Appendix: Calculation of demographic-adjusted z-scores

Based on the results from multiple linear regression models (Table 4) for the UDSNB 3.0, we can calculate the demographic-adjusted z-scores for each neuropsychologic test in the UDSNB 3.0 battery as follows:

$$Z = \frac{Y - \hat{Y}}{\hat{\sigma}}$$

Where Z is the z-score estimate for an individual subject, Y is the raw score for an individual subject from a given test, $\hat{Y}$ is the predicted population mean score obtained from linear regression models using age, sex, education and race/ethnicity (non-Hispanic White or non-Hispanic Black) as predictors, $\hat{\sigma}$ is the root mean square error of the linear regression model. Because a greater score on trails A and B response time is indicative of worse performance, the z-score estimates for these two tests were reversed. Both EAS and NACC norms were provided so that users can choose or compare the demographic-adjusted z-scores obtained using either norms. Impairment indicator defined by a specific SD level c below the mean, which equals to 1 if $Z \le c$, and 0 otherwise, can also be obtained.

Use MOCA score as an example, based on EAS norms,

$$\hat{Y} = 24.60 + 1.21 * \text{women} - 0.29 * (\text{age} - 77) + 0.39 * (\text{educyrs} - 16) - 2.27 * \text{nonH\_Black}$$

$$\hat{\sigma} = 3.21$$

Therefore for a subject A has MOCA score $Y = 30$, who is male, 77 years old, has 16 years of education, and is non-Hispanic White, then the calculated demographic-adjusted z-score is

$$Z = \frac{30 - 24.6}{3.21} = 1.68.$$

If we use NACC norm, then

$$\hat{Y} = 25.63 + 0.69 * \text{women} - 0.10 * (\text{age} - 77) + 0.27 * (\text{educyrs} - 16) - 2.76 * \text{nonH\_Black}$$

$$\hat{\sigma} = 2.59$$

For the same subject A, the calculated demographic-adjusted z-score is

$$Z = \frac{30 - 25.63}{2.59} = 1.69 \ .$$

Use MINT total score as another example, based on EAS norms,

$$\hat{Y} = 28.04 + 0.52 * \text{women} - 0.10 * (\text{age} - 77) + 0.32 * (\text{educyrs} - 16) - 1.17 * \text{nonH\_Black}$$

$$\hat{\sigma} = 3.90$$

For the same subject with MINT total score 29, the calculated demographic-adjusted z-score is

$$Z = \frac{29 - 28.04}{3.90} = 0.25$$

Use NACC norms,

$$\hat{Y} = 30.68 - 0.83 * \text{women} - 0.07 * (\text{age} - 77) + 0.11 * (\text{educyrs} - 16) - 2.54 * \text{nonH\_Black}$$
$$\hat{\sigma} = 2.15$$

So the calculated demographic-adjusted z-score is
$$Z = \frac{29 - 30.68}{2.15} = -0.78$$

We provided software including SAS macro and R-package, and online calculator in our website https://einsteinmed.org/departments/neurology/clinical-research-program/eas/data-sharing.aspx