

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. control¹⁻³
- Decreased muscle mass assoc'd with functional limitations, pain⁴⁻⁶
- Muscle mass assessed by volume, cross-sectional area (CSA), MRI and CT
- Adipose tissue can also be quantified

¹Ikeda S. Orthop Sci. 2005;10(2):121-6. ²Petterson SC. Med Sci Sports Exerc. 2008;40(3):422-7. ³Liikavainio T. Arch Phys Med Rehabil. 2008;89(11):2185-94. ⁴Berger MJ. Interdiscip Top Gerontol. 2010;37:94-114. ⁵O'Reilly SC. AnnRheumDis. 1998;57(10):588-94. ⁶McAlindon TE. AnnRheumDis. 1993;52(4):258-62.

BACKGROUND:

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- 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 mass⁷
- Assoc'n between IMF and physical function and symptoms in people with OA unknown

⁷Delmonico M. J. Am J Clin Nutr. 2009;90(6):1579-85.

OBJECTIVE:

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- 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:

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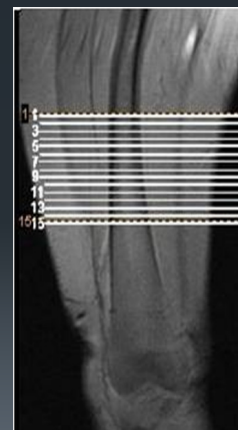
- OAI database
 - ✓ men ≥ 50 y old
 - ✓ BL and 2y thigh MRI scans
 - ✓ incidence or progression cohorts (no control)
- Database and images further searched for⁸:
 - a) BL and 2y Kellgren-Lawrence (K-L) grades available (BU scoring), AND
 - b) matching pixel spacing (BL and 2y), AND
 - c) co-registered BL and 2y images (shape & 12 slices)

⁸Beattie KA, et. al. Arthritis Care Res. 2012;64(1):22-9.

METHODS – MRI Scans:

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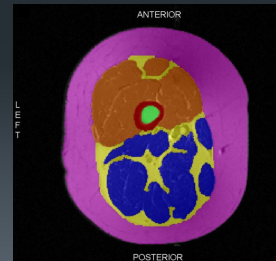
- 72 randomly selected scans analyzed
- T1-weighted axial scan
- 5mm slice thickness
- 15 slices
- Most distal slice = 10 cm proximal to epiphyseal line of distal femur
- 12 most proximal matching slices segmented



METHODS – Analysing MR Scans:

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- Right thighs segmented - SliceOmatic v4.3 (TomoVision, Canada) using watershed algorithm⁸
- Tissues “tagged” using colours
- Segmentation of first slice propagated forward, edited
- Reliability (intra-, inter-rater) ICC>0.98, RMSCV <5%⁸

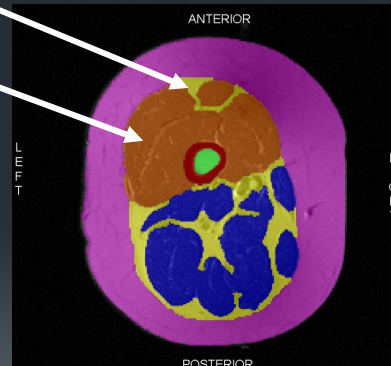


⁸Beattie KA, et. al. Arthritis Care Res. 2012;64(1):22-9.

METHODS – MR Scan Data:

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- 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:

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- 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:

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- Backwards linear regression :

QM volume
IMF volume



Self-reported function, pain
Physical performance

- Covariates age, BMI and K-L grade
- SPSS v20

RESULTS:

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Variable	Mean (SD)	Max.
Age (years)	63.3 (8.1)	
Body Mass Index (kg/m ²)	29.8 (4.1)	
K-L Grades (N)	0	28
	1	12
	2	15
	3	11
	4	6
QM volume (cm ³)	362.1 (65.1)	
IMF volume (cm ³)	121.4 (35.4)	
Self-Report	WOMAC physical function	8.7 (10.5) 68 😞
	KOOS function sport & rec	62.9 (28.8) 100 😊
	WOMAC pain (right)	2.7 (3.1) 20 😞
Performance	Max. ext. strength (right) (N)	442.1 (138.9)
	20 metre walk time (s)	15.6 (2.3)

RESULTS:

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		Unstandardized β (p-value)	Standardized β (p-value)
<u>Self-report</u>			
<u>Function</u>			
WOMAC Phys. Fun.	IMF	0.119	0.400 (0.001)
KOOS Sport/Rec	IMF	-0.261	-0.330 (0.030)
<u>Symptoms</u>			
WOMAC pain (right)	IMF	0.026	0.293 (0.011)
<u>Performance</u>			
max ext. force (right)	QM	1.425	0.650 (0.001)
20 m walk time	IMF	0.019	0.290 (0.013)

Age, BMI, K-L grade covariates not significant

LIMITATIONS:

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- 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:

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- IMF volume significantly, weakly associated with physical function & performance
 - consistent with healthy aging¹⁰⁻¹²
 - consistent with women
- Knee extensor force
 - not associated with IMF volume¹³
 - associated with QM volume and CSA¹³, not K-L grade
- QM not assoc'd with function/performance

¹⁰Goodpaster B. J Appl Physiol. 2001;90:2157-65. ¹¹Visser M. J Am Geriatr Soc. 2002;50:897-904. ¹²Kidde J. Physiother Can. 2009;61:197-209. ¹³Segal NA. PM & R 2011;3(4):314-23. 13.

FUTURE DIRECTIONS:

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- 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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