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全面性发育迟缓（global developmental delay, GDD）是一种发生在五岁以下儿童的神经发育障碍性疾病，定义为存在两项或两项以上发育里程碑的显著延迟，包括粗大运动或精细动作、语言、认知、社交和日常生活活动。GDD的患病率约为1%~3%，其病因复杂，涉及多种因素相互作用，使得诊断、干预和预后评估面临极大挑战。缺乏早期诊断和干预可能导致GDD儿童进一步发展为智力障碍，严重影响日常生活和社会交往。

目前，临床上对GDD儿童的诊断评估主要依赖发育量表，但这种方法主观性较强，可能导致评估结果不准确。同时，目前尚缺乏针对GDD的特异性生物标志物。因此，研究GDD儿童的脑微结构以期开发出定量诊断的神经生物标志物具有重要意义。

扩散峰度成像（diffusion kurtosis imaging, DKI）是一种定量磁共振成像技术，能够模拟复杂结构中的微环境，在检测神经组织发育和生理机制变化方面表现出较高的敏感性和特异性。基于束的空间统计学方法（tract-based spatial statistics, TBSS）是一种针对全脑白质进行空间统计分析的方法，能够避免手动勾画感兴趣区导致的测量偏差。

本研究收集了所有受试者的临床资料和DKI扫描数据，采用两独立样本t检验和χ^2检验比较两组在年龄和性别上的差异，并使用TBSS方法分析DKI参数在GDD儿童和健康对照儿童之间的差异。此外，使用Spearman相关分析探索有显著组间差异白质脑区内DKI参数值与Gesell发育诊断量表的相关性。结果表明，与健康对照组相比，GDD儿童的平均扩散率（mean diffusivity, MD）和径向扩散系数（radial diffusivity, RD）显著升高，而径向峰度（radial kurtosis, RK）显著降低，受影响的白质脑区包括丘脑前辐射、皮质脊髓束、下额枕束、上纵束、下纵束和钩状束等。此外，相关性分析显示RK参数值与GDD儿童的神经发育水平相关。DKI技术能够检测到GDD儿童大脑白质纤维束微结构的异常，有助于发现GDD的潜在神经生物标志物。详见内文第19页。

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About the cover

Global developmental delay (GDD) is a neurodevelopmental disorder occurring in children under the age of five, characterized by significant delays in two or more developmental milestones, including gross or fine motor, language, cognition, social interaction, and daily living activities. The prevalence of GDD is approximately 1%-3%, with a complex etiology involving multiple interacting factors, posing significant challenges for diagnosis, intervention, and prognosis. Lack of early diagnosis and intervention can result in GDD children developing intellectual disabilities, severely impacting their daily lives and social interactions.

Currently, clinical diagnosis and evaluation of GDD in children primarily rely on developmental scales; however, this method is highly subjective, potentially leading to inaccurate assessments. Additionally, there are no specific biomarkers for diagnosing GDD. Therefore, studying the brain microstructure of GDD children is crucial to developing quantitative diagnostic neurobiomarkers.

Diffusion kurtosis imaging (DKI) is a quantitative magnetic resonance imaging technique that can simulate the microenvironment of complex structures, showing high sensitivity and specificity in detecting neural tissue development and physiological changes. Tract-based spatial statistics (TBSS) is a method for spatial statistical analysis of whole-brain white matter, which avoids measurement bias caused by manually drawing regions of interest.

This study collected clinical data and DKI scan data from all participants, using independent sample *t*-tests and chi-squared tests to compare age and gender differences between the two groups. TBSS was used to analyze differences in DKI parameters between GDD children and healthy controls. Additionally, Spearman correlation analysis was used to explore the relationship between DKI parameter values in significantly different white matter regions and the Gesell Developmental Schedules. The results showed that compared to healthy controls, GDD children had significantly increased mean diffusivity (MD) and radial diffusivity (RD), and significantly decreased radial kurtosis (RK) in affected white matter regions, including the anterior thalamic radiation, corticospinal tract, inferior fronto-occipital fasciculus, superior longitudinal fasciculus, inferior longitudinal fasciculus, and uncinate fasciculus. Furthermore, correlation analysis indicated that RK parameter values were associated with the neurodevelopmental levels of GDD children. DKI technology can detect microstructural abnormalities in the white matter tracts of GDD children's brains, aiding in the identification of potential neurobiomarkers for GDD. Please see text page 19.