Quadriceps Muscle and Intermuscular Fat Volumes in the Thighs of Men in the OAI are Associated with Physical Function and Knee Pain

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BACKGROUND:

- Individuals with knee OA have lower quad muscle (QM) mass, strength vs. control

- Decreased muscle mass assoc’d with functional limitations, pain

- Muscle mass assessed by volume, cross-sectional area (CSA), MRI and CT

- Adipose tissue can also be quantified

Background:
- Role of adipose tissue in OA not well understood
- With aging, thigh intermuscular fat (IMF) CSA increases in men and women regardless of change in body mass\textsuperscript{7}
- Assoc’n between IMF and physical function and symptoms in people with OA unknown


Objective:
- To investigate the association between mid-thigh QM and IMF volumes and measures of physical performance/function and pain in men participating in the OAI.
METHODS – Participant selection:

- OAI database
  - men ≥50y old
  - BL and 2y thigh MRI scans
  - incidence or progression cohorts (no control)

- Database and images further searched for:
  a) BL and 2y Kellgren-Lawrence (K-L) grades available (BU scoring), AND
  b) matching pixel spacing (BL and 2y), AND
  c) co-registered BL and 2y images (shape & 12 slices)


METHODS – MRI Scans:

- 72 randomly selected scans analyzed
- T1-weighted axial scan
- 5mm slice thickness
- 15 slices
- Most distal slice =10 cm proximal to epiphyseal line of distal femur
- 12 most proximal matching slices segmented
METHODS – Analysing MR Scans:

- Right thighs segmented - SliceOmatic v4.3 (TomoVision, Canada) using watershed algorithm\(^8\)
- Tissues “tagged” using colours
- Segmentation of first slice propagated forward, edited
- Reliability (intra-, inter-rater) ICC>0.98, RMSCV <5\(^8\)


METHODS – MR Scan Data:

- Yellow = IMF (deep to fascia, around muscles)
- Orange = QM
- Fat *within* muscle not segmented separately from muscle
- Volume of each tissue in successive 12 slices determined
METHODS – Dependent Outcomes:

- Data downloaded from OAI database:
  
  **Self-report**
  
  Function:
  - WOMAC Physical Function
  - KOOS Function in Sports and Recreation
  
  Symptoms:
  - WOMAC pain (right knee)

  **Performance**
  - maximum extensor force (right leg)
  - 20 m walk time

METHODS – Analyses:

- Backwards linear regression:

  - QM volume
  - IMF volume
  - Self-reported function, pain
  - Physical performance

- Covariates age, BMI and K-L grade
- SPSS v20
### RESULTS:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean (SD)</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>63.3 (8.1)</td>
<td></td>
</tr>
<tr>
<td>Body Mass Index (kg/m²)</td>
<td>29.8 (4.1)</td>
<td></td>
</tr>
<tr>
<td>K-L Grades (N)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>11</td>
<td>28</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>QM volume (cm³)</td>
<td>362.1 (65.1)</td>
<td></td>
</tr>
<tr>
<td>IMF volume (cm³)</td>
<td>121.4 (35.4)</td>
<td></td>
</tr>
<tr>
<td>WOMAC physical function</td>
<td>8.7 (10.5)</td>
<td>68</td>
</tr>
<tr>
<td>KOOS function sport &amp; rec</td>
<td>62.9 (28.8)</td>
<td>100</td>
</tr>
<tr>
<td>WOMAC pain (right)</td>
<td>2.7 (3.1)</td>
<td>20</td>
</tr>
<tr>
<td>Max. ext. strength (right) (N)</td>
<td>442.1 (138.9)</td>
<td></td>
</tr>
<tr>
<td>20 metre walk time (s)</td>
<td>15.6 (2.3)</td>
<td></td>
</tr>
</tbody>
</table>

### RESULTS:

<table>
<thead>
<tr>
<th></th>
<th>Unstandardized β (p-value)</th>
<th>Standardized β (p-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Self-report</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Function</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WOMAC Phys. Fun.</td>
<td>IMF 0.119 (0.001)</td>
<td>IMF -0.261 (0.030)</td>
</tr>
<tr>
<td>KOOS Sport/Rec</td>
<td>IMF 0.400 (0.001)</td>
<td>IMF -0.330 (0.030)</td>
</tr>
<tr>
<td>Symptoms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WOMAC pain (right)</td>
<td>IMF 0.026 (0.011)</td>
<td></td>
</tr>
<tr>
<td><strong>Performance</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>max ext. force (right)</td>
<td>QM 1.425 (0.001)</td>
<td>IMF 0.650 (0.001)</td>
</tr>
<tr>
<td>20 m walk time</td>
<td>IMF 0.019 (0.013)</td>
<td></td>
</tr>
</tbody>
</table>

Age, BMI, K-L grade covariates not significant
LIMITATIONS:

- Did not assess whether excluded participants were “different” than those included
- Variability in location of thigh ROI
- Unable to measure intramuscular fat
- Data are cross-sectional – no indication of change over time (yet)

DISCUSSION:

- IMF volume significantly, weakly associated with physical function & performance
  - consistent with healthy aging\textsuperscript{10-12}
  - consistent with women
- Knee extensor force
  - not associated with IMF volume\textsuperscript{13}
  - associated with QM volume and CSA\textsuperscript{13}, not K-L grade
- QM not assoc’d with function/performance

FUTURE DIRECTIONS:

- quantify longitudinal changes in IMF and QM volume, compare with women and across K-L grades
- clinical relevance of changes in IMF
- association between IMF and cartilage morphometry, JSN

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