Multimodal Structural Neuroimaging Markers of Brain Development and ADHD Symptoms

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Abstract

OBJECTIVE: Attention deficit hyperactivity disorder (ADHD) is a multifactorial disorder with diverse associated risk factors and comorbidities. In this study, the authors sought to understand ADHD from a dimensional perspective and to identify neuroanatomical correlates of traits and behaviors that span diagnostic criteria.

METHODS: Multimodal neuroimaging data and multi-informant cognitive and clinical data were collected in a densely phenotyped pediatric cohort (N=160; 70 with ADHD; age range, 9-12 years). Multivariate analysis identified associations between clinical and cognitive factors and multimodal neuroimaging markers (across tissue volume, cortical thickness, cortical area, and white matter microstructure). The resulting imaging markers were validated in an independent cohort (N=231; 132 with ADHD; age range, 7-18 years).

RESULTS: Four novel patterns of neuroanatomical variation that related to phenotypic variation were identified. The first imaging pattern captured association of head size with sex, socioeconomic status, and mathematics and reading performance. The second pattern captured variation associated with development and showed that individuals with delayed development were more likely to be receiving ADHD medication. The third pattern was associated with hyperactivity, greater comorbidities, poorer cognition, lower parental education, and lower quality of life. The fourth pattern was associated with a particular profile of poorer cognition and irritability independent of ADHD. The authors further demonstrated that these imaging patterns could predict variation in age and ADHD symptoms in an independent cohort.

CONCLUSIONS: The findings suggest that ADHD presentation may arise from a summation of several clinical, developmental, or cognitive factors, each with a distinct neuroanatomical foundation. This informs the neurobiological foundations of ADHD and highlights the value of detailed phenotypic data in understanding the neurobiology underlying neurodevelopmental disorders.