RSNA Press Release

Hidden Fat in Your Body Type May Put You at Greater Brain Risk

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Kai Liu, M.D., Ph.D.

OAK BROOK, Ill. (January 27, 2026) – The effect of obesity on brain health may depend not only on how much fat is in the body, but also on the areas of the body where fat is stored, according to a study published today in *Radiology*, the flagship journal of the Radiological Society of North America (RSNA).

Researchers at The Affiliated Hospital of Xuzhou Medical University in Xuzhou, China described two previously unidentified fat distribution types on MRI that show the strongest associations with adverse brain and cognitive outcomes: a “pancreatic predominant” type, which shows a markedly high concentration of fat in the pancreas compared with other areas of the body, and a “skinny fat” type, which has a high fat burden despite not fitting the typical patterns of high obesity.

While previous research has established a link between obesity and brain/cognitive health, particularly in people with higher ratios of visceral fat, this new study focuses on the specific risks associated with specific fat distribution patterns, explained study coauthor Kai Liu, M.D., Ph.D., an associate professor in The Affiliated Hospital’s Department of Radiology.

“Our work leveraged MRI’s ability to quantify fat in various body compartments, especially internal organs, to create a classification system that’s data-driven instead of subjective,” Dr. Liu said. “The data-driven classification unexpectedly discovered two previously undefined fat distribution types that deserve greater attention.”

The researchers used data from 25,997 individuals in the UK Biobank database, which houses anonymized medical imaging measurements alongside volunteers’ physical measurements, demographics, disease biomarkers, medical history and answers to lifestyle questionnaires. This allowed the team to compare brain health outcomes with patterns of body fat distribution.

Of the body fat profiles the team identified, “pancreatic-predominant” and “skinny fat” profiles were most associated with extensive gray matter atrophy, accelerated brain aging, cognitive decline and increased risk of neurological disease. These risks were present in both men and women, with nuanced variations between the sexes.

Individuals with “pancreatic-predominant” distribution patterns showed a proton density fat fraction—an MRI marker that provides a precise estimation of fat concentration in tissue—of around 30 percent in the pancreas.

“This level is about two to three times higher than that of other fat distribution categories, and it can be up to six times higher than that of lean individuals with low overall fat,” Dr. Liu said. “Additionally, this group tends to have a higher BMI and overall body fat load.”

Interestingly, however, these individuals didn’t have significantly pronounced liver fat compared to those with other profiles. High pancreatic fat accompanied by relatively low liver fat emerges as a distinct, clinically overlooked phenotype, Dr. Liu noted.

“In our daily radiology practice, we often diagnose ‘fatty liver,’” Dr. Liu said. “But from the perspectives of brain structure, cognitive impairment and neurological disease risk, increased pancreatic fat should be recognized as a potentially higher-risk imaging phenotype than fatty liver.”

Individuals with “skinny fat” profiles show the highest fat burden in nearly all areas except the liver and pancreas. Unlike a balanced “high obesity” profile, “skinny fat” tends to be more concentrated in the abdomen.

“Most notably, this type does not fit the traditional image of a very obese person, as its actual average BMI ranks only fourth among all categories,” explained Dr. Liu. “The increase is perhaps more in fat proportion. Therefore, if one feature best summarizes this profile, I think, it would be an elevated weight-to-muscle ratio, especially in male individuals.”

In this study, the research team focused specifically on the neurological and brain cognitive risks associated with different fat distribution patterns. As for risks in other areas, such as cardiovascular or metabolic health, Dr. Liu noted that more research is needed to determine how these patterns could be related.

Understanding the risks associated with specific fat distribution patterns can help health care providers guide more personalized treatment and help patients keep their brains healthier. As Dr. Liu explained, “Brain health is not just a matter of how much fat you have, but also where it goes."

“Association of Body Fat Distribution Patterns at MRI with Brain Structure, Cognition, and Neurological Diseases.” Collaborating with Dr. Liu were Miao Yu, M.D., Libin Yao, M.D., Sanjeev Shahi, M.M., Yingqianxi Xu, M.M., Meizi Li, M.M., Qingtong Zheng, M.M., Di Ma, M.M., Qi Zhang, M.M., Dan Wang, B.M., Yang Wu, B.M., Xiao Zhou, B.M., Haitao Ge, Ph.D., Chunfeng Hu, M.D., and Yanjia Deng, M.D., Ph.D.

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Images (JPG, TIF):

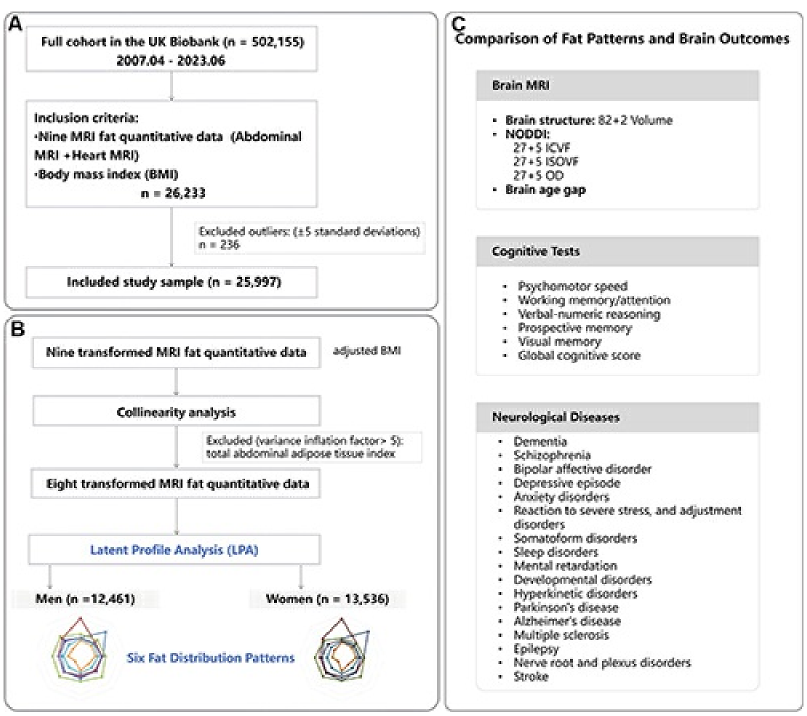

Figure 1: Participant selection and study design. **(A)** Flow diagram of the participant selection process in UK Biobank. **(B)** Nine quantitative MRI-derived adipose measurements were extracted from the UK Biobank. Following adjustment for body mass index (BMI) and collinearity analysis, eight adipose parameters were retained for latent profile analysis (LPA). Sex-specific clustering yielded six distinct fat distribution patterns in male and female participants. **(C)** These patterns were subsequently analyzed for associations with brain structural metrics, neurite orientation dispersion and density imaging (NODDI) parameters, brain age gap, cognitive performance measures, and neurologic diseases. ICVF = intracellular volume fraction, ISOVF = isotropic or free water volume fraction, OD = orientation dispersion index.

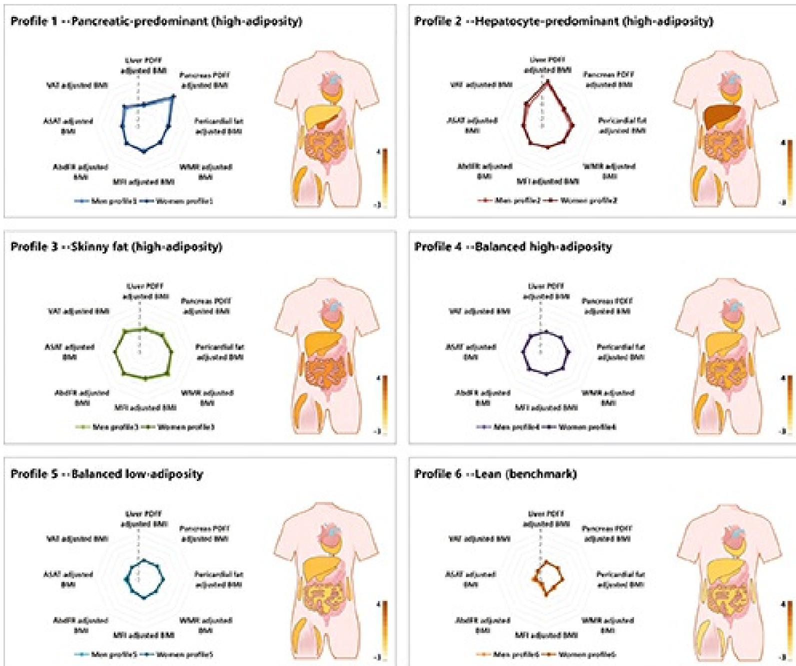

Figure 2: Latent profile analysis identified six profiles of body fat distribution with distinct body mass index (BMI)–adjusted MRI fat quantitation in eight depots. The defining features of each profile are as follows. Profile 1 is pancreatic predominant (elevated pancreatic proton density fat fraction [PDFF]). Profile 2 is hepatocyte predominant (elevated hepatic proton density fat fraction). Profile 3 is skinny fat (elevated visceral adipose tissue [VAT], abdominal fat ratio [AbdFR], and weight-to-muscle ratio [WMR], representing the highest overall adiposity burden despite moderate BMI). Profile 4 is balanced high adiposity (uniform fat distribution across all depots with elevated burden of adiposity compared with the average level). Profile 5 is balanced low adiposity (uniform fat distribution across all depots with decreased burden of adiposity compared with the average level). Profile 6 is lean (lowest fat content in all depots, particularly in abdominal depots). The color scale of the depots and organs in the illustrations represents the BMI-adjusted standardized z scores of the fat parameters, with darker shades indicating higher values. ASAT = abdominal subcutaneous adipose tissue, MFI = muscle fat infiltration.

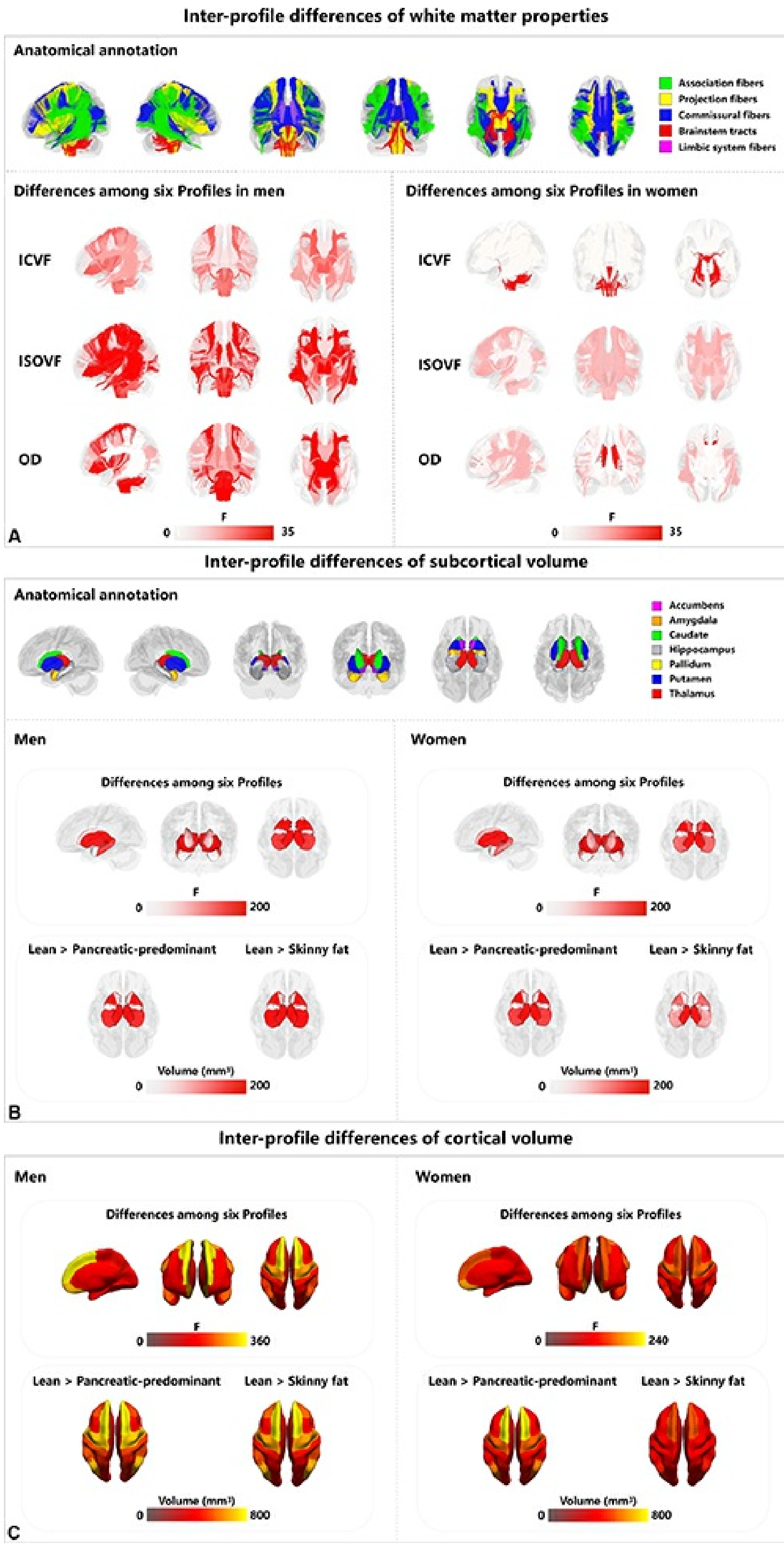

Figure 3: Group comparisons reveal differences across the six profiles in **(A)** brain white matter properties, **(B)** subcortical volume, and **(C)** cortical volume. **(A)** Five types of white matter fibers in the brain are shown (top). Sex-specific analysis shows differences among the six profiles in neurite orientation dispersion and density imaging (NODDI) measurements of intracellular volume fraction (ICVF), isotropic or free water volume fraction (ISOVF), and orientation dispersion index (OD), presented separately for male participants (bottom left) and female participants (bottom right). **(B)** Seven subcortical areas are shown (top). Sex-specific analysis shows overall interprofile differences in subcortical volume among the six fat distribution profiles (middle) and comparisons of two high-risk profiles (pancreatic predominant and skinny fat) against the benchmark profile (lean) (bottom). **(C)** Sex-specific analysis shows overall interprofile differences in cortical volume among the six fat distribution profiles (top)

and comparisons of two high-risk profiles (pancreatic predominant and skinny fat) against the benchmark profile (lean) (bottom). For the diagrams showing the differences among the six profiles, the color scale indicates the F value. For the diagrams showing the mean difference between high-risk profiles and the benchmark profile, the color scale indicates the regional volume in the high-risk profile compared with the benchmark profile.

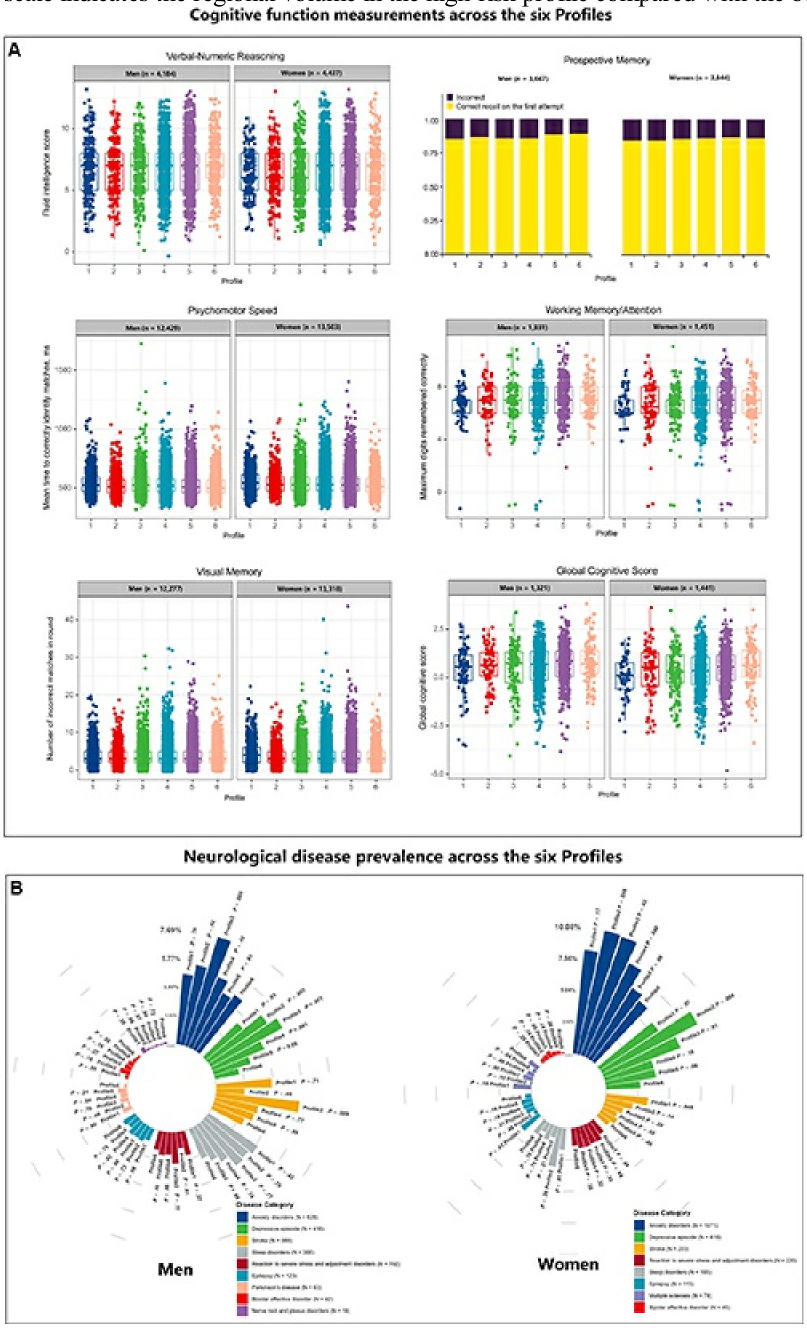

Figure 4: Cognitive performance and risk of neurologic disorders among six fat distribution profiles. **(A)** Plots for six cognitive function measurements. Data are presented separately for male and female participants, and colors correspond to individual profiles. In the box and whisker plots, the box indicates the IQR, the center line indicates the median, whiskers indicate 1.5 times IQR, and dots represent the cognitive scores of individual participants. Prospective memory is plotted in stacked bar plots. Sample sizes for each cognitive test are annotated on the plots, as they varied across tests due to missing data. **(B)** Circular barplots show neurologic disease prevalence across fat distribution profiles for male participants (left) and female participants (right). Elevated rates of anxiety, depression, and stroke are observed in specific profiles.

Resources:

[Abstract link]