

**SUPPLEMENTARY MATERIAL**

**Supplementary Table S1.** Indicators selected for developing the brain age model

Indicators	Explanations	Coefficient
Intercept	/	46.96821896
A	maximum width of the frontal horns	-0.32239863
D	skull width at the same level (frontal horns)	-1.21952626
B	minimum width of the lateral ventricles	0.68702558
E	skull width at the same level (lateral ventricles)	-1.44806101
C	width of the third ventricle	0.73629074
F	skull width at the same level (third ventricle)	-1.62765432
G	maximum width of the skull	-1.20323171
H	width of the lateral ventricles	-0.49937827
I	the choroid plexuses distance	-0.76690965
J	width of the fourth ventricle	-0.63398516
FI	width of the longitudinal cerebral fissure in the anterior part	0.08184237
ICR	width of the right insular cisterns	-0.25489171
ICL	width of the left insular cisterns	1.80324723
SW	greatest width of the cerebral sulci at the skull vault	1.25166406
CFW	greatest width of the cerebellar fissures	1.73562135
O	temporal horn diamete	-0.52862717
P	suprasellar cistern width	0.43267614
Bicaudate index	B/E	1.28067551
Bifrontal index	A/D	0.57087919
Evans index	A/F	0.85895920
Cella index	C/F	1.16221018
Celda Media index	G/H	0.12561976
Ventricular index	B/A	1.08961937
Hackman number	A+B	0.16895929

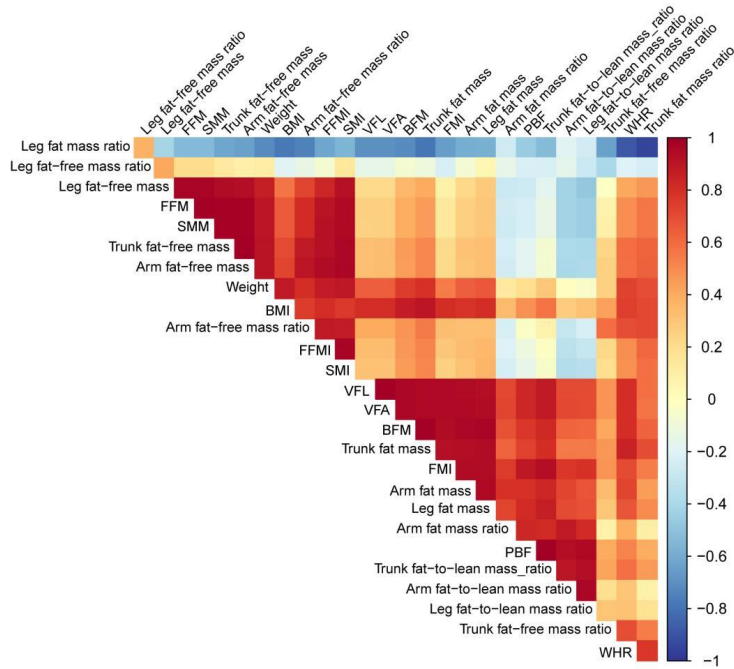
**Note.** In developing the brain age model via ridge regression, the regularization parameter ( $\lambda = 1.65$ ) was determined through ten-fold cross-validation.

**Supplementary Table S2.** Descriptive statistics of body composition indicators

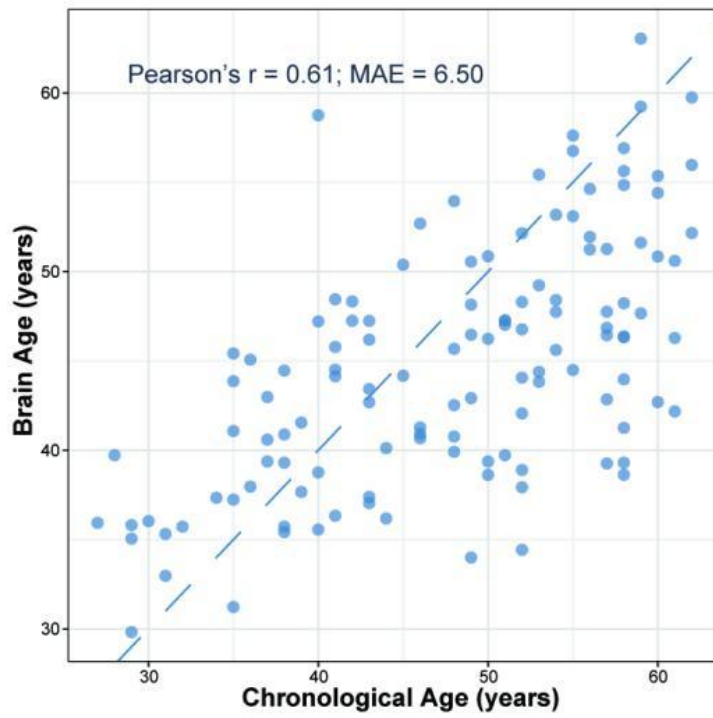
Indicators	Explanations/Construction formulas	Median (IQR)	Units
Weight	/	63.90 (55.70, 74.25)	kg
BMI	body mass index = weight / height <sup>2</sup>	23.80 (21.30, 26.30)	kg/m <sup>2</sup>
PBF	percentage of body fat mass	27.90 (24.00, 32.50)	/
WHR	waist-hip ratio = waist circumference / hip circumference	0.8900 (0.8600, 0.9300)	/
VFL	visceral fat level	8.00 (5.50, 10.00)	/
VFA	visceral fat area	80.90 (59.95, 101.15)	cm <sup>2</sup>
BFM	body fat mass	18.30 (14.10, 21.90)	kg
FMI	fat mass index = body fat mass / height <sup>2</sup>	6.70 (5.30, 8.10)	kg/m <sup>2</sup>
FFM	fat-free mass	46.00 (39.30, 53.80)	kg
FFMI	fat-free mass index = fat-free mass / height <sup>2</sup>	17.00 (15.40, 18.65)	kg/m <sup>2</sup>
SMM	skeletal muscle mass	25.40 (21.15, 31.10)	kg
SMI	skeletal muscle index = appendicular skeletal muscle mass / height <sup>2</sup>	7.10 (6.20, 7.90)	kg/m <sup>2</sup>
Arm fat mass	(right arm fat mass + left arm fat mass) / 2	1.15 (0.85, 1.45)	kg
Leg fat mass	(right leg fat mass + left leg fat mass) / 2	2.70 (2.20, 3.15)	kg
Trunk fat mass	/	9.30 (7.00, 11.60)	kg
Arm fat-free mass	(right arm fat-free mass + left arm fat-free mass) / 2	2.48 (1.90, 3.04)	kg
Leg fat-free mass	(right leg fat-free mass + left leg fat-free mass) / 2	7.10 (5.98, 8.40)	kg
Trunk fat-free mass	/	21.20 (17.60, 24.60)	kg
Arm fat mass ratio	arm fat mass / body fat mass	0.0651 (0.0595, 0.0692)	/
Leg fat mass ratio	leg fat mass / body fat mass	0.1489 (0.1410, 0.1581)	/
Trunk fat mass ratio	trunk fat mass / body fat mass	0.5110 (0.4891, 0.5285)	/
Arm fat-free mass ratio	arm fat-free mass / fat-free mass	0.0531 (0.0487, 0.0565)	/
Leg fat-free mass ratio	leg fat-free mass / fat-free mass	0.1535 (0.1489, 0.1588)	/
Trunk fat-free mass ratio	trunk fat-free mass / fat-free mass	0.4544 (0.4433, 0.4640)	/
Arm fat-to-lean mass ratio	arm fat mass / arm fat-free mass	0.4854 (0.3446, 0.6562)	/
Leg fat-to-lean mass ratio	leg fat mass / leg fat-free mass	0.3728 (0.3028, 0.4620)	/
Trunk fat-to-lean mass ratio	trunk fat mass / trunk fat-free mass	0.4422 (0.3507, 0.5386)	/

**Note.** Variables were described as median (interquartile range, IQR). Units were listed in the "Units" column, and "/" indicated no units.

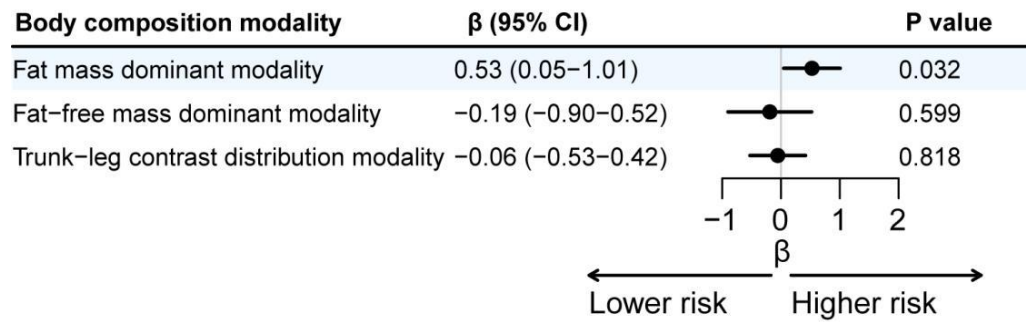
### Correlation Heatmap of Body Composition Indicators



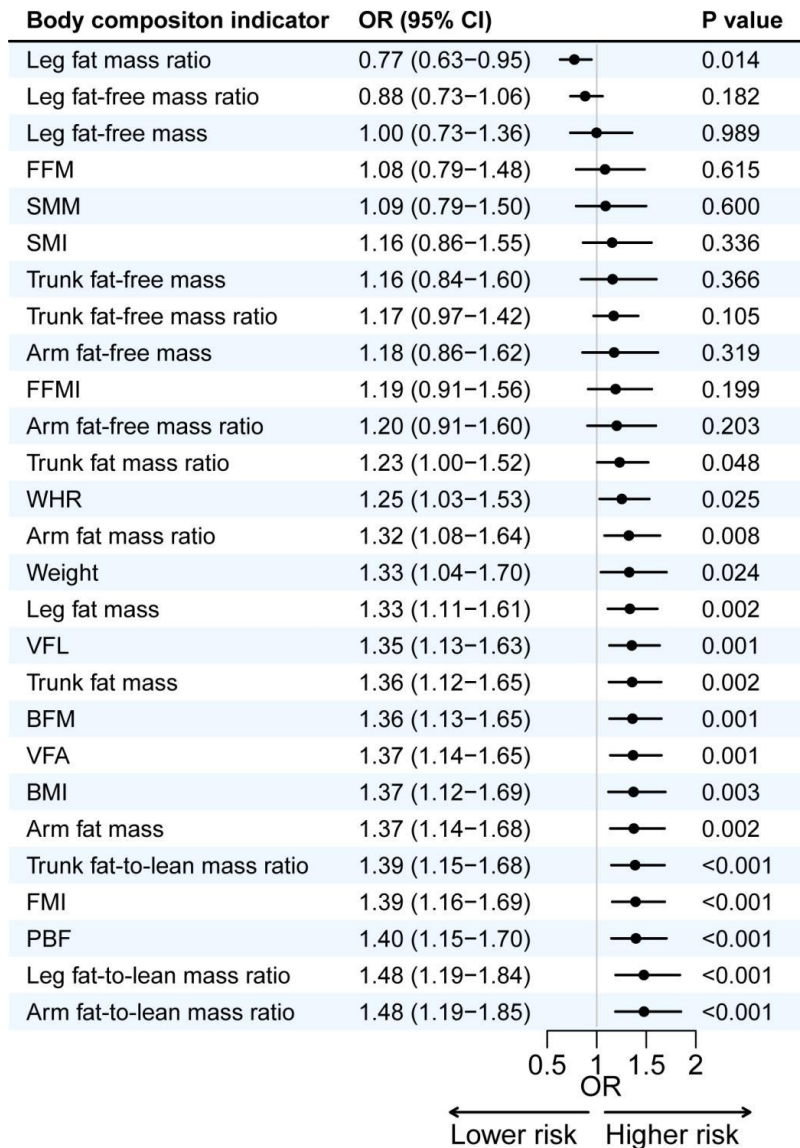
**Supplementary Figure S1.** Correlation heatmap of body composition indicators. This heatmap displays the Pearson correlation coefficients among the 27 body composition indicators. Warmer colors (red) indicate positive correlations, and cooler colors (blue) indicate negative correlations. The heatmap reveals distinct blocks of highly inter-correlated variables, the strong covariance structure confirms that the data is well-suited for principal component analysis (PCA) to identify underlying body composition modalities.



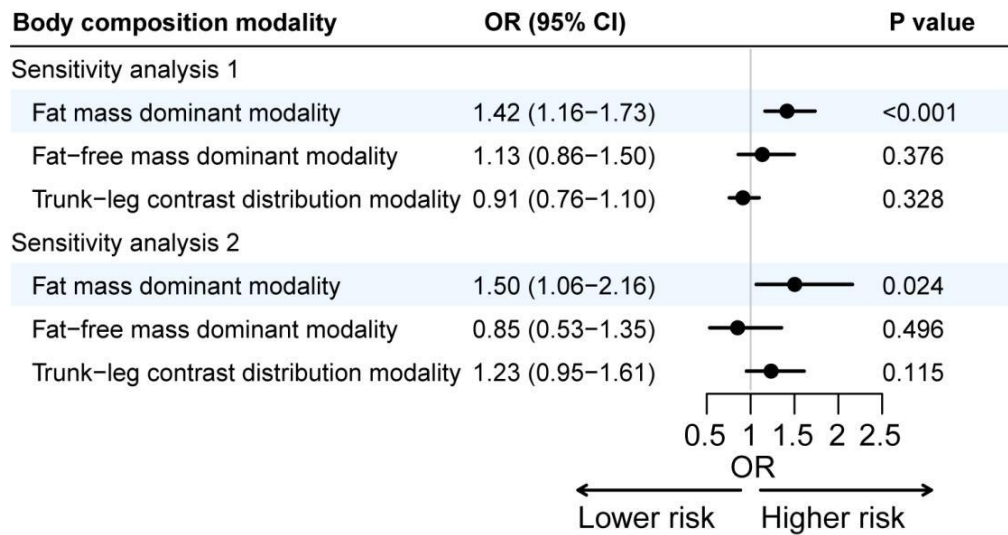
**Supplementary Figure S2.** The predictive performance of the MRI-derived brain age model in JASHA. MAE, mean absolute error; JASHA, the ZheJiang longitudinal Study of Healthy Aging.



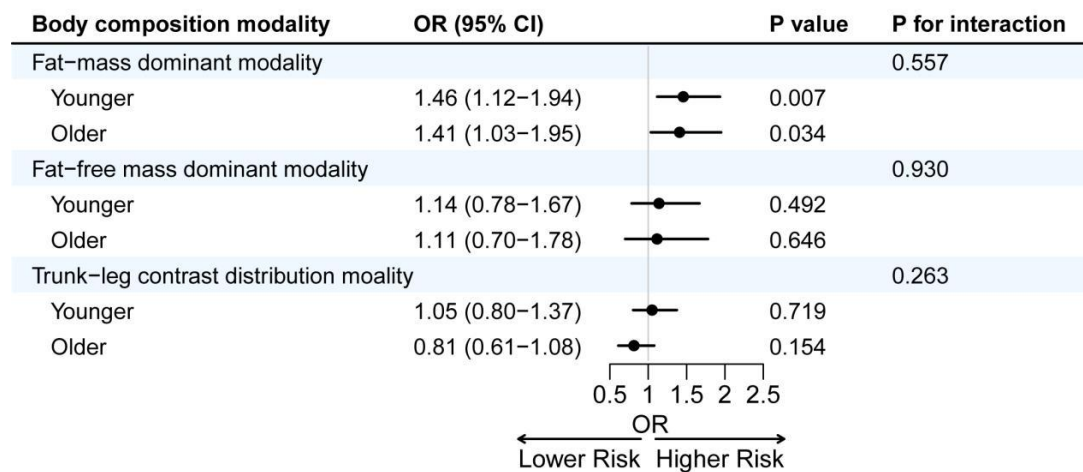
**Supplementary Figure S3.** Associations between body composition modalities and brain age gap (in continuous variable). This forest plot shows the association between body composition modalities and the brain age gap as a continuous variable, using multiple linear regression analysis. All estimates were from the fully adjusted model, which adjusted for age, sex, marital status, smoking and drinking statuses, educational attainment, occupation, monthly household income, physical activity, and disease histories (diabetes, hypertension, hyperlipidemia, stroke, and psychological disorders).  $\beta$ , beta coefficients; CI, confidence interval.



**Supplementary Figure S4.** Associations between individual body composition indicators and brain age gap groups. All models were adjusted for age, sex, marital status, smoking and drinking statuses, educational attainment, occupation, monthly household income, physical activity, and disease histories (diabetes, hypertension, hyperlipidemia, stroke, and psychological disorders). OR, Odds Ratio; CI, confidence interval.



**Supplementary Figure S5.** Sensitivity analysis for the associations between body composition modalities and brain age gap groups. Sensitivity analysis 1, further adjusted for cognitive function (i.e., MoCA) score based on Model 3. Sensitivity analysis 2, repeated the main analyses after excluding participants with disease histories of diabetes, hypertension, hyperlipidemia, stroke, and psychological disorders. OR, Odds Ratio; CI, confidence interval.



**Supplementary Figure S6.** Associations between body composition modalities and brain age gap groups, stratified by age group. Participants were stratified into younger and older groups based on the median age of the cohort. All estimates were from the fully adjusted model, which adjusted for age, sex, marital status, smoking and drinking statuses, educational attainment, occupation, monthly household income, physical activity, and disease histories (diabetes, hypertension, hyperlipidemia, stroke, and psychological disorders). “P for interaction” tests whether the association between each modality and brain age gap groups significantly differs between the two age groups. OR, Odds Ratio; CI, confidence interval.