RSNA Press Release

Hidden Muscle Fat Poses Danger to Heart, Metabolism

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Sebastian Ziegelmayer, M.D.

OAK BROOK, Ill. – Using a deep learning model to analyze the composition of large muscles on MRI, German researchers found that the proportions of intermuscular fat and lean muscle mass were associated with high blood pressure and unhealthy lipid and blood sugar levels. Results of the study were published today in *Radiology*, a journal of the Radiological Society of North America (RSNA).

In the retrospective, cross-sectional study, 11,348 participants (56.9% men, median age 43) without any known pre-existing conditions underwent whole-body MRI at five imaging sites. Using a segmentation algorithm—a method used to divide data into meaningful parts or regions based on shared characteristics—they developed, the researchers quantified the amount of intermuscular adipose tissue, or hidden fat, and functional muscle tissue in the paraspinal muscles that run along the spine between the neck and pelvis. Until recently, measuring these features required a time-intensive manual analysis.

“Skeletal muscle is a major driver of metabolic health, influencing cardiovascular outcomes through multiple pathways, including glucose regulation, energy metabolism, and inflammatory responses, all of which influence cardiovascular health outcomes,” said lead researcher Sebastian Ziegelmayer, M.D., associate professor and attending radiologist at Technical University of Munich.

The participants’ cardiometabolic risk factors were collected as part of a prospective, multicenter population study. Laboratory test results and clinical examinations revealed many had previously undiagnosed conditions: hypertension (16.2%), abnormal blood sugar (8.5%) and unhealthy lipid patterns (45.9%). Lipids are fatty, oily and waxy compounds that perform a number of functions in the body.

“We focused on a healthy population with no known prior disease, and yet we found quite substantial cardiometabolic risk factors in these participants,” Dr. Ziegelmayer said. “We found that the higher the intermuscular fat and the lower the muscle mass, the greater the cardiometabolic risk factors.”

After adjusting for age, sex, physical activity and study site, an increase in intermuscular adipose tissue was associated with a significantly higher odds ratio for high blood pressure (hypertension), abnormal blood sugar, and unhealthy lipid patterns for both sexes. An increase in lean muscle mass was associated with a protective effect against cardiometabolic risk factors only in men.

“For women, we saw that lean muscle mass remained relatively stable until the ages of 40 to 50, after which we observed a substantial decline,” Dr. Ziegelmayer said. “This timing overlaps with the menopausal transition and estrogen reduction, which may partly explain why we found protective associations of lean muscle mass only in men.”

The researchers also found that low physical activity was associated with increased intermuscular adipose tissue and decreased lean muscle mass.

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Dr. Ziegelmayer said the study is an initial step toward establishing an imaging-based biomarker that could identify patients who may be vulnerable to cardiometabolic issues.

Because MRI is already widely used for other clinical purposes, Dr. Ziegelmayer said it could be used opportunistically to augment traditional risk factor screening, providing additional health insights from scans already being performed. He said the approach could help identify high-risk individuals who appear metabolically healthy by conventional standards for early intervention.

"With MRI, we can perform much more complex analysis if we extend this to more advanced sequences," Dr. Ziegelmayer said. "Further exploring this direction holds considerable potential, as muscle composition may not only reflect cardiometabolic health, but health in general."

"Associations of MRI-derived Paraspinal IMAT and LMM with Cardiometabolic Risk Factors: Results from a German Cohort." Collaborating with Dr. Ziegelmayer were Hartmut Häntze, M.Sc., Christian Mertens, M.D., Felix Busch, M.D., Tristan Lemke, M.D., Markus Graf, M.D., Nassir Navab, Ph.D., Shahrooz Faghihroohi, Ph.D., Jakob Nikolas Kather, M.D., Daniel Truhn, M.D., Thomas Kröncke, M.D., Jacqueline Lammert, M.D., Su Hwan Kim, M.D., Benedikt Wiestler, M.D., Jeanette Schulz-Menger, M.D., Annette Peters, Ph.D., Henry Völzke, M.D., Robin Bülow, M.D., Thoralf Niendorf, Ph.D., Hans-Ulrich Kauczor, M.D., Tobias Nonnenmacher, M.D., Tobias Pischon, M.D., Steffen Ringhof, M.D., Christopher L. Schlett, M.D., Jakob Weiß, M.D., Fabian Bamberg, M.D., Ulrike Streit, M.D., Martin Hadamitzky, Marcus R. Makowski, M.D., Lisa Adams, M.D., and Keno Bressem, M.D.

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For patient-friendly information on MRI, visit *RadiologyInfo.org*.

Images (JPG, TIF):

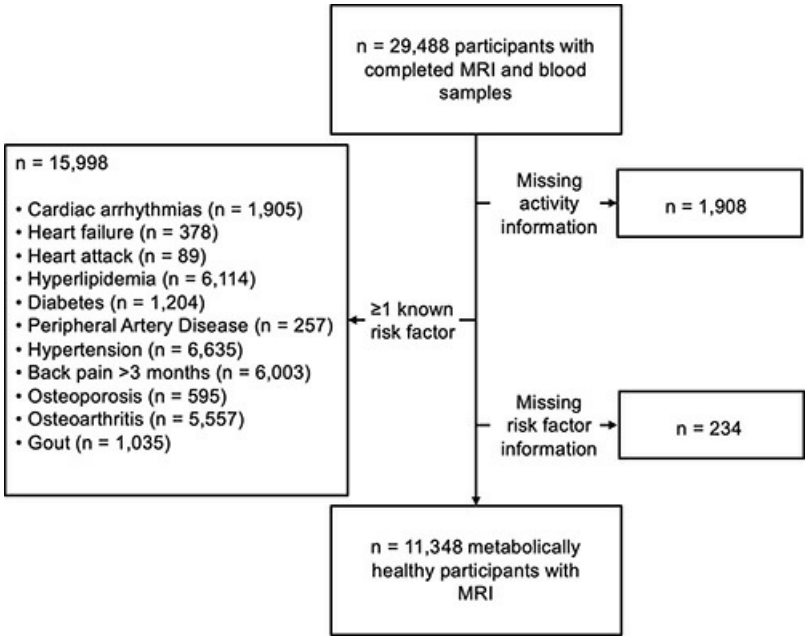


Figure 1. Flow diagram for patient enrollment.

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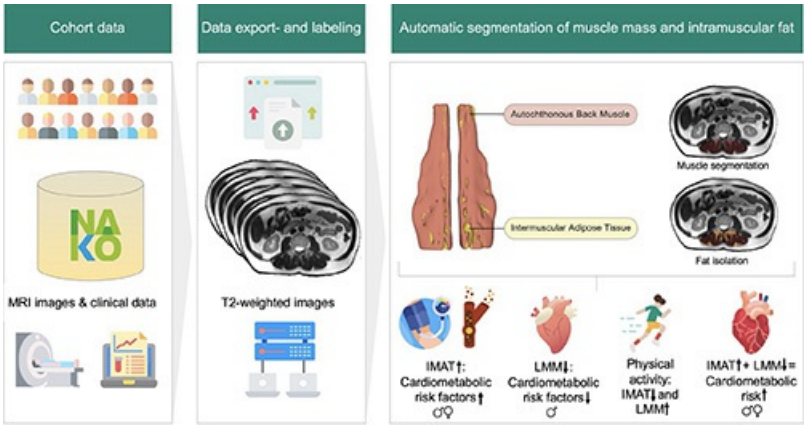


Figure 2. Schematic shows the workflow for lean muscle mass (LMM) and intermuscular fat analysis at MRI in the German National Cohort (NAKO) health study cohort. The cohort data acquisition is the collection of participant data and T2-weighted MRI scans with associated clinical information from NAKO. Data export and labeling is the export and automatic segmentation of muscle composition. The automatic segmentation of muscle mass and intramuscular fat shows associations between imaging biomarkers (intermuscular adipose tissue [IMAT] and LMM) and cardiovascular risk factors. IMAT is linked to hypertension, dysglycemia, and atherogenic dyslipidemia, whereas LMM correlates with cardiometabolic risk factors and physical activity. The combination of IMAT and LMM may provide a comprehensive assessment of cardiometabolic risk.

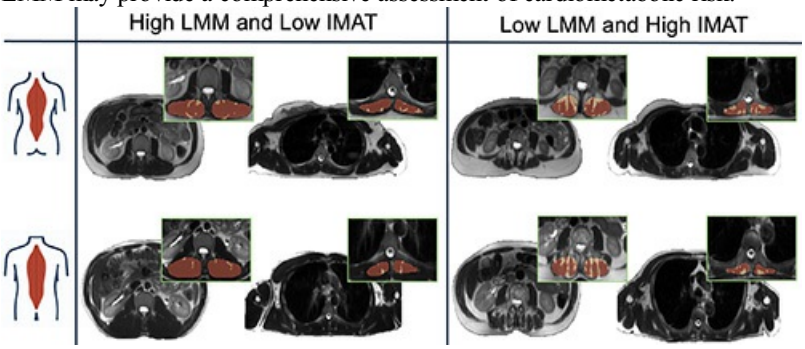


Figure 3. Exemplary cases across four intermuscular adipose tissue (IMAT)–lean muscle mass (LMM) z score combinations. The figure shows four LMM-IMAT combinations in women (top row) and men (bottom row). From right to left, the panels show axial T2-weighted half-Fourier acquisition single-shot turbo spin-echo images of the thoracic and lumbar regions in individuals with high LMM and low IMAT and with low LMM and high IMAT. Participants were randomly selected from the highest or lowest quartile of each respective LMM-IMAT combination and were of similar age (44 years ± 2 [SD]) and body mass index in weight in kilograms divided by height in meters squared (21 ± 2). Segmentation masks for intermuscular fat and lean muscle are displayed in the top right corner of each region.

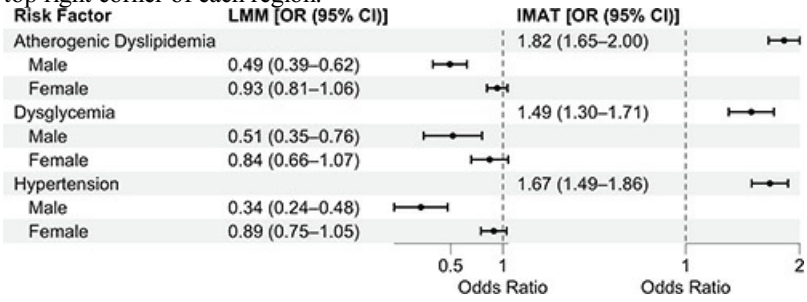


Figure 4. Forest plot shows the risk factor associations for intermuscular adipose tissue (IMAT) and lean muscle mass (LMM). Displayed are the sex-stratified odds ratios (ORs) and CIs for all cardiometabolic risk factors for LMM and IMAT. Greater IMAT was associated with increased odds of hypertension, dysglycemia, and atherogenic dyslipidemia, with no evidence of sex interaction. However, LMM showed sex-specific associations. In men, higher LMM was associated with lower odds in all cardiometabolic risk factors, whereas in women, the associations were weaker and not statistically significant.

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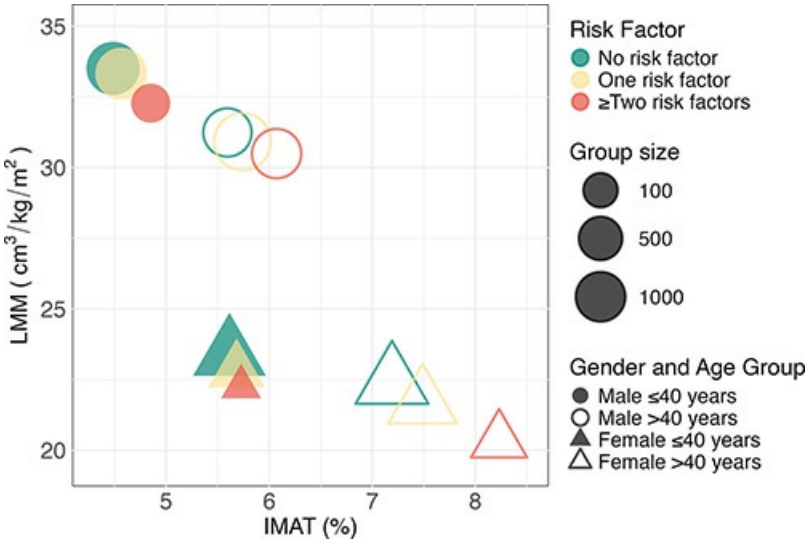


Figure 5. Presence or absence of risk factors for age- and sex-defined groups. The plot shows the presence or absence of risk factors for age- and sex-defined groups. Regardless of age- and sex-related variation in intermuscular adipose tissue (IMAT) and lean muscle mass (LMM), an increase in IMAT and a decrease in LMM with increasing risk factor count are shown.

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