

Cognitive Norms in the UK Biobank: data-driven definition of cognitive impairment

BACKGROUND

The UK Biobank (UKB) is a large-scale ageing dataset that includes, among other data, cognitive performance data from 501,978 participants. Cognitive tests conducted in the UKB have been adapted for widespread use at assessment centres or online, limiting their applicability to established test norms. This limits the utility of the data for establishing cognitive impairment across the age course of the UKB. Furthermore, mild cognitive impairment is not reliably coded in the UKB because there is no standardised clinical diagnostic code. We sought to address this limitation by calculating norms for cognitive performance in the UKB and using this data to establish a data-driven diagnosis of MCI.

METHODS

We analysed cognitive test data from 501,978 UKB participants across 13 cognitive tests and 7 timepoints. Penalised B-spline normative models were developed using Generalised Additive Models for Location, Scale and Shape (GAMLSS), accounting for age, education, and sex in the test performance means and variances. Distribution families were selected per test based on AIC and residual statistics. Z-scores for each testing instance were generated from the norms, using a 10-fold cross-validation design with participant-level fold allocation to avoid repeated measures bias.

RESULTS

Penalised B-spline normative models were successfully applied to the cognitive test data, with model convergence achieved in all tests. Z-scores were then attached to each test score. An impaired test was defined as performance >1.5 standard deviations worse than the normative mean. Mild cognitive impairment was then defined as having at least 2 impaired tests in any single testing instance. Groups were defined as either cognitively healthy ($n = 341024$) or mild cognitive impairment ($n = 40747$). We then show that worse cognitive z-scores were associated with eventual diagnosis of dementia. Further correlations were performed between cognitive z-scores and neurobiomarker levels.

CONCLUSION

We successfully used normative modelling to transform cognitive test scores into z-scores, making cognitive data in the UKB more accessible to future research. We then define an MCI group based on cognitive performance, providing a critical resource for the study of ageing and dementias in the UKB.