RSNA Radiological Society of North America
RADIOLOGICAL SOCIETY OF NORTH AMERICA
820 JORIE BLVD, OAK BROOK, IL 60523
TEL 1-630-571-2670 FAX 1-630-571-7837
RSNA.ORG
NEWS

PRECISION IMAGING OF SEX-SPECIFIC ADAPTATION IN GLUTEUS MAXIMUS MORPHOLOGY AND TYPE-2 DIABETES: A LARGE-SCALE MRI STUDY

PURPOSE

The gluteus maximus (GM) is one of the body's largest muscles, playing a key role in bipedal motion and metabolic health. MRI studies often focus on measuring its volume or fat infiltration. Statistical shape analysis characterizes tissue morphology and localizes shape variation via statistical parametric maps (SPMs), independent of volume. While widely used for internal organs, its application to skeletal muscle, especially the GM, remains limited. This study uses UK Biobank MRI data to examine how sex-specific GM morphology is related to body measures and type 2 diabetes (T2D).

METHODS AND MATERIALS

MRI scans were acquired using a Siemens Aera 1.5T scanner, with imaging protocols reported previously. GM was segmented from 61,290 UK Biobank Dixon MRI scans using a deep-learning pipeline trained on 158 manual annotations (Dice = 0.94), with quality visually validated at multiple stages by experienced analysts. Predictors of GM measures were identified using least absolute shrinkage and selection operator regression with stability selection across 86 variables (demographics, biomarkers, and diseases). Population-based templates were built for left/right GM in 300 men and 300 women, then registered to individual segmentations using affine and non-rigid registration to propagate standardized surface meshes (~15,000 vertices) with anatomical correspondence. Surface-to-surface (S2S) distance quantified shape variation as vertex-wise deviations from the template mesh, in millimeters, with positive values for outward expansion and negative for shrinkage. Mass univariate regression with correction for multiple testing identified variables associated with S2S variation.

RESULTS

GM shape exhibited outward S2S deformation in the anterior to posterior view with BMI, alcohol intake, physical activity, and grip strength, and an inward deformation with age, frailty, osteoporosis, and sedentary time ($P<0.05$). In men, T2D was associated with focal areas of inward S2S deformation (median S2S:-0.41mm for right and -0.39mm for left GM, $P<0.05$), suggesting atrophic changes. In contrast, women with T2D exhibited focal outward deformation (median S2S: 0.45mm for right and 0.49 mm for left GM, $P<0.05$), suggesting fatty hypertrophy.

CONCLUSIONS

This study highlights the value of automated MRI-based 3D phenotyping for musculoskeletal analysis, with SPMs revealing distinct, sex-specific GM morphological signatures associated with T2D, potentially reflecting divergent phenotypes of metabolic dysfunction.

CLINICAL RELEVANCE/APPLICATIONS

Sex-specific GM shape changes in T2D may indicate early functional decline and metabolic compromise, reflecting local differences in response to insulin tolerance that require further investigation.