# eAppendix

## Continuous measure of cognitive function

In estimating an OLS regression of continuous cognitive function score on time and selected covariates, results are consistent with the logistic regression models in the main text, indicating that controlling for practice effects reverses the time trend in cognitive function scores.

eTable 1 OLS regression of continuous cognitive function score on time and selected covariates.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Model 1 | [95% CI] | | Model 2 | | [95% CI] | | Model 3 | | [95% CI] | |
| Time (unit: 10 years) | 0.25 | [0.18, 0.32] | | -0.22 | | [-0.36, -0.08] | | -0.57 | | [-0.68, -0.46] | |
| Race/Ethnicity (ref. White) | | | | | | | | | | |
| Black | -3.4 | [-3.6, -3.2] | | -3.3 | | [-3.6, -3.1] | | -2.5 | | [-2.7, -2.4] | |
| Latinx | -3.1 | [-3.4, -2.8] | | -3.0 | | [-3.3, -2.7] | | -1.5 | | [-1.7, -1.3] | |
| Other | -1.8 | [-2.5, -1.2] | | -1.8 | | [-2.4, -1.1] | | -1.5 | | [-1.9, -1.1] | |
| Man (ref. Woman) | -0.54 | [-0.66, -0.42] | | -0.46 | | [-0.59, -0.34] | | -0.57 | | [-0.67, -0.46] | |
| Age (unit: 10 years) | -0.22 | [-0.40, -0.04] | | -0.76 | | [-0.94, -0.57] | | -0.29 | | [-0.45, -0.12] | |
| Age2 (unit: 10 years) | -0.37 | [-0.41, -0.32] | | -0.28 | | [-0.32, -0.23] | | -0.32 | | [-0.35, -0.28] | |
| Interview Mode (ref. Face-to-Face) | | |  | |  | |  | |  | |
| Telephone | 0.70 | [0.63, 0.77] | | 0.69 | | [0.62, 0.76] | | 0.65 | | [0.58, 0.71] | |
| Man x Telephone | -0.26 | [-0.36, -0.15] | | -0.28 | | [-0.38, -0.18] | | -0.40 | | [-0.49, -0.31] | |
| Test Number (ref. 1st) |  |  | |  | |  | |  | |  | |
| 2nd |  |  | | 0.14 | | [0.07, 0.22] | | 0.14 | | [0.06, 0.21] | |
| 3-4 |  |  | | 0.44 | | [0.34, 0.55] | | 0.40 | | [0.30, 0.49] | |
| 5-7 |  |  | | 0.90 | | [0.70, 1.1] | | 0.78 | | [0.62, 0.95] | |
| 8+ |  |  | | 1.3 | | [1.04, 1.6] | | 1.2 | | [0.95, 1.4] | |
| Education (ref. <HS) |  |  | |  | |  | |  | |  | |
| HS/GED |  |  | |  | |  | | 2.7 | | [2.6, 2.8] | |
| Associate degree + |  |  | |  | |  | | 4.5 | | [4.3, 4.6] | |
| Constant | 17.7 | [17.6, 17.9] | | 18.0 | | [17.8, 18.2] | | 14.8 | | [14.6, 15.0] | |
| Observations | 165,926 |  | | 165,926 | |  | | 165,926 | |  | |
| R-squared | 0.22 |  | | 0.22 | |  | | 0.32 | |  | |
| Notes: Model 1 controls age, age squared, race/ethnicity, and the interaction between gender and interview mode. Model 2 adds test number. Model 3 adds educational attainment. | | | | | | | | | | |

## Restricting sample to respondents aged 65 and over at the time of interview

eTable 2 Odds ratios (OR) and 95% confidence intervals (95% CI) from logistic regression models for any cognitive impairment and dementia; sample restricted to respondents aged 65 and over at the time of interview.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Any Cognitive Impairment** | | | | | | | **Dementia** | | | | | | |
|  | Model 1 | [95% CI] | Model 2 | [95% CI] | Model 3 | [95% CI] | Model 1 | | [95% CI] | Model 2 | [95% CI] | Model 3 | [95% CI] |
| Time (unit: 10 years) | 0.81 | [0.77 - 0.85] | 1.24 | [1.15 - 1.33] | 1.42 | [1.32 - 1.54] | 0.86 | | [0.80 - 0.92] | 1.34 | [1.21 - 1.49] | 1.55 | [1.39 - 1.72] |
| Race/ethnicity (ref. White) | | | | | | | | | | | | | | |
| Black | 4.7 | [4.2, 5.2] | 4.6 | [4.2, 5.1] | 3.4 | [3.1, 3.7] | 4.2 | | [3.7, 4.7] | 4.1 | [3.7, 4.6] | 3.0 | [2.7, 3.3] |
| Latinx | 3.8 | [3.3, 4.5] | 3.7 | [3.1, 4.3] | 2.1 | [1.8, 2.4] | 3.0 | | [2.6, 3.5] | 2.9 | [2.5, 3.4] | 1.7 | [1.5, 2.0] |
| Other | 1.8 | [1.1, 3.1] | 1.8 | [1.1, 3.0] | 1.7 | [1.1, 2.6] | 1.7 | | [0.9, 3.2] | 1.6 | [0.9, 3.1] | 1.5 | [0.8, 2.6] |
| Man (ref. Woman) | 1.1 | [1.0, 1.2] | 1.1 | [1.0, 1.1] | 1.1 | [1.0, 1.2] | 1.0 | | [0.9, 1.1] | 1.0 | [0.9, 1.1] | 0.96 | [0.88, 1.1] |
| Age (unit: 10 years) | 2.1 | [1.8, 2.6] | 2.2 | [1.8, 2.6] | 1.8 | [1.5, 2.2] | 4.9 | | [3.5, 6.7] | 4.9 | [3.6, 6.8] | 4.4 | [3.1, 6.2] |
| Age-squared (unit: 10 years) | 1.0 | [1.0, 1.1] | 1.0 | [1.0, 1.1] | 1.1 | [1.0, 1.1] | 0.91 | | [0.87, 0.96] | 0.91 | [0.87, 0.96] | 0.92 | [0.87, 0.98] |
| Interview mode (ref. Face-to-Face) | | | | | | | | | | | | | | |
| Telephone | 0.78 | [0.75, 0.82] | 0.76 | [0.72, 0.80] | 0.78 | [0.74, 0.82] | 0.84 | | [0.77, 0.92] | 0.80 | [0.73, 0.87] | 0.83 | [0.76, 0.91] |
| Proxy | 9.1 | [7.8, 10.5] | 5.4 | [4.6, 6.4] | 5.5 | [4.6, 6.6] | 21.5 | | [18.7, 24.7] | 11.5 | [9.8, 13.5] | 11.7 | [9.9, 13.9] |
| Telephone × Man | 1.1 | [0.99, 1.2] | 1.1 | [1.0, 1.2] | 1.1 | [1.1, 1.2] | 0.88 | | [0.76, 1.0] | 0.89 | [0.78, 1.0] | 0.94 | [0.82, 1.1] |
| Proxy × Man | 0.39 | [0.33, 0.46] | 0.41 | [0.34, 0.49] | 0.36 | [0.30, 0.44] | 0.39 | | [0.33, 0.46] | 0.41 | [0.34, 0.48] | 0.38 | [0.32, 0.45] |
| Test Number (ref. 1st) | | | | | | | | | | | | | | |
| 2nd |  |  | 0.90 | [0.84, 0.96] | 0.91 | [0.84, 0.97] |  | |  | 0.91 | [0.81, 1.0] | 0.91 | [0.81, 1.0] |
| 3-4 |  |  | 0.73 | [0.69, 0.78] | 0.75 | [0.70, 0.80] |  | |  | 0.68 | [0.60, 0.76] | 0.69 | [0.61, 0.77] |
| 5-7 |  |  | 0.54 | [0.49, 0.60] | 0.57 | [0.52, 0.63] |  | |  | 0.48 | [0.42, 0.54] | 0.50 | [0.45, 0.57] |
| 8+ |  |  | 0.41 | [0.36, 0.47] | 0.45 | [0.39, 0.51] |  | |  | 0.34 | [0.28, 0.41] | 0.36 | [0.29, 0.43] |
| Educational Attainment (ref. <HS) | | | | | | | | | | | | | | |
| HS/GED |  |  |  |  | 0.33 | [0.31, 0.36] |  | |  |  |  | 0.38 | [0.35, 0.41] |
| Associate + |  |  |  |  | 0.16 | [0.15, 0.18] |  | |  |  |  | 0.23 | [0.20, 0.26] |
| Constanta | 0.03 | [0.03, 0.04] | 0.04 | [0.03, 0.05] | 0.12 | [0.09, 0.17] | 0.00 | | [0.00, 0.00] | 0.00 | [0.00, 0.00] | 0.00 | [0.00, 0.01] |
| Person-waves | 103,108 |  | 103,108 |  | 103,108 |  | 103,108 | |  | 103,108 |  | 103,108 |  |
| Notes: Model 1 includes time, age, age squared, race/ethnicity, and the interaction between gender and interview mode. Model 2 adds test number. Model 3 adds educational attainment.  a The constant represents the baseline odds (not odds ratio) when categorical variables are at their reference values and age and time at values to which these were centered (age 50, year 2000). | | | | | | | | | | | | | | |

eTable 3 Predicted prevalence of and annual percent change in any cognitive impairment and dementia for ages 65 and over from 1996 and 2014.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **Any cognitive impairment, %** | | | | **Dementia, %** | | | |
|  |  | 1996 | 2014 | Annual % change a[95% CI] | | 1996 | 2014 | Annual % change a[95% CI] | |
| **Women** | Model 1 | 33.8 | 26.8 | -1.3 | [-1.6, -1.0] | 11.6 | 9.6 | -1.1 | [-1.5, -0.6] |
|  | Model 2 | 26.6 | 32.4 | 1.1 | [0.56, 1.6] | 8.9 | 12.0 | 1.7 | [1.0, 2.4] |
| **Men** | Model 1 | 31.7 | 26.2 | -1.0 | [-1.4, -0.68] | 8.9 | 7.5 | -0.9 | [-1.6, -0.2] |
|  | Model 2 | 24.7 | 31.5 | 1.4 | [0.82, 1.9] | 6.5 | 9.7 | 2.2 | [1.1, 3.3] |
| Notes: Model 1 controls for age, age squared, race/ethnicity, and interview mode. Model 2 adds test number.  a Annual percent change is calculated as 100 \*[(P2014/P1996)^(1/18)-1], where P2014 and P1996 are the predicted probabilities in years 2014 and 1996, respectively. | | | | | | | | | |

## Testing different cut-points for any cognitive impairment and dementia

As a sensitivity analysis, we test whether shifting the cut-points by up to two points in either direction in defining any cognitive impairment (typically defined as scoring 0-11 points) or dementia (typically 0-6 points) changes the results of our primary model (Model 2). Regardless of the cut-point, results show increasing trends in any cognitive impairment and dementia.

eTable 4a Odds ratios (OR) and 95% confidence intervals (95% CI) from logistic regression modelsfor any cognitive impairment using Model 2, with varying cut-points

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Any cognitive impairment** | | | | | | | | | |
| **Cognitive function score using varying cut-points** | **0-9 points** | **[95% CI]** | **0-10 points** | **[95% CI]** | **0-11 points** | **[95% CI]** | **0-12 points** | **[95% CI]** | **0-13**  **points** | **[95% CI]** |
| Time (unit: 10 years) | 1.23 | [1.14, 1.32] | 1.19 | [1.11, 1.27] | 1.14 | [1.06, 1.22] | 1.14 | [1.07, 1.23] | 1.13 | [1.05, 1.21] |
| Race/Ethnicity (ref. White) |  |  |  |  |  |  |  |  |  |  |
| Black | 4.9 | [4.4, 5.4] | 4.8 | [4.3, 5.3] | 4.6 | [4.2, 5.1] | 4.6 | [4.1, 5.0] | 4.4 | [4.0, 4.9] |
| Latinx | 3.8 | [3.3, 4.4] | 3.9 | [3.3, 4.5] | 4.0 | [3.5, 4.6] | 3.9 | [3.4, 4.4] | 3.8 | [3.4, 4.3] |
| Other | 2.1 | [1.4, 3.2] | 2.2 | [1.5, 3.2] | 2.3 | [1.6, 3.4] | 2.2 | [1.5, 3.2] | 2.3 | [1.6, 3.2] |
| Man (ref. Woman) | 1.0 | [0.96, 1.1] | 1.0 | [0.98, 1.1] | 1.1 | [1.0, 1.2] | 1.1 | [1.1, 1.2] | 1.2 | [1.1, 1.2] |
| Age (unit: 10 years) | 2.3 | [2.0, 2.5] | 2.1 | [1.9, 2.3] | 1.9 | [1.7, 2.1] | 1.8 | [1.7, 2.0] | 1.7 | [1.5, 1.9] |
| Age2 (unit: 10 years) | 1.0 | [1.0, 1.1] | 1.0 | [1.0, 1.1] | 1.1 | [1.0, 1.1] | 1.1 | [1.0, 1.1] | 1.1 | [1.1, 1.1] |
| Interview Mode (ref. Face-to-Face) |  |  |  |  |  |  |  |  |  |  |
| Telephone | 0.79 | [0.75, 0.84] | 0.79 | [0.74, 0.83] | 0.79 | [0.75, 0.83] | 0.81 | [0.77, 0.84] | 0.82 | [0.79, 0.85] |
| Proxy | 5.7 | [5.0, 6.4] | 4.0 | [3.5, 4.6] | 4.4 | [3.9, 5.0] | 3.2 | [2.8, 3.6] | 2.3 | [2.0, 2.5] |
| Telephone × Man | 1.1 | [0.99, 1.2] | 1.1 | [1.0, 1.2] | 1.1 | [1.0, 1.2] | 1.1 | [1.0, 1.1] | 1.1 | [1.0, 1.2] |
| Proxy × Man | 0.37 | [0.32, 0.43] | 0.36 | [0.31, 0.41] | 0.46 | [0.40, 0.54] | 0.44 | [0.38, 0.51] | 0.43 | [0.37, 0.49] |
| Test Number (ref. 1st) |  |  |  |  |  |  |  |  |  |  |
| 2nd | 0.90 | [0.83, 0.97] | 0.90 | [0.85, 0.96] | 0.94 | [0.88, 1.00] | 0.94 | [0.89, 1.00] | 0.93 | [0.89, 0.97] |
| 3-4 | 0.70 | [0.65, 0.76] | 0.72 | [0.67, 0.77] | 0.77 | [0.72, 0.82] | 0.78 | [0.74, 0.83] | 0.79 | [0.75, 0.83] |
| 5-7 | 0.50 | [0.45, 0.57] | 0.54 | [0.48, 0.60] | 0.58 | [0.52, 0.64] | 0.59 | [0.54, 0.65] | 0.62 | [0.56, 0.68] |
| 8+ | 0.37 | [0.32, 0.42] | 0.40 | [0.35, 0.46] | 0.46 | [0.40, 0.53] | 0.47 | [0.41, 0.54] | 0.50 | [0.44, 0.57] |
| Constant a | 0.02 | [0.02, 0.02] | 0.03 | [0.03, 0.04] | 0.05 | [0.04, 0.06] | 0.07 | [0.06, 0.08] | 0.11 | [0.10, 0.12] |
| Observations | 179,236 |  | 179,236 |  | 179,236 |  | 179,236 |  | 179,236 |  |
| Notes: The bolded column titles indicate the range of points considered cognitively impaired out of a total of 27 points. In the main text, any impairment is 0-11 points, the center column.  a The constant represents the baseline odds (not odds ratio) when categorical variables are at their reference values and age and time at values to which these were centered (age 50, year 2000). | | | | | | | | | | |

eTable 4b Odds ratios (OR) and 95% confidence intervals (95% CI) from logistic regression modelsfor dementia using Model 2, with varying cut-points

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Dementia** | | | | | | | | | |
| **Cognitive function score using varying cut-points** | **0-4**  **points** | **[95% CI]** | **0-5**  **points** | **[95% CI]** | **0-6**  **points** | **[95% CI]** | **0-7**  **points** | **[95% CI]** | **0-8**  **points** | **[95% CI]** |
| Time (unit: 10 years) | 1.23 | [1.10, 1.38] | 1.33 | [1.19, 1.49] | 1.29 | [1.16, 1.44] | 1.26 | [1.14, 1.39] | 1.27 | [1.15, 1.39] |
| Race/Ethnicity (ref. White) |  |  |  |  |  |  |  |  |  |  |
| Black | 3.5 | [2.9, 4.1] | 3.9 | [3.3, 4.5] | 4.3 | [3.8, 4.9] | 4.5 | [4.0, 5.1] | 4.8 | [4.4, 5.3] |
| Latinx | 2.5 | [2.1, 2.9] | 2.9 | [2.5, 3.3] | 3.2 | [2.7, 3.7] | 3.3 | [2.9, 3.9] | 3.5 | [3.1, 4.1] |
| Other | 1.6 | [0.9, 2.9] | 1.9 | [1.1, 3.2] | 1.9 | [1.1, 3.4] | 2.0 | [1.2, 3.4] | 2.0 | [1.2, 3.3] |
| Man (ref. Woman) | 1.0 | [0.89, 1.1] | 0.98 | [0.88, 1.1] | 1.0 | [0.92, 1.1] | 1.0 | [0.93, 1.1] | 1.0 | [0.93, 1.1] |
| Age (unit: 10 years) | 4.0 | [3.3, 4.9] | 3.5 | [2.9, 4.1] | 3.2 | [2.7, 3.7] | 2.8 | [2.4, 3.2] | 2.6 | [2.3, 3.0] |
| Age2 (unit: 10 years) | 0.94 | [0.91, 0.97] | 0.97 | [0.94, 1.0] | 0.98 | [0.96, 1.0] | 1.0 | [0.97, 1.0] | 1.0 | [0.99, 1.0] |
| Interview Mode (ref. Face-to-Face) |  |  |  |  |  |  |  |  |  |  |
| Telephone | 0.71 | [0.62, 0.82] | 0.74 | [0.66, 0.83] | 0.78 | [0.72, 0.86] | 0.77 | [0.72, 0.83] | 0.78 | [0.73, 0.84] |
| Proxy | 15.6 | [13.4, 18.2] | 11.9 | [10.4, 13.5] | 10.7 | [9.4, 12.2] | 7.3 | [6.4, 8.3] | 6.1 | [5.4, 6.9] |
| Telephone × Man | 0.94 | [0.78, 1.1] | 0.97 | [0.83, 1.1] | 0.95 | [0.84, 1.1] | 1.0 | [0.92, 1.2] | 1.1 | [0.99, 1.2] |
| Proxy × Man | 0.40 | [0.34, 0.48] | 0.39 | [0.33, 0.47] | 0.37 | [0.32, 0.43] | 0.36 | [0.31, 0.42] | 0.35 | [0.31, 0.41] |
| Test Number (ref. 1st) |  |  |  |  |  |  |  |  |  |  |
| 2nd | 0.99 | [0.85, 1.2] | 0.92 | [0.81, 1.1] | 0.91 | [0.83, 1.0] | 0.89 | [0.82, 0.98] | 0.89 | [0.83, 0.96] |
| 3-4 | 0.65 | [0.55, 0.76] | 0.63 | [0.55, 0.72] | 0.66 | [0.59, 0.74] | 0.69 | [0.63, 0.75] | 0.68 | [0.63, 0.73] |
| 5-7 | 0.47 | [0.40, 0.56] | 0.44 | [0.37, 0.51] | 0.46 | [0.40, 0.53] | 0.48 | [0.42, 0.54] | 0.48 | [0.43, 0.54] |
| 8+ | 0.35 | [0.28, 0.44] | 0.31 | [0.25, 0.38] | 0.33 | [0.27, 0.40] | 0.35 | [0.29, 0.42] | 0.34 | [0.29, 0.40] |
| Constanta | 0.00 | [0.00, 0.00] | 0.00 | [0.00, 0.00] | 0.00 | [0.00, 0.00] | 0.01 | [0.01, 0.01] | 0.01 | [0.01, 0.01] |
| Observations | 179,236 |  | 179,236 |  | 179,236 |  | 179,236 |  | 179,236 |  |
| Notes: The bolded column titles indicate the range of points considered cognitively impaired or demented out of a total of 27 points. In the main text, dementia is 0-6 points, the center column.  a The constant represents the baseline odds (not odds ratio) when categorical variables are at their reference values and age and time at values to which these were centered (age 50, year 2000). | | | | | | | | | | |

## Controlling for selective mortality

Subjects with lower cognitive scores or faster cognitive decline experience higher mortality. In order to test whether selective sample attrition due to death biases our results, we estimate joint models that simultaneously estimate the parameters of a linear mixed model for the continuous measure of cognitive function and the parameters of a proportional hazards model for death.1 The link between the two components of the joint model are shared random effects.2 In the longitudinal model of the cognitive function scores, the shared random effects allow for individually heterogeneous intercepts and age slopes, and in the survival model, they raise or lower the log-hazard of death, thereby controlling for differential mortality of subjects in the sample. We specified the random effects for the regression intercept and the age slope without placing any restrictions on their variances and covariance.

To arrive at a comparable specification of a joint model with our baseline model, we make a number of adjustments. First, we check the linear models from Appendix II for robustness. Second, existing implementations of the complex estimation procedure cannot accommodate survey weights.3,4 Lastly, the survival sub-model requires that we set the data as time span data, which means that we cannot utilize the last score observation (wave 12 in 2014), as covariate values for any time span after that point are unknown. In order to obtain meaningful model comparisons, we sequentially introduce the following modifications to the original OLS Model (Model A), as shown above in Table A-1, Model 2. We remove the complex survey design from estimation (Model B); we drop observations from wave 12 (Model C); we estimate a pure linear mixed model with random effects introduced in the way just described (Model D); finally, we compare the parameters of that model to estimates from a joint model, whose only difference to the mixed model is that it controls for selective mortality (Model E).

Estimation is done in Stata 15 using the stjm add-on module.3 Table A-5 shows the results. The joint model time coefficient of -0.32 is slightly lower than in the original model (-0.22). However, the time coefficient remains consistently negative across specifications, implying that selective mortality does not significantly bias our findings of a negative time trend in cognitive function from 1996-2014.

There are, however, two noteworthy changes when we introduce random effects (Model D). First, the number of tests taken coefficients are attenuated. This may be evidence that these coefficients, whose regressors measure time-in-sample, are sensitive to general non-response sample selection. Low-scoring respondents are less likely to self-respond. Second, the introduction of random effects slightly alters the age trajectory. When graphing the implied polynomials, the mixed-effects model trajectory is flatter at younger sample ages, but has more curvature - hence a steeper decline - at higher ages. This observation, too, points to non-response sample selectivity. Individuals with poor cognitive trajectories are less likely to respond and even less often at older ages. By attributing slow and fast rates of cognitive decline to individual heterogeneity, mixed models may be able to partially account for the selection.

The bias introduced by non-response sample selection is likely present in all models that use a continuous measure of cognitive function, as these models exclude proxy interviews. We do not construct a continuous cognitive function score based on proxy interviews because the measure constructed from proxy responses was intended to identify CIND and dementia. We hypothesize it is less accurate in understanding continuous cognitive decline. If we could include proxy interviews in the OLS regression, we expect we would find coefficients in between the values in Models A and D. The logit models in the main text do include proxy interviews, and therefore sample selection should be less problematic.

eTable 5 Comparing OLS, mixed, and joint regression models of continuous cognitive function score on time and selected covariates. a

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **(Model A)** | | **(Model B)** | | **(Model C)** | | **(Model D)** | | **(Model E)** | |
|  | **Original model (OLS)** | **[95% CI]** | **Model A without weights** | **[95% CI]** | **Model B without wave 12** | **[95% CI]** | **Model C as a mixed model** | **[95% CI]** | **Model D as a joint model** | **[95% CI]** |
| Time (unit: 10 years) | -0.22 | [-0.36, -0.08] | -0.27 | [-0.33, -0.22] | -0.32 | [-0.45, -0.18] | -0.28 | [-0.35, -0.22] | -0.31 | [-0.38, -0.25] |
| Race/Ethnicity (ref. White) | | | | | | | | | | |
| Black | -3.3 | [-3.6, -3.1] | -3.3 | [-3.4, -3.3] | -3.3 | [-3.6, -3.1] | -3.4 | [-3.5, -3.3] | -3.4 | [-3.5, -3.3] |
| Latinx | -3.0 | [-3.3, -2.7] | -3.1 | [-3.2, -3.0] | -3.0 | [-3.3, -2.7] | -3.2 | [-3.3, -3.0] | -3.1 | [-3.3, -3.0] |
| Other | -1.8 | [-2.4, -1.1] | -1.8 | [-1.9, -1.6] | -1.8 | [-2.5, -1.0] | -1.8 | [-2.1, -1.6] | -1.8 | [-2.1, -1.6] |
| Man (ref. Woman) | -0.46 | [-0.59, -0.34] | -0.41 | [-0.46, -0.35] | -0.49 | [-0.62, -0.37] | -0.50 | [-0.58, -0.41] | -0.51 | [-0.60, -0.43] |
| Age (unit: 10 years) b | -0.76 | [-0.94, -0.57] | -0.82 | [-0.90, -0.73] | -0.70 | [-0.91, -0.50] | 0.26 | [0.16, 0.36] | 0.01 | [0.00, 0.02] |
| Age-squared (unit: 10 years)b | -0.28 | [-0.32, -0.23] | -0.26 | [-0.28, -0.24] | -0.26 | [-0.31, -0.22] | -0.52 | [-0.54, -0.50] | -0.01 | [-0.01, -0.01] |
| Interview Mode (ref. Face-to-Face) | | | | | | | | | | |
| Telephone | 0.69 | [0.62, 0.76] | 0.83 | [0.78, 0.89] | 0.68 | [0.61, 0.75] | 0.45 | [0.40, 0.49] | 0.44 | [0.40, 0.48] |
| Telephone × Man | -0.28 | [-0.38, -0.18] | -0.35 | [-0.43, -0.27] | -0.26 | [-0.38, -0.15] | -0.39 | [-0.45, -0.32] | -0.38 | [-0.44, -0.32] |
| Test Number (ref. 1st) |  |  |  |  |  |  |  |  |  |  |
| 2nd | 0.14 | [0.07, 0.22] | 0.22 | [0.15, 0.29] | 0.17 | [0.09, 0.25] | 0.17 | [0.12, 0.22] | 0.15 | [0.11, 0.20] |
| 3-4 | 0.44 | [0.34, 0.55] | 0.44 | [0.38, 0.51] | 0.43 | [0.31, 0.54] | 0.17 | [0.11, 0.23] | 0.17 | [0.11, 0.23] |
| 5-7 | 0.90 | [0.70, 1.1] | 0.95 | [0.87, 1.0] | 0.93 | [0.74, 1.1] | 0.36 | [0.27, 0.45] | 0.36 | [0.27, 0.44] |
| 8+ | 1.3 | [1.0, 1.6] | 1.3 | [1.2, 1.5] | 1.3 |  | 0.38 | [0.25, 0.51] | 0.44 | [0.31, 0.56] |
| Constant | 18.0 | [17.8, 18.2] | 17.9 | [17.8, 18.0] | 18.2 | [18.0, 18.4] | 17.7 | [17.6, 17.8] | 17.8 | [17.7, 17.9] |
| Observations | 165,926 |  | 165,946 |  | 144,698 |  | 144,698 |  | 149,643 |  |
| a Model A is Model 2 from Appendix Table A-1. Model B excludes survey weights and Model C excludes wave 12, neither of which can be used in the joint model estimation. Model D is the mixed model, and Model E is the joint model.  b Age coefficients of the joint model are not comparable to those of the other models. In the joint model, age plays the role of analysis time (in the hazard regression) and hence was not rescaled. | | | | | | | | | | |

## Additional approaches to check for distortive collinearity among age, time, and practice effects

Alternative specifications for age, time, and practice effects suggest that regardless of specification of time, age, or test number, trends in any impairment (Panel A) and dementia (Panel B) are not negative, and trends in cognitive function score are negative (Panel C).

eTable 6 Odds ratios or linear regression coefficients[95% CIs] for time from models regressing any cognitive impairment or dementia (logit) or continuous cognitive function score (OLS) on alternative model specifications of time, age, and test number.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Panel A. Any cognitive impairment** | | | | | | | | | | | | |
|  | |  | | **Test number specification** | | | | | | | | |
| **Time Specification** | | **Age Specification** | Linear | | | Square root | | Categorical:  (1, 2, 3-4, 5-7, 8+) | | Categorical:  (1, 2, 3, 4+) | | | |
| OR | | [95% CI] | OR | [95% CI] | OR | [95% CI] | OR | [95% CI] | | |
| Exact time (continuous, 10-year units) | | Age, Age squared | 1.14 | | [1.04, 1.25] | 1.13 | [1.03, 1.24] | 1.14 | [1.06, 1.22] | 1.02 | [0.96, 1.08] | | |
| 50-54, 55-59, …, 90+ | 1.11 | | [1.02, 1.22] | 1.10 | [1.01, 1.21] | 1.12 | [1.04, 1.20] | 1.01 | [0.96, 1.07] | | |
| 50-64, 65-74 75-84, 85+ | 1.01 | | [0.93, 1.11] | 1.00 | [0.91, 1.09] | 1.04 | [0.97, 1.12] | 0.95 | [0.90, 1.01] | | |
| Wave pairs ref. 1996-1998 | | | | | | | | | | | | | |
| 2000-2002 | | Age, Age squared | 1.12 | | [1.07, 1.17] | 1.20 | [1.14, 1.27] | 1.25 | [1.18, 1.32] | 1.30 | [1.23, 1.37] | | |
| 50-54, 55-59, …, 90+ | 1.11 | | [1.06, 1.16] | 1.18 | [1.12, 1.25] | 1.24 | [1.17, 1.31] | 1.29 | [1.22, 1.36] | | |
| 50-64, 65-74 75-84, 85+ | 1.07 | | [1.02, 1.12] | 1.11 | [1.05, 1.17] | 1.13 | [1.07, 1.19] | 1.16 | [1.10, 1.22] | | |
| 2004-2006 | | Age, Age squared | 1.16 | | [1.07, 1.26] | 1.24 | [1.13, 1.37] | 1.33 | [1.23, 1.45] | 1.35 | [1.25, 1.46] | | |
| 50-54, 55-59, …, 90+ | 1.13 | | [1.04, 1.22] | 1.20 | [1.10, 1.32] | 1.30 | [1.20, 1.41] | 1.33 | [1.22, 1.44] | | |
| 50-64, 65-74 75-84, 85+ | 1.00 | | [0.93, 1.07] | 1.03 | [0.95, 1.11] | 1.08 | [1.00, 1.16] | 1.09 | [1.02, 1.18] | | |
| 2008-2010 | | Age, Age squared | 1.25 | | [1.13, 1.38] | 1.31 | [1.18, 1.46] | 1.37 | [1.26, 1.49] | 1.31 | [1.22, 1.42] | | |
| 50-54, 55-59, …, 90+ | 1.20 | | [1.09, 1.32] | 1.26 | [1.13, 1.39] | 1.33 | [1.22, 1.44] | 1.29 | [1.19, 1.39] | | |
| 50-64, 65-74 75-84, 85+ | 1.05 | | [0.96, 1.15] | 1.06 | [0.96, 1.16] | 1.12 | [1.04, 1.21] | 1.09 | [1.01, 1.17] | | |
| 2012-2014 | | Age, Age squared | 1.29 | | [1.12, 1.49] | 1.34 | [1.16, 1.55] | 1.38 | [1.24, 1.53] | 1.22 | [1.12, 1.34] | | |
| 50-54, 55-59, …, 90+ | 1.24 | | [1.08, 1.43] | 1.28 | [1.11, 1.48] | 1.33 | [1.20, 1.48] | 1.20 | [1.10, 1.32] | | |
| 50-64, 65-74 75-84, 85+ | 1.07 | | [0.93, 1.23] | 1.06 | [0.93, 1.22] | 1.15 | [1.04, 1.27] | 1.03 | [0.94, 1.12] | | |
| Wave groups ref. 1996-2000 | | | | | | | | | | | | | |
| 2002-2006 | | Age, Age squared | 1.03 | | [0.97, 1.10] | 1.07 | [1.00, 1.15] | 1.08 | [1.02, 1.15] | 1.19 | [1.11, 1.27] | | |
| 50-54, 55-59, …, 90+ | 1.01 | | [0.95, 1.08] | 1.05 | [0.98, 1.12] | 1.06 | [1.00, 1.13] | 1.16 | [1.08, 1.25] | | |
| 50-64, 65-74 75-84, 85+ | 0.94 | | [0.89, 1.00] | 0.96 | [0.90, 1.02] | 0.97 | [0.91, 1.02] | 1.03 | [0.96, 1.10] | | |
| 2008-2014 | | Age, Age squared | 1.14 | | [1.03, 1.27] | 1.15 | [1.03, 1.28] | 1.16 | [1.07, 1.26] | 1.12 | [1.03, 1.22] | | |
|  | | 50-54, 55-59, …, 90+ | 1.11 | | [1.00, 1.23] | 1.11 | [1.00, 1.23] | 1.13 | [1.04, 1.23] | 1.10 | [1.01, 1.20] | | |
| 50-64, 65-74 75-84, 85+ | 0.99 | | [0.89, 1.10] | 0.97 | [0.88, 1.08] | 1.03 | [0.95, 1.11] | 0.98 | [0.90, 1.06] | | |
| Notes: In addition to the varying specifications of time, age, and number of tests taken, each model includes as covariates race/ethnicity and the interaction between gender and interview mode. | | | | | | | | | | |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Panel B. Dementia** | | | | | | | | | | | | |
|  |  | **Test number specification** | | | | | | | | | | | |
| **Time Specification** | **Age Specification** | Continuous | | Square root | | | Categorical:  (1, 2, 3-4, 5-7, 8+) | | | Categorical:  (1, 2, 3, 4+) | | | |
| OR | [95% CI] | | OR | [95% CI] | | OR | [95% CI] | | OR | [95% CI] | |
| Exact time (continuous, 10-year units) | Age, Age squared | 1.26 | [1.09, 1.45] | | 1.25 | [1.09, 1.44] | | 1.29 | [1.16, 1.44] | | 1.14 | [1.04, 1.25] | |
| 50-54, 55-59, …, 90+ | 1.23 | [1.06, 1.42] | | 1.21 | [1.05, 1.40] | | 1.27 | [1.14, 1.41] | | 1.13 | [1.03, 1.24] | |
| 50-64, 65-74 75-84, 85+ | 1.10 | [0.95, 1.28] | | 1.08 | [0.94, 1.26] | | 1.21 | [1.08, 1.35] | | 1.08 | [0.99, 1.19] | |
| Wave pairs ref. 1996-1998 | | | | | | | | | | | | | | | |
| 2000-2002 | Age, Age squared | 1.07 | [0.97, 1.19] | | 1.18 | [1.06, 1.33] | | 1.38 | [1.26, 1.52] | | 1.43 | [1.30, 1.57] | |
| 50-54, 55-59, …, 90+ | 1.06 | [0.96, 1.17] | | 1.16 | [1.04, 1.30] | | 1.36 | [1.24, 1.49] | | 1.41 | [1.29, 1.55] | |
| 50-64, 65-74 75-84, 85+ | 1.03 | [0.93, 1.13] | | 1.09 | [0.98, 1.21] | | 1.27 | [1.16, 1.38] | | 1.30 | [1.19, 1.42] | |
| 2004-2006 | Age, Age squared | 1.25 | [1.08, 1.44] | | 1.39 | [1.18, 1.63] | | 1.63 | [1.44, 1.84] | | 1.70 | [1.50, 1.92] | |
| 50-54, 55-59, …, 90+ | 1.20 | [1.04, 1.39] | | 1.32 | [1.12, 1.56] | | 1.58 | [1.40, 1.78] | | 1.65 | [1.46, 1.87] | |
| 50-64, 65-74 75-84, 85+ | 1.06 | [0.93, 1.22] | | 1.12 | [0.96, 1.31] | | 1.36 | [1.20, 1.53] | | 1.41 | [1.25, 1.60] | |
| 2008-2010 | Age, Age squared | 1.27 | [1.05, 1.53] | | 1.36 | [1.12, 1.66] | | 1.63 | [1.40, 1.90] | | 1.59 | [1.37, 1.84] | |
| 50-54, 55-59, …, 90+ | 1.21 | [1.00, 1.47] | | 1.29 | [1.06, 1.58] | | 1.58 | [1.36, 1.83] | | 1.54 | [1.33, 1.78] | |
| 50-64, 65-74 75-84, 85+ | 1.05 | [0.87, 1.26] | | 1.08 | [0.89, 1.31] | | 1.38 | [1.19, 1.61] | | 1.35 | [1.17, 1.57] | |
| 2012-2014 | Age, Age squared | 1.46 | [1.18, 1.82] | | 1.53 | [1.23, 1.92] | | 1.74 | [1.48, 2.05] | | 1.53 | [1.32, 1.77] | |
| 50-54, 55-59, …, 90+ | 1.40 | [1.12, 1.75] | | 1.45 | [1.16, 1.83] | | 1.69 | [1.44, 1.99] | | 1.50 | [1.30, 1.73] | |
| 50-64, 65-74 75-84, 85+ | 1.19 | [0.95, 1.48] | | 1.19 | [0.95, 1.50] | | 1.52 | [1.29, 1.79] | | 1.33 | [1.15, 1.54] | |
| Wave groups ref. 1996-2000 | | | | | | | | | | | | | |
| 2002-2006 | Age, Age squared | 1.04 | [0.93, 1.17] | | 1.11 | [0.98, 1.26] | | 1.17 | [1.07, 1.29] | | 1.34 | [1.20, 1.49] | | |
| 50-54, 55-59, …, 90+ | 1.02 | [0.91, 1.14] | | 1.07 | [0.95, 1.22] | | 1.15 | [1.05, 1.26] | | 1.31 | [1.18, 1.45] | | |
| 50-64, 65-74 75-84, 85+ | 0.95 | [0.85, 1.06] | | 0.98 | [0.86, 1.10] | | 1.07 | [0.98, 1.18] | | 1.19 | [1.08, 1.33] | | |
| 2008-2014 | Age, Age squared | 1.17 | [0.97, 1.40] | | 1.19 | [0.99, 1.43] | | 1.31 | [1.14, 1.51] | | 1.29 | [1.13, 1.49] | | |
|  | 50-54, 55-59, …, 90+ | 1.12 | [0.93, 1.35] | | 1.14 | [0.94, 1.37] | | 1.28 | [1.11, 1.47] | | 1.27 | [1.10, 1.46] | | |
|  | 50-64, 65-74 75-84, 85+ | 1.00 | [0.83, 1.20] | | 0.99 | [0.82, 1.19] | | 1.20 | [1.04, 1.38] | | 1.17 | [1.01, 1.34] | | |
| Notes: In addition to the varying specifications of time, age, and number of tests taken, each model includes as covariates race/ethnicity and the interaction between gender and interview mode. | | | | | | | | | | | | | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Panel C. Continuous cognitive function score** | | | | | | | | | | | | |
|  | |  | **Test number specification** | | | | | | | | | |
| **Time Specification** | | **Age Specification** | Continuous | | | Square root | | | Categorical:  (1, 2, 3-4, 5-7, 8+) | | Categorical:  (1, 2, 3, 4+) | | | |
| b | [95% CI] | b | | [95% CI] | b | | [95% CI] | b | [95% CI] | |
| Exact time (continuous) | | Age, Age squared | -0.27 | [-0.43, -0.12] | -0.26 | | [-0.41, -0.11] | -0.22 | | [-0.36, -0.08] | -0.02 | [-0.12, 0.09] | |
| 50-54, 55-59, …, 90+ | -0.23 | [-0.38, -0.07] | -0.21 | | [-0.35, -0.06] | -0.17 | | [-0.31, -0.03] | 0.01 | [-0.10, 0.11] | |
| 50-64, 65-74 75-84, 85+ | -0.04 | [-0.19, 0.11] | -0.01 | | [-0.16, 0.13] | -0.01 | | [-0.14, 0.13] | 0.13 | [0.02, 0.24] | |
| Wave pairs ref. 1996-1998 | | | | | | | | | | | | |
| 2000-2002 | | Age, Age squared | -0.35 | [-0.43, -0.26] | -0.48 | | [-0.58, -0.38] | -0.51 | | [-0.60, -0.41] | -0.55 | [-0.65, -0.46] | |
| 50-54, 55-59, …, 90+ | -0.33 | [-0.41, -0.25] | -0.45 | | [-0.54, -0.35] | -0.47 | | [-0.57, -0.38] | -0.53 | [-0.62, -0.44] | |
| 50-64, 65-74 75-84, 85+ | -0.25 | [-0.33, -0.16] | -0.31 | | [-0.40, -0.21] | -0.27 | | [-0.37, -0.17] | -0.30 | [-0.40, -0.20] | |
| 2004-2006 | | Age, Age squared | -0.40 | [-0.54, -0.27] | -0.54 | | [-0.68, -0.39] | -0.56 | | [-0.70, -0.43] | -0.57 | [-0.70, -0.43] | |
| 50-54, 55-59, …, 90+ | -0.35 | [-0.48, -0.22] | -0.47 | | [-0.61, -0.32] | -0.49 | | [-0.62, -0.36] | -0.51 | [-0.65, -0.38] | |
| 50-64, 65-74 75-84, 85+ | -0.11 | [-0.24, 0.02] | -0.15 | | [-0.29, -0.01] | -0.09 | | [-0.22, 0.04] | -0.11 | [-0.24, 0.02] | |
| 2008-2010 | | Age, Age squared | -0.54 | [-0.71, -0.37] | -0.64 | | [-0.82, -0.46] | -0.60 | | [-0.75, -0.44] | -0.52 | [-0.66, -0.38] | |
| 50-54, 55-59, …, 90+ | -0.47 | [-0.64, -0.30] | -0.55 | | [-0.73, -0.38] | -0.52 | | [-0.67, -0.36] | -0.46 | [-0.61, -0.32] | |
| 50-64, 65-74 75-84, 85+ | -0.20 | [-0.37, -0.03] | -0.22 | | [-0.39, -0.04] | -0.14 | | [-0.30, 0.01] | -0.10 | [-0.24, 0.05] | |
| 2012-2014 | | Age, Age squared | -0.58 | [-0.83, -0.34] | -0.66 | | [-0.91, -0.41] | -0.63 | | [-0.85, -0.40] | -0.40 | [-0.58, -0.22] | |
| 50-54, 55-59, …, 90+ | -0.51 | [-0.75, -0.27] | -0.57 | | [-0.81, -0.33] | -0.54 | | [-0.76, -0.32] | -0.35 | [-0.53, -0.17] | |
| 50-64, 65-74 75-84, 85+ | -0.21 | [-0.44, 0.03] | -0.21 | | [-0.45, 0.03] | -0.18 | | [-0.40, 0.04] | -0.01 | [-0.19, 0.18] | |
| Wave groups ref. 1996-2000 | | | | | | | | | | | | |
| 2002-2006 | | Age, Age squared | -0.15 | [-0.25, -0.06] | -0.22 | | [-0.33, -0.12] | -0.17 | | [-0.27, -0.07] | -0.30 | [-0.43, -0.18] | |
| 50-54, 55-59, …, 90+ | -0.11 | [-0.21, -0.02] | -0.17 | | [-0.27, -0.07] | -0.11 | | [-0.21, -0.01] | -0.24 | [-0.37, -0.12] | |
| 50-64, 65-74 75-84, 85+ | 0.02 | [-0.08, 0.12] | 0.01 | | [-0.10, 0.12] | 0.09 | | [-0.01, 0.20] | 0.03 | [-0.10, 0.16] | |
| 2008-2014 | | Age, Age squared | -0.33 | [-0.51, -0.15] | -0.34 | | [-0.52, -0.16] | -0.26 | | [-0.43, -0.10] | -0.20 | [-0.36, -0.03] | |
|  | | 50-54, 55-59, …, 90+ | -0.26 | [-0.44, -0.09] | -0.27 | | [-0.44, -0.09] | -0.19 | | [-0.35, -0.03] | -0.14 | [-0.30, 0.02] | |
|  | | 50-64, 65-74 75-84, 85+ | -0.05 | [-0.22, 0.13] | -0.02 | | [-0.20, 0.16] | 0.03 | | [-0.13, 0.20] | 0.12 | [-0.04, 0.29] | |
| Notes: In addition to the varying specifications of time, age, and number of tests taken, each model includes as covariates race/ethnicity and the interaction between gender and interview mode. | | | | | | | | | | | |

### Simulation methods

Our regressions include age at interview, time, and test number. Since all of these variables increase linearly over time, they exhibit a high degree of collinearity. However, there are two counteracting circumstances. First, the sample refreshments of the HRS that take place every three waves add participants aged 51-57, which reduces the collinearity between age and time. Second, non-response, including proxy responses, constitute a non-trivial fraction of survey outcomes. Non-responses, which can occur for several waves in a row followed by a return to participation, alleviate the collinearity between number of tests taken and the other two variables. The question is, are these alleviating factors strong enough for robust coefficient estimation? We investigate the issue by means of a simulation exercise. In short, after generating simulated cognitive function trajectories for HRS respondents, we re-estimate the simulation model from the simulated data and check how accurately we can recover parameters. Biased parameters would point to a fundamental collinearity problem.

The simulation setup is as follows. To represent the HRS population with respect to its distribution of sex, education, etc., individuals are taken from the original HRS data. Proxy interviews are excluded. Each of the individuals provides values for basic demographic variables. We model the evolution of the cognitive score of these subjects up to age 110. For simulated observations beyond what is recorded in the HRS, we draw interview times from the distribution of interview times over the calendar year from past surveys. The cognitive score trajectories are calculated based on the predictors age, age-squared, sex, education, race/ethnicity, test number (categorized into four bins as 1st/2nd/3rd/4th+ test), and a time trend. For all predictors we collect suitable coefficient magnitudes from the literature,5,6 or we assign values based on own experimental estimates. We add an error structure that corresponds to the linear mixed and joint models discussed in the previous section, with correlated random intercepts and random slopes of age. The cognitive score variable is then transformed by rounding to integers, capping at a maximum score of 27, and dropping individuals who ever have a negative score. In a second step, we simulate a death process which terminates individual life histories before the maximum age. We use a Gompertz model whose predictors include sex, age, race/ethnicity, and education. Finally, we discard all values after 2014, which is when our actual HRS sample ends. We then re-estimate the simulated data using mixed models and OLS. OLS, given the simulation model, gives consistent estimates. An additional joint model estimation would not yield further insights since our simulated death process is not contingent on cognitive scores.

Table A-7 below shows the original and recovered coefficients. Recovered coefficient estimates include the ones that are based on the original simulated (continuous and unbounded) scores and on scores that are restricted to conform with cognitive function score values.

Both mixed models and OLS regressions recover the simulation coefficients well. We conclude that the degree of collinearity in the data is no concern for the validity of the estimates in the main text. The transformation of the score variable to the integer range[0 to 27] is visible in the coefficient estimates, but does not change qualitative conclusions.

In the last column of the table we see that the omission of test number in the model re-estimation biases the time trend upward from 0.1 to 0.17. This implies an additional increase in scores of about 1.4 score points over the sample span. However, this is contingent on the (assumed) presence of practice effects of meaningful size. If practice effects are present, then our simulations show that their omission can introduce a serious upward bias to the time trend.

eTable 7 Original and recovered coefficients of the mixed and OLS models regressing cognitive function score on time and selected covariates in the simulated data

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **Recovered Values** | | | | | | | | |
|  |  | **Mixed model** | | | | **OLS** | | | |
| **Coefficient** | **Simulation value** | **Original simulated scores** | **[95% CI]** | **Integer scores 0<=x<=27** | **[95% CI]** | **Integer scores 0<=x<=27** | **[95% CI]** | **No test number regressor** | **[95% CI]** |
| Time trend | 0.11 | 0.11 | [0.10, 0.11] | 0.1 | [0.10, 0.10] | 0.10 | [0.10, 0.10] | 0.17 | [0.17, 0.17] |
| Race/ethnicity (ref. White) | | | | | | | | |  | |
| Black | -2.50 | -2.56 | [-1.62, -1.09] | -2.37 | [-1.47, -0.98] | -2.41 | [-1.32, -1.09] | -2.53 | [-1.44, -1.21] |
| Latinx | -1.50 | -1.37 | [-2.67, -2.44] | -1.24 | [-2.47, -2.26] | -1.26 | [-2.46, -2.36] | -1.39 | [-2.58, -2.48] |
| Other | -1.50 | -1.35 | [-1.52, -1.22] | -1.23 | [-1.38, -1.10] | -1.21 | [-1.32, -1.19] | -1.32 | [-1.46, -1.32] |
| Man (ref. Woman) | 0.59 | 0.56 | [0.48, 0.65] | 0.50 | [0.43, 0.58] | 0.50 | [0.47, 0.54] | 0.42 | [0.39, 0.46] |
| Age | 0.11 | 0.16 | [0.10, 0.23] | 0.15 | [0.09, 0.21] | 0.23 | [0.16, 0.30] | 1.20 | [1.14, 1.27] |
| Age-squared | -0.54 | -0.54 | [-0.56, -0.53] | -0.51 | [-0.52, -0.50] | -0.53 | [-0.55, -0.51] | -0.71 | [-0.72, -0.69] |
| Test number (ref. 1st) | | | | | | | | |  | |
| 2nd | 1.22 | 1.22 | [1.20, 1.25] | 1.14 | [1.11, 1.16] | 1.14 | [1.08, 1.20] | .. |  |
| 3rd | 1.81 | 1.80 | [1.77, 1.83] | 1.65 | [1.62, 1.68] | 1.67 | [1.60, 1.73] | .. |  |
| 4th+ | 2.32 | 2.30 | [2.26, 2.34] | 2.11 | [2.08, 2.15] | 2.13 | [2.07, 2.20] | .. |  |
| Education (ref. <HS) | | | | | | | | |  | |
| HS/GED | 2.24 | 2.28 | [2.18, 2.39] | 2.22 | [2.12, 2.32] | 2.21 | [2.17, 2.26] | 2.24 | [2.20, 2.29] |
| Associate + | 3.24 | 3.22 | [3.09, 3.35] | 2.99 | [2.87, 3.11] | 2.98 | [2.93, 3.04] | 3.01 | [2.96, 3.07] |
| Constant | 18.90 | 18.80 | [18.67, 18.94] | 18.70 | [18.58, 18.83] | 18.66 | [18.58, 18.74] | 18.82 | [18.74, 18.90] |
|  |  |  |  |  |  |  |  |  |  |
| Error term variances | | | | | | | | |  | |
| Random intercept | 16.4 | 16.69 | [16.33, 17.07] | 14.4 | [14.07, 14.73] | .. |  | .. |  |
| Random age slope | 0.01 | 0.01 | [0.01, 0.01] | 0.01 | [0.01, 0.01] | .. |  | .. |  |
| Covariance | -0.22 | -0.23 | [-0.24, -0.21] | -0.22 | [-0.23, -0.21] | .. |  | .. |  |
| Idiosyncratic error | 2.62 | 2.61 | [2.59, 2.63] | 2.4 | [2.38, 2.42] | .. |  | .. |  |

# Appendix References

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