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NEWS

Higher Weight and Body Mass Index Are Associated with Poor Brain Health in U.S. Children

PURPOSE

We aimed to investigate the relationship of pre-adolescents' weight and Body Mass Index (BMI) with microstructural, morphological, and functional brain magnetic resonance imaging (MRI) metrics.

METHODS AND MATERIALS

We evaluated baseline information of the Adolescent Brain Cognitive Development (ABCD) study that included 11,878 children aged 9-10 years from 21 centers across the U.S. to represent the national sociodemographic diversity. Inclusion required complete anthropometric and MRI data and absence of neurodevelopmental/psychiatric diseases or traumatic brain injury. T1- and T2-weighted structural MRI, diffusion tensor imaging, resting-state fMRI, and Restriction Spectrum Imaging were quantified in a region-of-interest (ROI) based approach. Separate generalized linear models determined the association of weight and BMI-z-scores with different imaging metrics after correction for age, gender, race/ethnicity, handedness, and parental education (as a surrogate for socioeconomic status). We analyzed the average fractional anisotropy (FA), mean (MD), axial (AD) and radial diffusivity (RD), and neurite density (ND) of 35 white matter (WM) tracts; cortical thickness and surface of 68 regions; and functional connectivity of 91 pre-defined network correlations.

RESULTS

5169 children (51.9% females) were included. According to the BMI-z-scores, the overweight and obesity rate were 21.0% and 17.6%, respectively. Higher weight and BMI-z-scores were associated with lower FA values in 16 and 25 tracts, higher FA values in 1 and no tracts, lower AD values in 23 and 30 tracts, higher RD values in 5 and 10 tracts, lower RD values in 3 and no tracts, lower ND values in 11 and 13 tracts, and higher ND values in 5 and 1 tracts, respectively. For both weight and BMI-z-scores, FA reductions were most pronounced in the corpus callosum (adjusted $p < 0.00000001$), fornix (adjusted $p < 0.000001$), and (parietal and temporal) superior longitudinal fasciculus (adjusted $p < 0.001$). Within all of these tracts, we observed higher RD and lower AD values which were significant for most of these ROIs. With increased weight and BMI-z-scores, we observed thinning of 63 and 54 cortical regions; higher surface area of 52 and 26 cortical regions; and significant disruptions in 37 and 31 inter- and intra-network correlations, respectively.

CONCLUSIONS

Higher weight in childhood is associated with worse brain white matter microstructural integrity, reduced cortical grey matter thickness, and decreased functional connectivity.

CLINICAL RELEVANCE/APPLICATIONS

Our findings highlight the neurodevelopmental implications of pre-adolescents' obesity and overweight and point to the need for targeting brain health indicators early on during childhood.