Physical Inactivity: The Biggest Public Health Problem of the 21st Century

Physical activity and health in work life
International PhD course
2012 Mai 21-25
University of Southern Denmark, Odense, Denmark

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Departments of Exercise Science & Epidemiology/Biostatistics
University of South Carolina
Professor Jerry Morris—Pioneer in studying physical activity and cardiovascular health
Physical Activity at Work and Coronary Artery Disease, 31,000 London Transport Workers

Morris JN et al. *Lancet* 1953

**Bar Graph**

- **Y-axis**: Rate/1000
- **X-axis 1**: Coronary Occlusion
- **X-axis 2**: Early Mortality*
  - *Within 3 days of MI*

- **Drivers** (Yellow)
- **Conductors** (Magenta)

*Early Mortality* within 3 days of MI
“We in the West are the first generation in human history in which the mass of the population has to deliberately exercise to be healthy. How can society’s collective adaptations match?”
Walking Pace, LTPA, and Resting HR in Relation to Mortality: 40 Years Follow-up of Original Whitehall Study

- **Original study**: 19,019 male, nonindustrial, London-based government employees, aged 40-69 years when first examined between 1967-70.
  - Completed a questionnaire about employment grade, smoking, marital status, and LTPA, and self-rated walking pace
  - Medical exam included resting HR, BP, height, weight, pulmonary function (FEV1), and an overnight fast, plasma cholesterol and post-challenge blood glucose concentration.

- **Records of 6928 men traced through National Health Service Central Registry, representing ~40 years follow-up through October 2008.**

Batty GD et al *Ann Epidemiol.* 2010; 20:661-9
Relation of LTPA with Mortality Outcomes: 40 years follow-up of Whitehall Study

* Adjusted for age, employment grade, SBP, cholesterol, smoking, BMI, glucose intolerance, diabetes, FEV1

Active: engaged in vigorous sports (e.g. swimming, athletics)
Moderate: participated in active hobbies (e.g. gardening, woodwork)
Inactive: no such physical exertion

Batty GD et al Ann Epidemiol. 2010; 20:661-9
Relation of Walking Pace with Mortality: 40 years follow-up of Whitehall Study

* Adjusted for age, employment grade, SBP, cholesterol, smoking, BMI, glucose intolerance, diabetes, FEV1

Batty GD et al Ann Epidemiol. 2010; 20:661-9
Articles/Period—Web of Science
Physical Activity or Physical Fitness and Cardiovascular Disease

# of Articles

Years
Non-Communicable Diseases (NCDs)

- Changing patterns in leisure and work have led to a health crisis
- NCDs cause 65% of all deaths worldwide
- 36.1 million deaths from CVD, Stroke, Diabetes, Cancer & Respiratory diseases.
- Physical inactivity causes 3.2 million deaths/year

Economic Burden

- Failure to reduce chronic diseases will result in heavy losses in terms of human life and economic production.

- Current losses:
  - US: $750 billion annually from CVD & diabetes alone.
  - China: $558 billion
  - India: $237 Billion
  - Britain: $33 Billion

- Trends suggest that risk factors and costs are on the rise.
Question

- Rank the following exposures by the number of deaths caused worldwide.
  - Tobacco use
  - Obesity
  - High blood pressure
  - Physical inactivity
  - High blood glucose
Leading risk factors for mortality by income group (estimates from 2004)

Mortality in millions (total 58.8 million)

© World Health Organization 2009

Physical Activity and CRF as Predictors of All-cause Mortality

- 31,818 men and 10,555 women
- 1492 deaths in men during average follow-up of 14.6 years, and 230 deaths in women during average follow-up of 12.8 years
- PA mortality trends not significant after adj for CRF
- CRF trends significant after adj for PA

Lee DC, et al. *BJSM* 2-11; 45:504-10
Risk Factors for Stroke in 22 Countries: INTERSTROKE Study

- Hypertension: 51.8%
- Current Smoker: 18.9%
- Waist-to-Hip Ratio: 26.5%
- Diet Risk Score: 18.8%
- Regular PA: 28.5%
- Diabetes: 5%
- Alcohol intake: 3.8%
- Stress/Depression: 5%
- Cardiac Causes: 6.7%
- Ratio of ApoB to ApoA: 24.9%

Adjusted for age, sex, and region

Harvard Alumni Health Study

Professor Ralph S. Paffenbarger, Jr
Great Leaders of Physical Activity Epidemiology
Harvard Alumni Health Study (HAHS)

- Begun in 1962 by Prof. Paffenbarger
- Subjects are male alumni who matriculated as undergrads at Harvard University, 1916-1950
- Thus, this is a FIXED COHORT (no new enrollees)
- Main exposure of interest: physical activity
- Main outcomes of interest: chronic diseases, especially coronary heart disease, when HAHS was initiated
Subject Selection

Why Harvard alumni?

- Good follow-up (potential bias if loss to follow-up is high)
- Able to provide good quality of info on health habits (including PA) and medical history via mail questionnaires
- Retrospective info available on health habits (including PA) in college
21. How many flights of stairs do you usually climb up each day?

   Number of flights
   Let 1 flight = 10 steps

   0 0
   1 1
   2 2
   3 3
   4 4
   5 5
   6 6
   7 7
   8 8
   9 9

22. How many city blocks or their equivalent do you regularly walk each day?

   Number of blocks
   Let 12 blocks = 1 mile

   0 0
   1 1
   2 2
   3 3
   4 4
   5 5
   6 6
   7 7
   8 8
   9 9

23. List any sports or recreation you have participated in during the past WEEK. Please include only the time you were physically active (i.e., actual playing time in jogging, bicycling, swimming, brisk walking, gardening, carpentry, calisthenics, etc.).

<table>
<thead>
<tr>
<th>Sport, recreation or other physical activity</th>
<th>Number of TIMES in WEEK</th>
<th>Average time per EPISODE Hours Minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

24. List any OTHER sports or recreation you have actively participated in during the past YEAR. Please remember seasonal sports or events.

<table>
<thead>
<tr>
<th>Sport, recreation or other physical activity</th>
<th>Number of WEEKS per YEAR</th>
<th>Average time per WEEK when active Hours Minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Validation of PA

Compared against:

- Other PA questionnaires
- Physiological variables influenced by PA (e.g., fitness, weight, blood pressure, lipids, glucose/insulin profile)
- Energy intake
- PA diaries
- Mechanical/electronic devices that measure movement
- Doubly-labeled water (a sophisticated technique for measuring energy expenditure)
Assessment of Outcomes

- Alumni report the occurrence of chronic diseases on periodically mailed questionnaires
- Self-reports have been validated against medical records, with high validity
- Fatal outcomes assessed by obtaining death certificates
- Mortality follow-up >99% complete
Physical Activity in Middle-Age and MI

Physical Activity and MI

Alumnus Activity, Kcal/Wk
p, trend < 0.01

Varsity Athlete
Intramural, <5 hr/wk
Intramural, 5+ hr/wk
College Activity
p, trend = 0.19

### Physical Activity and Longevity

Added years of life to age 80, active vs inactive men:

<table>
<thead>
<tr>
<th>Age at study entry</th>
<th>Added years</th>
</tr>
</thead>
<tbody>
<tr>
<td>35-39</td>
<td>2.5</td>
</tr>
<tr>
<td>40-44</td>
<td>2.3</td>
</tr>
<tr>
<td>45-49</td>
<td>2.1</td>
</tr>
<tr>
<td>50-54</td>
<td>2.1</td>
</tr>
<tr>
<td>55-59</td>
<td>2.0</td>
</tr>
<tr>
<td>60-64</td>
<td>1.8</td>
</tr>
<tr>
<td>65-69</td>
<td>1.4</td>
</tr>
<tr>
<td>70-74</td>
<td>0.7</td>
</tr>
<tr>
<td>75-79</td>
<td>0.4</td>
</tr>
</tbody>
</table>

Is it physical activity that is responsible for the lower CHD rates? Or, are associated healthy habits (active men are younger, smoke less, eat better, etc.) responsible for the lower CHD rates? We are concerned about CONFOUNDING by other variables related to physical activity, which also predict CHD risk.
<table>
<thead>
<tr>
<th></th>
<th>Inactive</th>
<th>Active</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age, yr*</td>
<td>68.6</td>
<td>66.2</td>
</tr>
<tr>
<td>Mean BMI</td>
<td>24.6</td>
<td>24.8</td>
</tr>
<tr>
<td>Smoker</td>
<td>9.5%</td>
<td>8.1%</td>
</tr>
<tr>
<td>No alcohol*</td>
<td>32.8%</td>
<td>25.9%</td>
</tr>
<tr>
<td>Red meat *</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥3 servings/wk</td>
<td>30.8%</td>
<td>31.1%</td>
</tr>
<tr>
<td>Vegetables *</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤1 serving/dy</td>
<td>31.6%</td>
<td>25.0%</td>
</tr>
</tbody>
</table>

* p <0.05
Physical Activity and CHD

RR’s adjusted for age; BMI; smoking; alcohol; hypertension; diabetes; early parental death; diet; vitamin/mineral supplements

Lee et al, Circulation 2000;102:981-6
PA Intensity and CHD

Relative Intensity

- Nothing-Weak
- Mod
- Somewhat Strong
- Strong-Maximal

Relative Risk* of CHD

P, trend = 0.003

* adjusted for age, smoking, alcohol, diet, early parental death

Lee et al; Circulation 2003;107:1110-6
The Women’s Health Initiative (WHI) Observational Study (OS)
Women’s Health Initiative (WHI) observational Study (OS)

• Subjects are postmenopausal women, 50-79 years at entry
• 93,676 women, 40 clinical centers, 1993-2010
• Examined the relationship between lifestyle, health and risk factors and specific disease outcomes.
6. Think about the walking you do outside the home. How often do you walk outside the home for more than 10 minutes without stopping? (Mark only one.)

- Rarely or never
- 1-3 times each month
- 1 time each week
- 2-3 times each week
- 4-6 times each week
- 7 or more times each week

6.1. When you walk outside the home for more than 10 minutes without stopping, for how many minutes do you usually walk?

- Less than 20 min.
- 20-39 min.
- 40-59 min.
- 1 hour or more

6.2. What is your usual speed?

- Casual strolling or walking (less than 2 miles an hour)
- Average or normal (2-3 miles an hour)
- Fairly fast (3-4 miles an hour)
- Very fast (more than 4 miles an hour)
- Don't know

7.1. STRENUEOUS OR VERY HARD EXERCISE (You work up a sweat and your heart beats fast). For example, aerobics, aerobic dancing, jogging, tennis, swimming laps.

- None
- 1 day per week
- 2 days per week
- 3 days per week
- 4 days per week
- 5 or more days per week

7.2. How long do you usually exercise like this at one time?

- Less than 20 min.
- 20-39 min.
- 40-59 min.
- 1 hour or more

7.3. MODERATE EXERCISE (Not exhausting). For example, biking outdoors, use of an exercise machine (like a stationary bike or treadmill), calisthenics, easy swimming, popular and folk dancing.

- None
- 1 day per week
- 2 days per week
- 3 days per week
- 4 days per week
- 5 or more days per week

7.4. How long do you usually exercise like this at one time?

- Less than 20 min.
- 20-39 min.
- 40-59 min.
- 1 hour or more

7.5. MILD EXERCISE. For example, slow dancing, bowling, golf.

- None
- 1 day per week
- 2 days per week
- 3 days per week
- 4 days per week
- 5 or more days per week

7.6. How long do you usually exercise like this at one time?

- Less than 20 min.
- 20-39 min.
- 40-59 min.
- 1 hour or more
Walking Compared with Vigorous Exercise for the Prevention of Cardiovascular Events in Women

JoAnn E. Manson, M.D., Dr.P.H., Philip Greenland, M.D., Andrea Z. LaCroix, Ph.D., Marcia L. Stefanick, Ph.D., Charles P. Mouton, M.D., Albert Oberman, M.D., M.P.H., Michael G. Perri, Ph.D., David S. Sheps, M.D., Mary B. Pettinger, M.S. and David S. Siscovick, M.D., M.P.H.

N Engl J Med
Volume 347;10:716-725
September 5, 2002
Age-Adjusted Relative Risks of Cardiovascular Disease According to Quintile of Total MET Score in Subgroups Defined by Race, Age, and Body-Mass Index (BMI)

Age-Adjusted Relative Risks of Cardiovascular Disease According to Energy Expenditure from Walking (MET-Hr/Wk) in Subgroups Defined by Race, Age, and Body-Mass Index (BMI)

Conclusions

- These prospective data indicate that both walking and vigorous exercise are associated with substantial reductions in the incidence of cardiovascular events among postmenopausal women, irrespective of race or ethnic group, age, and body-mass index.

- Prolonged sitting predicts increased cardiovascular risk.
Aerobics Center
Longitudinal Study
Design of the ACLS

1970 More than 80,000 patients 2005
Cooper Clinic examinations--including history and physical exam, clinical tests, body composition, EBT, and CRF
Mortality surveillance to 2003
More than 4000 deaths

1982 '86 '90 '95 '99 '04
Mail-back surveys for case finding and monitoring habits and other characteristics
All-Cause Death Rates by CRF Categories—3120 Women and 10 224 Men—ACLS

Blair SN. JAMA 1989
Amount of Specific Physical Activities for Moderately Fit Women and Men

- Detailed physical activity assessments in women and men who also completed a maximal exercise test
- Average min/week for the moderately fit who only reported each specific activity

Stofan JR et al. *AJPH* 1998; 88:1807
Define CRF in the ACLS

- Quantified as the total duration of a treadmill test (Modified Balke protocol)
- Highly correlated with measured maximal oxygen uptake ($r > 0.92$)
- Age-, sex-specific quintiles for treadmill time in the overall ACLS population

| Low: Quintile 1 (Q1, the lowest 20%) |
| Moderate: Quintile 2 and 3 (Q2-3, the middle 40%) |
| High: Quintile 4 and 5 (Q4-5, the upper 40%) |

Table values are maximal METs attained during the exercise test.
## Fitness and Mortality in Women, ACLS, Fitness Categories

<table>
<thead>
<tr>
<th>Fitness group</th>
<th>20-39</th>
<th>40-49</th>
<th>50-59</th>
<th>60+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>≤8.1</td>
<td>≤7.5</td>
<td>≤6.5</td>
<td>≤5.7</td>
</tr>
<tr>
<td>Mod</td>
<td>8.2-10.5</td>
<td>7.6-9.5</td>
<td>6.6-8.3</td>
<td>5.7-7.5</td>
</tr>
<tr>
<td>High</td>
<td>&gt;10.5</td>
<td>&gt;9.5</td>
<td>&gt;8.3</td>
<td>&gt;7.5</td>
</tr>
</tbody>
</table>

Table values are maximal METs attained during the exercise test.
Does Changing Cardiorespiratory Fitness Reduce Mortality Risk?
Fitness Change Categories

- Unfit was defined as the least fit 20% of men in each age group.
- Men were classified as fit or unfit at both examinations.
- Change categories:
  - Unfit at both examinations = never fit
  - Unfit at first, fit at second = improvers
  - Fit at both examinations = always fit

Blair SN et al. *JAMA* 1995; 273:1093-8
## Age-Adjusted Death Rates by Fitness Change Groups, Men, ACLS

<table>
<thead>
<tr>
<th>Fitness Groups</th>
<th>Age-adjusted Death Rates/10,000 Man-years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CVD</td>
</tr>
<tr>
<td>Never fit</td>
<td>65</td>
</tr>
<tr>
<td>Improvers</td>
<td>31</td>
</tr>
<tr>
<td>Always fit</td>
<td>14</td>
</tr>
</tbody>
</table>

Blair SN et al. *JAMA* 1995; 273:1093-8
CVD Death Rates* by Fitness Groups, 7,080 Women and 25,341 Men, ACLS

Deaths/10,000 PY

Adjusted for age, exam year, and other risk factors

Blair SN et al. *JAMA* 1996; 276:205-10
Cardiorespiratory Fitness, Risk Factors and All-Cause Mortality, Men, ACLS

*Adjusted for age, exam year, and other risk factors

Blair SN et al. *JAMA* 1996; 276:205-10
Cardiorespiratory Fitness, Risk Factors, and All-Cause Mortality, Women, ACLS

Cardiorespiratory Fitness Groups

*Adjusted for age, exam year, and other risk factors

Blair SN et al. *JAMA* 1996; 276:205-10
CRF and Other Health Outcomes
38,801 men, ages 20-88 years
283 digestive system cancer deaths in 17 years of follow-up
CRF was inversely associated with death after adjustment for age, examination year, body mass index, smoking, drinking, family history of cancer, personal history of diabetes
Fit men had lower risk of colon, colorectal, and liver cancer deaths

CRF and Breast Cancer Mortality

- 14,551 women, ages 20-83 years
- Completed exam 1970-2001
- Followed for breast cancer mortality to 12/31/2003
- 68 breast cancer deaths in average follow-up of 16 years
- Odds ratio adjusted for age, BMI, smoking, alcohol intake, abnormal ECT, health status, family history, & hormone use

Sui X et al. *MSSE* 2009; 41:742
Incidence of depressive symptoms by cardiorespiratory fitness categories among women

Cumulative Incidence Rate (%)

Low  Moderate  High
Cardiorespiratory Fitness Level

Linear trend $P < 0.0001$

*Unadj incidence rates

CRF and Risk of Incident Hypertension, ACLS Women

- 4,884 healthy women examined at the Cooper Clinic, 1970-1998
- 157 women developed hypertension during average follow-up of 5 years
- Risk adjusted for age, exam year, alcohol intake, smoking, BP, family history of hypertension, waist girth, glucose, & triglycerides

Age-adjusted Incidence Rates of Type 2 Diabetes By CRF Levels Quantified by 1-MET Increment, ACLS, 6249 Women

Sui X, Hooker SP, Lee I-M, ...Blair SN. Diabetes Care 2008; 31:550-5
Multivariate adjusted HR of Type 2 Diabetes by Fitness Groups, ACLS, 16745 Men

*Adjusted for age, exam year, smoking, drinking, BP, cholesterol, and BMI

Lee DC, Sui X, Church TS,... Blair SN. Diabetes Care 2009; 32: 257-62
Multivariate adjusted HR of Incident Hypertension by Fitness Groups, ACLS, 16601 Men


*Adjusted for age, exam year, BMI, smoking, drinking, BP, hypercholesterolemia, DM, family history HTN and CVD
Multivariate adjusted HR of **Nonfatal CVD, CHD, and MI**, by Fitness Groups, ACLS, 20728 men

<table>
<thead>
<tr>
<th>Event</th>
<th>CVD</th>
<th>CHD</th>
<th>MI</th>
</tr>
</thead>
<tbody>
<tr>
<td>345</td>
<td>664</td>
<td>533</td>
<td>212</td>
</tr>
<tr>
<td>664</td>
<td>503</td>
<td>400</td>
<td>154</td>
</tr>
<tr>
<td>503</td>
<td>289</td>
<td>123</td>
<td>123</td>
</tr>
<tr>
<td>289</td>
<td>533</td>
<td>212</td>
<td>123</td>
</tr>
<tr>
<td>212</td>
<td>400</td>
<td>154</td>
<td>123</td>
</tr>
<tr>
<td>154</td>
<td>123</td>
<td>123</td>
<td>123</td>
</tr>
</tbody>
</table>

*HR adjusted for age, exam year, smoking, drinking, family history, and abnormal ECG*

**Sui X, LaMonte MJ, Blair SN. Am J Epidemiol 2007; 165:1413-23**
Age and Exam Year-adjusted CVD Incidence Rates by Fitness Groups, across Number of Risk Factors, ACLS, 20728 men


*Risk factors include current smoking, hypertension, hypercholesterolemia, diabetes, and family history of CVD
Multivariate adjusted HR of Nonfatal CVD, CHD, and MI, by Fitness Groups, ACLS, 5909 women


*adjusted for age, exam year, smoking, drinking, family history, and abnormal ECG
Age and Exam year-adjusted CVD Incidence Rate by Fitness Groups, across Number of Risk Factors, ACLS, 5909 women


*Risk factors include current smoking, hypertension, hypercholesterolemia, diabetes, and family history of CVD
Diet, Fitness, and Health
Aerobics Center Longitudinal Study

- 13,621 men and women from ACLS
- Participants were followed for mortality until 2003.
- One major dietary pattern emerged and was tagged the Unhealthy Eating Index.
- This pattern was characterized by high consumption of red and processed meat, white potato products, non-whole grains, added fat, and reduced consumption of non-citrus fruits.

All-cause mortality risk: cardiorespiratory fitness and the unhealthy eating index

Activity, Fitness, and Mortality in Older Adults
Cardiorespiratory Fitness and All-Cause Mortality, Women and Men ≥60 Years of Age

- 4060 women and men ≤60 years
- 989 died during ~14 years of follow-up
- ~25% were women
- Death rates adjusted for age, sex, and exam year

Sui M et al. JAGS 2007.
Mortality Risk in U.S. Veterans by Fitness Categories

Adjusted for age, peak METs achieved, resting systolic BP (mmHg), BMI, ethnicity, CVD, cardiovascular medications, and risk factors (hypertension, diabetes mellitus, dyslipidemia, and smoking)

## Prevalence of Self-reported Functional Limitations by Fitness and Age Groups

<table>
<thead>
<tr>
<th>Age Groups (years)</th>
<th>Fitness Group</th>
<th>40-49</th>
<th>50-59</th>
<th>60+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Women</td>
<td>Low</td>
<td>18*</td>
<td>23</td>
<td>46</td>
</tr>
<tr>
<td></td>
<td>Moderate</td>
<td>8</td>
<td>13</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>7</td>
<td>3</td>
<td>18</td>
</tr>
<tr>
<td>Men</td>
<td>Low</td>
<td>7</td>
<td>14</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>Moderate</td>
<td>3</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>3</td>
<td>1</td>
<td>7</td>
</tr>
</tbody>
</table>

*Prevalence (%) Huang et al. MSSE 1998, 30:1430-5
### Adjusted OR for Functional Limitations

<table>
<thead>
<tr>
<th></th>
<th>Men</th>
<th></th>
<th>Women</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR</td>
<td>95% CI</td>
<td>OR</td>
<td>95% CI</td>
</tr>
<tr>
<td><strong>High strength</strong></td>
<td>0.56</td>
<td>0.34-0.93</td>
<td>0.54</td>
<td>0.21-1.39</td>
</tr>
<tr>
<td><strong>TM time (min)</strong></td>
<td>0.90</td>
<td>0.86-0.93</td>
<td>0.90</td>
<td>0.83-0.98</td>
</tr>
<tr>
<td><strong>Age (year)</strong></td>
<td>1.05</td>
<td>1.04-1.07</td>
<td>1.04</td>
<td>1.00-1.10</td>
</tr>
<tr>
<td><strong>BMI</strong></td>
<td>1.03</td>
<td>0.99-1.07</td>
<td>1.04</td>
<td>0.94-1.14</td>
</tr>
<tr>
<td><strong>Health prob</strong></td>
<td>2.14</td>
<td>1.57-2.92</td>
<td>2.72</td>
<td>1.50-4.96</td>
</tr>
</tbody>
</table>

OR adjusted for exam year and all variables in table

Brill PA et al. *MSSE* 2000; 32:412-6
Cardiorespiratory Fitness and Risk of Dementia, ACLS

- 59,960 women and men
- Followed for 16.9 years after clinic exam
- 4,108 individuals died
  - 161 with dementia listed on the death certificate
- Hazard ratio adjusted for age, sex, exam yr, BMI, smoking, alcohol, abnormal ECG, history of hypertension, diabetes, abnormal lipids, and health status

Lui R et al. In Press. MSSE
Means estimated from repeated measures ANCOVA adjusted for gender, field center and baseline values.
**LIFE-P**

**Serious adverse events**

<table>
<thead>
<tr>
<th>Event</th>
<th>Physical activity N=213</th>
<th>Successful aging N=211</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death</td>
<td>0.9%</td>
<td>0.9%</td>
<td>&gt;0.99</td>
</tr>
<tr>
<td>Life threatening event</td>
<td>1.4%</td>
<td>1.4%</td>
<td>&gt;0.99</td>
</tr>
<tr>
<td>Hospitalization</td>
<td>20.7%</td>
<td>20.9%</td>
<td>&gt;0.99</td>
</tr>
<tr>
<td>Significant lab exam</td>
<td>2.8%</td>
<td>3.8%</td>
<td>0.60</td>
</tr>
<tr>
<td>Any SAE</td>
<td>22.5%</td>
<td>23.7%</td>
<td>0.82</td>
</tr>
</tbody>
</table>

Muscular Strength and Mortality
Muscular Strength and Health Outcomes

Definition of Muscular Strength

- Assessed in the upper and lower body using resistance weight machines
  - Upper body strength: 1-repetition maximum (1- RM) supine bench press
  - Lower body strength: 1-RM seated leg press
- A combination score was calculated as the mean of the bench and leg press standardized scores
- Thirds of the age-specific composite score was used for analysis
Thirds of Muscle Strength and Mortality, 8762 Men--ACLS

503 deaths (145 CVD) during average follow-up of 18.9 years

Strength, Adiposity, and Cancer Mortality

- 8,677 men, 20-82 years
- 18.8 years of follow-up, 211 cancer deaths
- Muscular strength assessed by 1-RM bench press and leg press
- Significant trend across strength categories remained after further adjustment for BMI, % body fat, waist circumference, and cardiorespiratory fitness

Odds of Cancer Death*

*Adj for age, exam yr, smoking, alcohol intake, and health status

P for trend=0.003

Multivariate-Adjusted HR for Incident Hypertension According to Thirds of Muscular Strength, ACLS, 4147 Men

Maslow AL, Sui X, Colabianchi N,...Blair SN. MSSE 2010;42:288-95

P for trend = 0.009

*adjusted for age, exam year, smoking, drinking, BP and family history
Additional Adjusting CRF Eliminated the Observed Association Between Muscular Strength and Hypertension

Maslow AL, Sui X, Colabianchi N,...Blair SN. MSSE 2010;42:288-95

HR

P for trend = 0.629

*adjusted for age, exam year, smoking, drinking, BP, family history, and CRF
Summary
Attributable fractions of health outcomes for low cardiorespiratory fitness and other predictors, ACLS

- Attributable fraction (%) is the estimated number of deaths due to a specific characteristic.
- Based on strength of association.
- Prevalence of the condition.
Attributable Fractions (%) for All-Cause Deaths
40,842 Men & 12,943 Women, ACLS

Gain in Longevity for a 45-Year Old Male

Comparison of Low, Moderate, and High Fitness Levels

Years of added life

Low vs Moderate: 5.8 years
Low vs High: 8.7 years
Thank you
Questions?