processing speed) in sample of healthy low active older adults

• To examine the improvements in functional fitness following the 8-week yoga intervention
Methods – Participants N=118

- Low Active older adults
- 55-79 years old
- Mean age 62.05 (±5.6)
- Females 78%
- Married 62%
- College graduate ≥ 66%
- Income 40,000 ≥75.8%
- Working full time 54%

- Hispanic/Latino 3.39%
- Caucasian 81.35%
- African American 10.16%
- Asian 3.4%
- American Indian or Alaskan Native 1.7%
- More than one race 3.4%
Yoga Intervention Group

n=61, \( M_{\text{attendance}} \) 80.82%

• Three session per week Hatha Yoga
• Equipment: yoga mats, yoga blocks, yoga belts
Stretching Control Group

n=57, M_{attendance} 81.29%

• Three sessions per week of stretching, balance, and strengthening exercises for all muscle groups
• Equipment: resistance bands, balance disks, mats, chairs
Hypotheses

• Yoga condition would improve measures of executive function (attention and working memory) compared to strengthening and stretching condition

• Both groups would demonstrate equivalent improvements in strength, flexibility, and mobility
RESULTS – COGNITIVE OUTCOMES

Gothe & McAuley (2014) *Journal of Gerontology: Medical Sciences*
Executive Function: Task Switching

- **Task Switching** (Kramer et al., 1999; Pashler 2000)
  
  - Task: switch between judging whether a number (1,2,3,4,6,7,8 or 9) is **odd or even** and judging whether it is **low or high** (i.e., smaller or larger than 5)
Results: Task Switching RT

**Single RT**
- Pre: 720.00, Post: 740.00
- Reaction Time (msec)
- F = 3.18, p = 0.07

**Mixed RT**
- Pre: 690.00, Post: 670.00
- Reaction Time (msec)
- F = 4.08, p = 0.04

**Repeat RT**
- Pre: 1020.00, Post: 1000.00
- Reaction Time (msec)
- F = 4.5, p = 0.03

**Switch RT**
- Pre: 1360.00, Post: 1340.00
- Reaction Time (msec)
- F = 1.72, p = 0.19

Yoga and Stretching conditions are plotted for each task type.
Results: Task Switching AC

- **Single AC**
  - Pre: 0.89, Post: 0.93
  - F = 5.35, p = .02

- **Mixed AC**
  - Pre: 0.89, Post: 0.94
  - F = 2.96, p = .09

- **Repeat AC**
  - Pre: 0.89, Post: 0.94
  - F = 3.2, p = .08

- **Switch AC**
  - Pre: 0.89, Post: 0.92
  - F = 2.56, p = .11
Executive Function: Working memory

- **Running Span Task** (Broadway & Engle, 2010)
  - report the last \(n\) letters \((n= 3, 4, 5 \text{ or } 6)\) from a string of \(m + n\) letters presented on the screen

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<tr>
<th>Pre</th>
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<th>Score</th>
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<tr>
<td>Stretching</td>
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<td>31.00</td>
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**Total recall (m=0)**

\[ F=2.82, \ p=.09 \]

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<td>Stretching</td>
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**Partial recall (m>0)**

\[ F=7.28, \ p=.008 \]
Executive Function: Working Memory

- **N-back Task** (Kirchner, 1958; Nystrom et al., 2000)
  - 1-back: B H H T
  - 2-back: B H T H N

![Graphs showing reaction times for 1-back and 2-back tasks before and after intervention, with statistical results F=.01, p=.91 for 1-back and F=1.40, p=.24 for 2-back.](image_url)
Working Memory: n-back AC

1-back AC

Accuracy %

F=1.62, p=.21

2-back AC

Accuracy %

F=11.87, p<.001
FUNCTIONAL OUTCOMES

Gothe & McAuley (2015) Journals of Gerontology Medical Sciences
Functional Outcomes: Balance

**Left Leg**

- Pre: [Data points]
- Post: [Data points]

**Time** (sec)

- Pre: [Data points]
- Post: [Data points]

**Right Leg**

- Pre: [Data points]
- Post: [Data points]

**Time** (sec)

- Pre: [Data points]
- Post: [Data points]

**Time*Group: F=4.25, p=.04**

**Time: F=5.49, p=.02**

**4-square step**

- Pre: [Data points]
- Post: [Data points]

**Time: F=39.75, p<.001**
Functional Outcomes: Strength

**Arm curls**

![Graph showing improvement in arm curls pre and post with labels: Time: F=93.52, p<.001.](image)

**Chair stands**

![Graph showing improvement in chair stands pre and post with labels: Time: F=92.97, p<.001.](image)
Functional Outcomes: Mobility

4m gait speed

- Pre: Time (sec) - Post: Time (sec)

- Time: F=34.56, p<.001

8-ft up and go

- Pre: Time (sec) - Post: Time (sec)

- Time: F=19.06, p<.001

Stairs up

- Pre: Time (sec) - Post: Time (sec)

- Time: F=15.97, p<.001

Stairs down

- Pre: Time (sec) - Post: Time (sec)

- Time: F=9.78, p<.001
Functional Outcomes: Flexibility

Back scratch - left

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<th>Inches</th>
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Time: F=13.47, p<.001

Back scratch - right

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Time: F=14.33, p<.001

Sit-n-reach - left

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Time: F=59.56, p<.001

Sit-n-reach - right

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Time: F=65.42, p<.001
Conclusions

• Yoga superior to stretching and strengthening for improving executive function
• Yoga equally effective in improving functional performance
• First RCT with low active older adults
• Well-validated measures of cognitive function
• Short-term effects, primarily white, female sample
• Provides foundation for subsequent larger RCTs
Comments From Participants

• “When I started the program I had no previous knowledge of yoga. This program has introduced me to its many facets – meditation, breathing and muscle exercises”

• “My body is much more flexible now. I also feel much stronger in my upper body”

• “The yoga experience has helped me to relax more easily”

• “I felt a connection – love and warmth toward the group. That was very interesting and unexpected”
Does Yoga Enhance Cognitive Function: A Meta-Analysis?

Gothe & McAuley (2015) *Psychosomatic Medicine*
Basic study characteristics

• 15 RCTs
  – 1 to 6 month interventions
  – Most commonly Hatha Yoga (8/15)

• 7 acute exercise studies
  – 5 examined Hatha yoga and cyclic meditation

• Cognitive assessments
  – Executive function most common
  – Attention, processing speed and memory
## Yoga Effects on Cognition

<table>
<thead>
<tr>
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<th>Overall Effect Sizes</th>
<th>Attention/Speed of Processing</th>
<th>Executive Function</th>
<th>Memory</th>
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<td>Acute Studies</td>
<td>.58</td>
<td>.49</td>
<td>.39</td>
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<td>Chronic Studies</td>
<td>.33</td>
<td>.33</td>
<td>.27</td>
<td>.18</td>
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Conclusions

• Yoga findings consistent with aerobic PA and cognitive and physical function relationship
• Acute effects greater than chronic ... again, consistent with the literature
• Limitations: N; yoga type/prescription; heterogeneity of cognitive measures
• Study serves as a foundation for large, well-controlled RCTs
Acknowledgement

- National Institute on Aging (Grant # AG18008, AG12113, AG20118, AG25667)
- National Cancer Institute (CA136859)
- National Multiple Sclerosis Society
- Center for Learning, Nutrition, and Memory
- Abbott Nutrition
- Khan Professorship in Applied Health Sciences
- Institute for Study of Aging
- Many, many current and former graduate students and colleagues at UIUC