Gender differences in body composition, motor performance and blood biomarkers in older adults

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OUTLINE

- Background
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- Materials and Methods
- Results
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- Acknowledgement
Aging-related changes in skeletal muscle and bone interactions

Aging is associated with a progressive loss of skeletal muscle and bone mass, and strength referred to as sarcopenia and osteopenia, respectively.

**Common factors:**
- **Sarcopenia**
  - ↓ Muscle mass
  - ↓ Muscle strength
  - ↓ Physical performance
- **Osteopenia**
  - ↓ Bone mass
  - ↓ Bone strength
  - ↓ Bone density

**Motor unit remodelling:**
- ↓ Motor unit number
- ↓ Muscle fibre number

**Muscle-tendon unit remodelling:**
- ↓ Tendon stiffness
- ↓ Muscle pennation angle
- ↑ Muscle fascicle length

**Bone remodelling:**
- ↓ Osteoblast activity
- ↑ Osteoclast activity
  - Changes in bone geometry
  - Changes in bone architecture

**Adapted by: Tagliaferr et al., 2015; Demontiero et al., 2014, Lopes et al., 2009**

**Research Objectives**

- To determine gender-specific associations between different diagnostic parameters for sarcopenia and whole-body bone mineral density (WBMD) in healthy older adults.

- To evaluate gender-specific associations of Achilles tendon stiffness and triceps surae muscle architecture with plantarflexor muscle strength and mobility in older adults.

- To evaluate gender differences in circulating markers of bone remodelling in older adults.
MATERIALS AND METHODS

Subjects

- European (EU) cross-sectional ageing study MYOAGE cohort consisted of healthy:
  - older men (OM) and older women (OW) aged 69-81 years (50% women)
  - young men (YM) and young women (YW) aged 18-30 years (52.2% women)
- The study included 454 participants (283 older and 171 young adults) from:
  - Leiden, The Netherlands (75 older and 35 young)
  - Jyväskylä, Finland (65 older and 34 young)
  - Tartu, Estonia (71 older and 39 young)
  - Paris, France (30 older and 35 young)
  - Manchester, UK (42 older and 28 young)
- The subjects were recreationally active, community-dwelling and they had body mass index (BMI) < 30 kg/m².
- All measurements were performed according to standard operating procedures that has been unified at the study centres.
- The study was approved by ethics committees at each institution.

Measurements

- **Body composition and bone mineral density** - by dual energy X-ray absorptiometry (DXA) with a whole–body scan.
- **Triceps surae muscle architecture and Achilles tendon properties** – by ultrasonography
- **Lower extremity motor performance** - by:
  - quadriceps femoris muscle and plantarflexor muscle isometric strength
  - Timed Up and Go test
  - 6 min walk test
- **Blood biomarkers** – by overnight fasting blood samples

Subject characteristics (mean ± SD)

<table>
<thead>
<tr>
<th>Group</th>
<th>Age (years)</th>
<th>Height (m)</th>
<th>Body mass (kg)</th>
<th>BMI (kg/m²)</th>
<th>Body fat (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>OM</td>
<td>74.9 ± 3.3</td>
<td>1.74 ± 0.06</td>
<td>78.3 ± 1.0</td>
<td>25.9 ± 3.1</td>
<td>25.5 ± 0.6</td>
</tr>
<tr>
<td>OW</td>
<td>74.2 ± 3.2</td>
<td>1.61 ± 0.06</td>
<td>64.6 ± 0.9</td>
<td>25.1 ± 3.6</td>
<td>34.6 ± 0.6</td>
</tr>
<tr>
<td>YM</td>
<td>23.6 ± 2.9</td>
<td>1.80 ± 0.06</td>
<td>76.0 ± 1.3</td>
<td>23.3 ± 3.1</td>
<td>16.6 ± 0.7</td>
</tr>
<tr>
<td>YW</td>
<td>23.2 ± 2.8</td>
<td>1.67 ± 0.06</td>
<td>62.2 ± 1.0</td>
<td>22.4 ± 3.0</td>
<td>29.6 ± 0.7</td>
</tr>
</tbody>
</table>

BMI – body mass index
* p<0.05 compared with gender-matched young subjects
# p<0.05 compared with age-matched men


RESULTS

Age-related changes in body composition in men and women

Body mass (kg):
OM = 78.3; YM = 76.0
OW = 64.6; YW = 62.2

ASM – appendicular skeletal muscle mass
ASMI – appendicular skeletal muscle index = ASM/height²

Body fat mass, lean mass and ASM presented in kg.
ASMI presented in kg/m²

Gender differences in body composition characteristics in older adults

ASM – appendicular skeletal muscle mass
ASMI – appendicular skeletal muscle index = ASM/height^2
* p<0.05 compared to age-matched men

Whole body bone mineral density (WBMD) and mineral content (WBMC)

Differences compared to gender-matched young

* p<0.05 compared to gender-matched young

Mean T-score values:
OM: -0.63 (normal)
OW: -1.47 (low or osteopenia), from them 11% osteoporotic (T-score > -2.5)

* p<0.05 compared to age-matched men

Gender differences in older


WBMD associated positively with components of body mass in older

Young men

Older men

Young women

Older women

*p < 0.01; ** p < 0.001.

Values were calculated with linear regression models for the association between components of body mass and WBMD with adjustments for age and country.

Young men

Older men

Young women

Older women

BMD – whole body bone mineral density

WBMD positively associated with diagnostic criterias for sarcopenia in older men and women

*p < 0.01; ** p < 0.001.

ASM – appendicular skeletal muscle mass
ASMI – appendicular skeletal muscle index = \( \frac{\text{ASM}}{\text{height}^2} \)
BMD – whole body bone mineral density
QF – quadriceps femoris muscle

Values were calculated with linear regression models for the association between diagnostic measures for sarcopenia and whole body BMD with adjustments for age and country.
Age-related changes in Achilles tendon stiffness and triceps surae muscle pennation angle in men and women


Gender differences in Achilles tendon stiffness and triceps surae muscle pennation angle in older adults

Regression analysis demonstrated a significant positive association of serum concentration of IGF-1 with quadriceps femoris muscle torque in older men but not in older women

<table>
<thead>
<tr>
<th>Group</th>
<th>B coefficient (95% CI)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>OM</td>
<td>0.67 (0.07 to 1.26) *</td>
<td>0.029</td>
</tr>
<tr>
<td>OW</td>
<td>0.02 (-0.37 to 0.41)</td>
<td>0.912</td>
</tr>
</tbody>
</table>

Adjusted for age, gender, z score of fat mass percentage height and country. Log-transformed data. * p<0.05

Serum concentration of IGF-1 (mean ± SD):
OM = 82.0 ± 51.5 ng/ml; YM = 154.9 ± 82.1; p<0.001
OW = 83.3 ± 41.9 ng/ml; YW = 159.4 ± 85.3; p<0.001

Mobility associated with Achilles tendon stiffness and parameters on triceps surae muscle architecture in older adults

Subjects: 70-81 yrs; n=52; 50% women

TUG – Timed Up and Go test
6mwt – 6 min walk test


Age-related changes in plasma concentration of the circulating markers of bone remodelling

Men
Women

Diskopf-1 Sclerostin Osteopontin Osteocalcin Osteoprotegrin

Bone resorption markers
Bone formation markers

*p<0.05 compared to gender-matched young

Gender differences in plasma concentrations of circulating markers of bone remodelling in older adults

Data are median ± 25th-75th percentiles

* p<0.05 compared to age-matched men


Bone turnover and circulating markers of bone remodelling

Fascilitation of bone formation:
Osteocalcin – released from the bone matrix during bone resorption

Reduction of bone resorption:
Osteoprotegrin – expressed by osteocytes and osteoblasts, can reduce production of osteoclasts

Fascilitation of bone resorption:
Osteopontin – released by osteoblasts, osteocytes and osteoclasts

Reduction of bone formation:
Diskopf-related protein – 1 – released by osteocytes, major non-collagen protein in matrix
Sclerostin – released by osteocytes

## CONCLUSIONS

- Healthy older men and women in this cross-sectional study exhibited significant gender differences in body composition, lower extremity motor performance and blood biomarkers.

- As compared to age-matched men, older women had:
  - ↑ general adiposity;
  - ↓ lean body mass, ASM, WBMC and WBMD;
  - ↓ Achilles tendon stiffness and soleus muscle pennation angle;
  - ↓ QF muscle strength;
  - ↓ plasma concentrations of sclerostin, osteopontin and osteoprotegerin.

- This study demonstrated common and gender-specific associations between different diagnostic parameters of sarcopenia and WBMD in older adults.

- Positively associated in older men and women:
  - WBMD ↔ body mass and body mass components (body fat mass and lean body mass), ASM index, plasma concentrations of discopf-1, sclerostin, osteocalcin and osteoprotegerin.
  - walking speed ↔ Achilles tendon stiffness and plantarflexor muscle strength.

- Positively associated in older men only:
  - QF muscle strength ↔ WBMD and serum concentration of IGF-1
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