

# Long-Term Cognitive Trajectory Prediction in a Chinese Cohort of Middle-Aged and Older Adults Using Causal Machine Learning

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## Abstract

As global life expectancy increases, cognitive impairment and dementia are becoming increasingly common. With limited effective treatments available, early identification of cognitive decline markers is essential for timely intervention. While many studies focus on predicting cognitive impairment, forecasting the trajectory of cognitive development offers greater foresight, enabling interventions even before diagnostic thresholds are reached. This study identifies 10 key determinants of cognitive trajectories and introduces a novel 2-stage model, CoTTA (Cognitive Trajectory Tracking Algorithm). CoTTA integrates causal inference with predictive modeling to forecast cognitive trajectories using data from 9,345 participants aged 50–80 at baseline year from CHARLS, a nationally representative sample of middle-aged and older Chinese adults. By leveraging causal features, CoTTA predicts the risk of consistently low cognitive function over an 8-year period, outperforming baseline models, particularly in recall and F1 score. This approach offers a scalable solution for early intervention and long-term cognitive health management.