Meeting Physical Activity Guidelines and Knee Osteoarthritis Risk

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Osteoarthritis Action Alliance

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Citation

Osteoarthritis in the US

- Most common type of arthritis
  - 27 million adults
  - A leading cause of disability and pain

- Knee OA affects an estimated 19–27% of adults ages 45 years and older

- Knee pain is reported in almost half of adults ages 50 years and older; an estimated 23% report severe and disabling knee pain

Public Health Implications of OA

- Immobility
- Poor quality of life
- Increasing knee replacements and costs
- Barrier to physical activity
- Affects management of other chronic diseases
Knee OA

Classified on different criteria

- Radiographic OA or ROA
  - 19-27% adults ≥45 years

- Symptomatic ROA
  - Meet radiographic and clinical criteria (i.e., knee pain)

**Kellgren and Lawrence Radiographic Criteria for Assessment of OA***

*Radiography does not reliably correlate with symptoms.*


<table>
<thead>
<tr>
<th>Radiographic grade</th>
<th>0</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Classification</strong></td>
<td>Normal</td>
<td>Doubtful</td>
<td>Mild</td>
<td>Moderate</td>
<td>Severe</td>
</tr>
<tr>
<td><strong>Description</strong></td>
<td>No features of OA</td>
<td>Minute osteophyte; doubtful significance</td>
<td>Definite osteophyte; normal joint space</td>
<td>Moderate joint space reduction</td>
<td>Joint space greatly reduced; subchondral sclerosis</td>
</tr>
</tbody>
</table>
Physical Activity

 CDC Winnable Battle
   Physical activity, nutrition, obesity

 Engaging in physical activity regularly has been shown to offer many benefits:
   Lower risk of early death
   Decrease risk of myocardial infarction, stroke, diabetes, depression
   Increase weight loss (combined with reduced calories)
HHS Physical Activity Recommendations

- **Aerobic physical activity**
  - 150 min/week of moderate
  - or 75 min/week of vigorous
  - or 150 min/week moderate and vigorous

Accessed 03-06-14:
Why study physical activity & knee OA?

- Physical activity has many benefits
- Are there negative effects that can be attributed to physical activity?
- Might physical activity lead to knee OA?
Theoretical Rationale
Physical Activity and Knee OA

Risk of "Poor Outcome"

- Immobile/inactive
- Low to moderate activity
- Optimal Range
- High Activity
- Very High Activity

Optimal Range
Physical Activity and Knee OA

- Complex and not well understood

- Protective?
  - Maintain joint health through cartilage synthesis\(^1\)

- Risk?
  - Injury, or trauma through high impact activities and twisting\(^2\)

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\(^1\) Kim YJ et al. J Biomech 1995; 28(9):1055-1066

## Physical Activity and Incident Knee OA Research

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>n</strong></td>
<td>715</td>
<td>470</td>
<td>354</td>
<td>1279</td>
</tr>
<tr>
<td><strong>Followup</strong></td>
<td>4 y</td>
<td>13 y</td>
<td>5 y</td>
<td>9 y</td>
</tr>
<tr>
<td><strong>Physical Activity</strong></td>
<td>Walk, job, sports</td>
<td>Combined (leisure, job)</td>
<td>Weekly sports ≥10 y</td>
<td>Walking</td>
</tr>
<tr>
<td><strong>Knee Outcome</strong></td>
<td>Osteophytes, JSN</td>
<td>ROA, symptomatic ROA</td>
<td>ROA</td>
<td>ROA, Symptomatic ROA, JSN</td>
</tr>
<tr>
<td><strong>Finding</strong></td>
<td>Walking (JSN) OR=0.4;95% CI:0.2–0.9</td>
<td>High Activity (≥3 hrs/day) a risk factor</td>
<td>Risk factor OR=3.3;95% CI:1.1–9.1</td>
<td>No association</td>
</tr>
</tbody>
</table>
Prior Longitudinal Studies

- Inconsistent findings

- Limitations of these studies:
  - Convenience samples (results not generalizable)
  - Crude measures of physical activity
  - Incident knee OA definitions that did not consider knee symptoms
  - Few confounders considered
Study Objective

Determine the association between baseline physical activity and incident knee OA
Johnston County Osteoarthritis Project Study Sample

Baseline
(1999-2004)
N=2573
Age 45 Years and Older

Completed Follow-up
(2005-2010)
N=1528
Median Follow-up Time
6.5 (Range: 4.0-10.2) years

Lost to Follow-up
(2005-2010)
N=1045
Mortality=358
Moving away=160
Physical or mental obstacles=165
Refusal=139
Lost contact=132
Unknown status=47
No clinic visit =48
Knee Outcome Definitions

- **Knee ROA**
  - Incident K/L ≥2
  - Incident knee replacement

- **Symptomatic Knee ROA (sROA)**
  - Incident ROA and knee symptoms without both ROA and symptoms at baseline
Minnesota Leisure Time Physical Activity Questionnaire

- Minnesota Leisure Time Physical Activity (MLTPA)
- 65 activities
- 10 categories
- Low, moderate, and vigorous physical activity

Minnesota Leisure Time Physical Activity Questionnaire

- MLTPA: 10 categories and 65 activities
  - Walking (n=10)
  - Conditioning exercises (n=5)
  - Swimming (n=9)
  - Winter (n=4)
  - Sports (n=15)
  - Golf (n=3)
  - Lawn and garden (n=6)
  - Home repair activities (n=4)
  - Fishing and hunting (n=5)
  - Other (n=1)
Physical Activity Exposure Categorization

- **Moderate-vigorous activities included**
  - Metabolic equivalent (MET) $\geq 3$, thus, 3 activities excluded

- **Average total min/week over 1 year**

- **Recommend Physical activity level based on HHS guidelines of $\geq 150$ minutes/week**

- **Defined physical activity using the 4 health benefit levels from the HHS Physical Activity Guidelines**
  - Inactive no benefits [0 to 10 minutes/week]
  - Low some benefits [10 to <150 minutes/week], medium
  - Substantial benefits [150 to 300 minutes/week],
  - High additional benefits [300 minutes/week]
Potential Confounders and Effect Modifiers

- **Demographics**
  - Age, sex, race, education

- **Anthropometric**
  - Body mass index (BMI)

- **Medical History**
  - Knee injury

- **Occupational Activity**
Interval Censored Data

- Outcome or failure occurs within a defined interval of time (exact time unknown)
Handling Interval Censored Data

- Parametric survival models can handle interval censoring
  - Parametric refers to data that assumes a probability distribution or a pattern
  - Weibull, exponential, and lognormal probability distributions
Complex Sample Design

- Strata (Townships)
- Primary sampling units (Streets)
- Secondary sampling units (Households)
- Sampling weights at follow-up
  - Blacks oversampled, non-response, and attrition
- Finite Population Correction (FPC)
  - Sampling without replacement
- Jackknife Resampling Method
  - Observations not independent
  - Estimate standard errors

\[ FPC = \sqrt{\frac{N-n}{N-1}}. \]
Analysis

- Stata 11.0

- Characteristics across physical activity levels
  - Independent two-sample t-tests and chi-square tests

- Weibull Parametric Regression
  - Hazard ratios for Interval censored
## Baseline Characteristics by Physical Activity Level (N=1522)

<table>
<thead>
<tr>
<th></th>
<th>Below Recommended Physical Activity (&lt;150 Min/Week)</th>
<th>Recommended Physical Activity (≥150 Min/Week)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall, %</td>
<td>44.1</td>
<td>55.9%</td>
<td></td>
</tr>
<tr>
<td>Age mean (SE), yrs</td>
<td>59.9 (0.5)</td>
<td>59.6 (0.4)</td>
<td>0.62</td>
</tr>
<tr>
<td>White, % Black, %</td>
<td>41.2 55.5</td>
<td>54.9 45.5</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>BMI mean (SE), kg/m²</td>
<td>31.8 (0.3)</td>
<td>30.0 (0.2)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Attended college, %</td>
<td>48.9</td>
<td>51.1</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Did not attend college, %</td>
<td>34.2</td>
<td>65.8</td>
<td></td>
</tr>
<tr>
<td>Prior knee injury, %</td>
<td>44.2</td>
<td>55.8</td>
<td>0.70</td>
</tr>
<tr>
<td>No prior knee injury, %</td>
<td>42.8</td>
<td>57.2</td>
<td></td>
</tr>
</tbody>
</table>
### Meeting physical activity guidelines and the risk of incident knee ROA and sROA: Hazard Ratio (95% CI)

<table>
<thead>
<tr>
<th></th>
<th>Incident knee ROA (N=981)</th>
<th>Incident knee sROA (N=1,114)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meets HHS physical activity guidelines†</td>
<td>1.20 (0.92–1.56)</td>
<td>1.24 (0.87–1.76)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HHS physical activity health benefits level</th>
<th>Incident knee ROA</th>
<th>Incident knee sROA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inactive (0–&lt;10 min)</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Low (10–&lt;150 min)</td>
<td>1.25 (0.75–2.10)</td>
<td>1.07 (0.56–2.05)</td>
</tr>
<tr>
<td>Medium (150–&lt;300 min)</td>
<td>1.14 (0.67–1.97)</td>
<td>1.16 (0.60–2.25)</td>
</tr>
<tr>
<td>High (≥ 300 min) †</td>
<td>1.62 (0.97–2.68)</td>
<td>1.42 (0.76–2.65)</td>
</tr>
</tbody>
</table>

† Adjusted for age, sex, race, BMI, education, prior knee injury, occupational activity activity.
Summary

- Meeting the physical activity guidelines was not associated with incident knee ROA or sROA over 6.5 years

- When analyzed by level of physical activity, high levels (300 minutes/week) were suggestive of an increased risk of knee ROA and sROA
  - Although these differences were not statistically significant
Limitations

- Recall bias for physical activity
  - Non-differential misclassification
  - Results biased to null

- Physical activity was measured at baseline only

- Potential for attrition bias resulting in differential loss to follow-up
Strengths

- Longitudinal study
  - Temporal inferences

- Addressed two major statistical issues:
  - Interval censored data and complex sample design

- Comprehensive physical activity measure (MLTPA)
  - Valid and Reliable (test-retest 0.92)

- Comprehensive Knee OA
  - Clinical and radiological outcomes
Public Health Implications

- These findings and studies in the literature suggest that engaging in moderate levels of physical activity does not increase the risk of knee OA.

- Activities such as walking, conditioning exercises, and household activities (that amount to moderate levels of physical activity) can continue to be encouraged.

- Conversely, we and others found an elevated risk of knee OA outcomes among persons in the highest level of physical activity, so high levels of physical activity may have negative implications.
Questions?

For more information please contact Centers for Disease Control and Prevention

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Telephone, 1-800-CDC-INFO (232-4636)/TTY: 1-888-232-6348
E-mail: cdcinfo@cdc.gov Web: www.cdc.gov

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.