ADULT CHILDREN'S EDUCATION AND TRAJECTORIES OF EPISODIC MEMORY AMONG OLDER PARENTS IN THE USA

Manacy Pai[a], Wentian Lu[b], Baowen Xue[b*]

[a] Department of Sociology, Kent State University, Kent, Ohio, USA

[b] Research Department of Epidemiology and Public Health, University College London, London, United Kingdom

[*] Corresponding author. Email: baowen.xue.10@ucl.ac.uk

Abstract

The purpose of this study is to assess the relationship between adult children's education and older parents' cognitive health, and the extent to which this relationship is moderated by parents' own socioeconomic and marital statuses. Data using waves 5 (2000) through 13 (2016) are drawn from the Health and Retirement Study (HRS), a nationally representative panel survey of individuals age 50 and above in the United States (US). Older parents' cognitive functioning is measured using episodic memory from waves 5 through 13. Adult children's education is measured using years of schooling, on average, for all adult children of a respondent. Analyses based on multilevel linear growth curve modelling reveal that parents with well-educated adult children report higher memory score over time compared to their counterparts whose children are not as well-educated. We also find that the positive effect of children's education on parents' cognitive health is moderated by parents' own education, though not by their income, occupation, or marital status. Our work contributes to the growing body of research on the "upward" flow of resources model that assesses the ways in which personal and social assets of younger generation shape the health and well-being of older generation. Our findings are particularly relevant to the US given the enduring linkage between socioeconomic status and health and the limited social and economic protection for those of lower social status.

Introduction

While cognitive performance generally declines with rising age (Harada et al., 2013), the progression and severity of this decline is far from evenly dispersed (de Frias et al., 2007). Specifically, older adults with more education report higher cognitive performance, a deferred onset of cognitive damage, and a relatively reduced risk of dementia compared to their counterparts who are not as well-educated (Clouston, Glymour and Terrera, 2015). Nevertheless, how individuals perform cognitively in later life may be influenced not only by their own education but also by the educational attainment of their family, particularly their adult children. Empirical studies do reveal that older parents with well-educated adult children report fewer physical limitations, reduced psychological distress, greater life satisfaction, and an overall improved life expectancy (Friedman and Mare, 2014; Lee, 2018; Lee et al., 2017; Torssander, 2013; Yahirun, Sheehan and Mossakowski, 2018).

The cognitive health impact of adult children's education is far less explored. While a limited body of research (e.g., Ma, 2019; Lee, 2018; Yahirun, Vasireddy, and Hayward, 2020) is beginning to assess this relationship, the extent to which the link between children's education and parents' cognitive health varies by parents' own social and relational assets remains to be tested empirically. According to the theory of resource substitution (Ross and Mirowsky, 2006), compared to their advantaged peers, those with fewer personal resources (e.g., education, income, power) are more likely to benefit from resources of others.

We employ the Health and Retirement Study (HRS), a nationally representative panel survey, to investigate the relationship between adult children's education and older parents' cognitive health among individuals 50 years and older. Moreover, and more importantly, we assess

whether this relationship is conditioned by parents' own socioeconomic and marital statuses. Understanding what modifiable factors can prevent or protect against cognitive decline is important given that decline in cognition can negatively alter the nature of social roles and relationships (e.g., Aartsen et al., 2004); increase mental distress; and affect quality of life, mobility, morbidity, and life expectancy (Ahn et al., 2009; Kim, Park and An, 2019; Maki et al., 2014; Parikh et al., 2016). Also, unlike past generations, today's parents and children spend several more decades of life together, with adult children shouldering the important and often prolonged responsibility of caregiving. As such, research on later life health should include examining the additive and interactive effects of attributes and assets of both older adults and their adult offspring.

Education and Later Life Cognitive Functioning

The commodity theories of education posit that education positively affects cognition in part through its link to socioeconomic resources of employment, income, and health insurance. While socioeconomic assets are consequential to cognitive health, theories of learned effectiveness suggest that education "develops habits, skills, resources, and abilities that enable people to achieve a better life" (Ross Mirowsky, 2010, p. 33). In addition to more sophisticated reading, writing, reasoning, and problem-solving skills, which improve brain functioning through cognitive reserve (e.g., Stern, 2012), higher education also is associated with greater belief in science, better access to health knowledge, early adoption of a health promoting lifestyle, and fewer risky health behaviours (CDC, 2013; Cutler and Lleras-Muney, 2010; Margerison-Zilko and Cubbin, 2012; Pampel, Krueger and Denny, 2010), all of which reflect better self-care and reduced risk of chronic conditions, such as obesity, hypertension, diabetes, heart disease, and stroke, which, in turn, are strong correlates of cognitive decline (Case, Fertig and Paxton, 2005; Clouston et al., 2012; Dodd, 2015; Dye et al., 2017; Yohannes et al., 2017; Leto and Feola, 2014; Levine et al., 2015; Taylor et

al., 2020). Education also means greater opportunities to meet people outside of immediate kin and develop social skills that help not only to initiate but preserve social relationships (Fischer and Beresford, 2015; Kohli, Hank and Künemund, 2009). Social relationships protect against cognitive distress (Kuiper et al., 2016). All these health benefits attached to education, nonetheless, can also spill over (Friedman and Mare, 2014) to members of a social network – especially one's family.

Adult Children's Education and Older Parents' Cognitive Functioning

Repeated scientific inquiry finds support for the "downward" flow of resources model showing us how educated parents prove immeasurably beneficial for the health and well-being of their children (Hayward and Gorman, 2004; Mare, 2011). Likewise, research on the "upward" flow of resources model suggests how well-educated children positively impact the health of older parents (Friedman and Mare, 2014; Lee, 2018; Lee et al., 2017; Yahirun, Sheehan and Mossakowski, 2020). According to the life course perspective's "linked lives" principle, the lives of family members are interdependently connected through shared expectations, experiences, and resources (Elder, Johnson and Crosnoe, 2003). Education is one such resource whose benefits extend beyond the individual to their social network. According to the social capital theory, educational accomplishments of one person may be consequential for the physical, mental, and social well-being of others in that network (Song and Chang, 2012). Adult children who often are a source of emotional, social, and instrumental support (Hogan and Eggebeen, 1995; Zarit and Eggebeen, 2002), serve as a medium through which personal resources are transmitted to other family members, namely older parents. The ability to help effectively, however, may be influenced by assets such as education. Like children who benefit from having more educated parents, parents in later life may benefit from having children who are well-educated.

Better-educated children may act as a mechanism of social control where they discourage risky health habits and instead push parents toward behaviours more beneficial to health, including proper diet, physical exercise, utilization of health services, and compliance with medication, which are linked to later life cognition (Cadar et al., 2012). Social learning theorists (e.g., Bandura, 1962) posit that children learn by observing their parents; it is just as likely then that parents are socialized into newer and healthier ways of living by observing their adult children (Friedman and Mare, 2014).

Better-educated children are in a better position to help parents in need. Recent research, for example, uncovers the physiological health benefits of having well-educated children by reporting an inverse association between adult children's education and older parents' risk for inflammation (Lee, 2018). Adult children's education also is linked to better physical functioning among older parents (Zimmer, Hermalin and Lin, 2002). Moreover, according to the "linked lives" principle, the stress felt by one family member often reverberates through the entire family (Elder et al., 2003). Adult children who grapple with economic instability and unsteady relationships are a source of mental distress for older parents (Greenfield and Marks, 2006). Alternatively, given that higher education is linked to economic and social stability (Hout, 2012), parents of well-educated children are far less psychologically and physically distressed (Lee et al., 2017; Ryff et al., 1994). These very mechanisms that explain the physical and psychological effects of children's education on their parents have the potential to explain its impact on parents' cognitive health. For instance, better-educated children may have knowledge of cognitively stimulating activities that could delay the onset of dementia; that knowledge may get transmitted to ageing parents, which consequently could positively shape their cognitive health. While Lee (2018); Ma (2019); and Yahirun, Vasireddy and Hayward (2020) do find cognitive health benefits of having well-educated

children, the extent to which this relationship is conditioned by the parents' own social and economic resources remains an empirically untested line of inquiry.

Resource Substitution Theory

The theory of resource substitution of education and health posits that education is more consequential to the health of individuals who are otherwise socially and economically disadvantaged (Ross and Mirowsky, 2006, 2010). Those with fewer personal, social, and economic means depend more on education for health than their peers with other flexible resources (e.g., income, wealth, power). "Resource substitution theory predicts that education interacts with disadvantaged social origins, such that education has a larger effect on health for individuals who grew up in families with poorly educated parents than it does for the more advantaged" (Ross and Mirowsky, 2011, p. 592). Based on this premise of the theory of resource substitution, we argue that adult children's education -- an achieved asset -- matters more for those parents who themselves are not as socioeconomically well-situated. We posit that compared to their well-to-do counterparts, for older adults with fewer social and economic resources, the education of adult children becomes a substitutable or transposable resource that is consequential for their cognitive health.

Older Parents' Own Socioeconomic Status (SES) and Marital Status as Moderators

Based on the resource substitution theory, there are a few reasons why adult children's education may matter more for older adults with fewer personal resources. Unlike their more educated peers, older adults with fewer years of education may not have comparable access to health knowledge or cultural health capital (Shim, 2010). They also may be more susceptible to other later life stressors, including loss of income, insufficient income following retirement, and chronic illnesses (Kaplan and Berkman, 2019). Having well-educated children, therefore, may

7

mean more to the socioeconomically disadvantaged than it does to advantaged older adults. Moreover, compared to lower-SES parents, parents of higher SES may rely more on their own human capital and hesitate to seek help from children. One caveat to this argument, however, is that children with more education are more likely to live farther away from their parents (Malamud and Wozniak 2012; Machin, Salvanes and Pelkonen, 2012), potentially limiting the care they can provide to ageing parents.

Like SES, marital relationship also represents a critical social resource upon which individuals depend for emotional, social, and instrumental needs. As such, research shows that transitions such as separation, divorce, and spousal death often result in physical and psychological distress, even if it is short-lived (Amato, 2000; Hansson and Stroebe, 2007; Holmes and Rahe, 1967). Both spousal death and divorce often represent loss of income, a confidant, a form of social control, and a source of emotional and instrumental support (Amato, 2000; Utz et al. 2004). Unmarried older adults are more socioeconomically disadvantaged than their married counterparts. And ample research has documented the psychological health benefit of married persons compared to their single counterparts (e.g., Pudrovska, Schieman and Carr, 2006; Umberson, Wortman and Kessler, 1992). Even after controlling for education, unmarried older adults are significantly poorer and endure a disproportionately higher risk of disability compared to their married peers (Lin and Brown, 2012). As such, adult children are most likely to step in as support providers when parents encounter marital dissolution. For instance, studies have shown that while through most of their lives, parents give more support than they receive, this equation changes when parents become widowed (Ha, 2008; Ha et al., 2006). Again, based on the theory of resource substitution, we assume that the positive impact of adult children's education on cognitive health is most foreseeable in the case of older parents without a partner as opposed to their partnered counterparts.

Summary, Aims, and Hypotheses

Understanding how children's resources improve older parents' cognitive functioning is important in identifying both older adults susceptible to cognitive decline and family-level resources that are most critical in preventing or slowing such a decline. This also is important as practitioners work to allocate health services and resources among those older adults with cognitive difficulties. We contribute to this task by assessing the relationship between adult children's education and older parents' cognitive health in the US. We also explore whether this relationship is moderated by older parents' own SES (namely educational attainment, income, and occupation) and marital status. We have two hypotheses guiding our study. *Hypothesis 1*: Adult children's education positively affects parents' episodic memory over time, such that those with better-educated children report a better memory trajectory than their counterparts with less well-educated offspring. *Hypothesis 2*: The positive impact of children's education on parents' episodic memory trajectory is stronger for parents who are less socioeconomically advantaged and those who are not living with a partner.

Methods

Data and Sample

This study employs waves 5 (2000) through 13 (2016) of the Health and Retirement Study (HRS). HRS, conducted by the University of Michigan, is a nationally representative longitudinal panel survey of approximately 20,000 individuals age 50 and above and their spouses in the US (Sonnega et al., 2014). It is supported by the National Institute on Aging (NIA U01AG009740) and the Social Security Administration. This cohort was first interviewed in 1992 (response rate is 81.6 percent) and subsequently every two years since then. The subcohorts were added at different stages of the HRS. HRS consists of seven subcohorts, including Initial HRS cohort (born 1931 to

1941): AHEAD (born before 1924); CODA (born 1924 to 1930); War Baby (born 1942 to 1947); and Early, Mid, and Late Baby Boomer (born after 1947). We did not use cohorts of Early, Mid, and Late Baby Boomer in our analysis because these cohorts were added after Wave 5. We began our analysis with wave 5, as a complete "census" of the schooling for all of the respondents' children was taken in that year.

We presumed that the survival effect might be a problem for the oldest-old in particular, that is, participants in the HRS aged 90+ are much healthier and have better cognitive function than their peers (aged 90+) who were not interviewed in the HRS. Additionally, previous research has revealed different results on the association between cognitive reserve (e.g., own education) and cognition decline among oldest-old (Cadar et al., 2016; Peltz et al., 2011). For example, higher reserve is not associated with cognitive decline or incident dementia among the oldest-old (Lavrencic et al., 2018). It is reasonable to assume that factors contributing to cognitive decline in the oldest-old may differ from causes attributed to cognitive decline in their young-old counterparts. Consequently, we chose not to include those aged 90+ in the main analysis.

Our sample is, therefore, composed of older adults aged 50 to 90 who reported having at least one adult child (here, defined as aged 25 or above) between wave 5 and wave 13. Wave 13 is the most recent wave used in present analysis. Cognitive measures when the oldest offspring was younger than 25 years old were excluded to ensure that the outcome transpired after the exposure. We included only participants who have at least two time points of valid measures of cognition (maximum nine time points), so as to contribute to the growth curve model. Participants with missing data at baseline were also excluded. The sample size for analysis was 11,086. See Figure 1 for the procedure of sample selection.

< Insert Figure 1 about here >

10

Measures

Older parents' cognitive assessments in the HRS include a widely used measure of episodic memory (Ofstedal et al., 2005), which is deemed a reliable indicator of preclinical signs of dementia (Bäckman et al, 2005). Episodic memory was assessed in a standardised way in each wave via two word recall tests: Respondents were read a series of 10 words and then asked to immediately recall as many words as possible in any order (immediate recall: range 0–10). After five minutes, respondents were asked to recall as many of the original words as possible in any order (delayed recall: range 0–10). From these we summed the number of words recalled (range 0–20), with higher scores indicating better episodic memory. Scores from the multiple waves were used to permit modelling of change in episodic memory over the follow-up period.

Our main independent variable of interest was adult children's education. Information on years of schooling of each child was collected in the HRS at wave 5 (our baseline). For children under age 30 and in school at baseline, years of schooling were remeasured in following waves, and the latest information on schooling was used in this study. There are many ways to parameterize adult children's education. In this analysis, we averaged the years of schooling for all adult children of a respondent (continuous variable). Consistent with prior research (Friedman and Mare, 2014; Yahirun, Vasireddy and Hayward, 2020), we include information only for those adult children aged 25 or older. Although not all adults have completed their schooling by age 25, limiting the offspring to those aged 25 and older eliminates most of those who are still in school (Yahirun and Arenas, 2018).

We included a number of characteristics of older parents as covariates. Time-fixed covariates include gender, race, parental education, and number of children. Race includes White/Caucasian and Black/African American/Other (<3 percent is Other). Parental education was

measured using the International Standard Classification of Education 1997, including the first stage of tertiary education/above (associate degree, bachelor's degree, or above); upper secondary education (general educational development or high school); lower secondary education (no degree but attained 8-12 years of schooling); and the primary education/below (no degree and attained <8 years of schooling). Time-varying covariates (at each wave) include parental occupation combined with labour forces status, household income per person (tertiles based on all HRS respondents in each wave), marital status (married/partnered; separated/divorced/spouse absent; widowed), smoking (nonsmokers; ex-smokers; current smokers), days of alcohol consumption per week, vigorous physical activity (yes/no), and chronic conditions (high blood pressure, diabetes, lung disease, heart problems, stroke, cancer, arthritis, and psychological problems). Medication and treatment for each chronic condition were accounted for as well.

Potential moderators we have tested are highest educational qualification, occupation, household income per person, and marital status of each older parent. Measures of the four moderators were described in the *Covariates* section above.

Statistical method

We applied linear growth curve models to estimate the association between adult children's education and older parents' episodic memory over time. In our model, the joint distribution of the observed episodic memory scores across waves is characterized as a function of age, age-squared, adult children's education, and other covariates. In the Basic Model, we controlled for covariates including personal characteristics (i.e., gender, race, marital status, and number of children), and parental SES at individual (i.e., parental education and occupation) and household (i.e., household income per person) levels. In the Fully Adjusted Model, we additionally controlled for health behaviours (i.e., smoking, days of alcohol consumption, vigorous physical activity) and eight

12

chronic conditions. Individual variation is expressed as random effects that are allowed to vary across individuals (Stata command, *xtmixed*). To visualise the results from these regressions, we show predicted trajectories of episodic memory across tertiles of adult children's schooling based on the Fully Adjusted Model (Stata command, *margins* and *marginsplot*).

The moderating effect of parents' SES (i.e., parental education, parental occupation, household income) or marital status was tested by including an interaction term (adult children's education × parental SES or marital status) to build the Interaction Model. The likelihood ratio test was applied to test the significance of the interaction terms. In the next step, analysis was stratified by parental SES if the interaction term was statistically significant (P-value <0.05). Predicted trajectories of episodic memory based on the Interaction Model were shown.

Sensitivity analyses

Several sensitivity analyses were performed to test the robustness of our results. We first conducted a sensitivity analysis using different constructions of adult children's education, including using the oldest child's years of schooling (Torssander, 2013) and the share of children with a college education (Yahirun, Sheehan and Hayward, 2017). Second, we included an interaction term between race and adult children's schooling into our models to test the extent to which race moderated the association between adult children's schooling and older parents' episodic memory. We did this because existing research reveals a higher incidence of dementia, including Alzheimer's disease among Black Americans compared to their non-Hispanic White counterparts (Weuve et al., 2018). At the same time, we are aware of race disparities in education, income, and wealth (Williams, Priest and Andersen, 2016). Education, particularly, is consequential to not just onset but progression of cognitive decline (Lövdén et al., 2020). Third, we conducted a sensitivity analysis by including in our sample adults aged 90+.

All analyses were performed using Stata SE 15.0.

Results

Table 1 shows the baseline descriptive characteristics of older parents. Their mean age was 65 years (S.D.=7.8). Of all selected older parents, 60 percent were women and 83 percent were White or Caucasian; 72 percent were married, and 16 percent were widowed. On average, each parent had around 4 (S.D.=2.6) children. More than half of the parents had an upper secondary educational qualification; 23 percent had a first stage of tertiary education or above, while 6 per cent had only primary education or below. As for jobs, 13 percent were in a managerial or professional occupation, one in eight had a technical/sales/administrative support occupation and 41 percent were retired. At baseline, 16 percent were current smokers, and 29 percent were drinkers. More than half of them had not done any vigorous physical activities per week during the previous 12 months. Arthritis was the most common (56 percent) chronic disease for these older parents, but less than half of those with arthritis were taking medications and/or treatments. Of the sample, 48 percent had high blood pressure, and most cases were being treated. Less than 10 percent of the sample had lung diseases, cancer, stroke, or psychological problems, and about 15 per cent had diabetes or heart problems. The mean score of episodic memory was 10.3 (S.D.=3.6), suggesting that around 10 out of 20 words were recalled correctly. The mean years of schooling for adult children were 13.6 (S.D.=2.2). The univariate relationships suggested that all covariates were significantly associated with adult children's education and/or episodic memory, except for lung diseases and cancer.

< Insert Table 1 about here >

Table 2 shows the associations between adult children's education and older parents' episodic memory from the linear growth curve models. In the Basic Model, the coefficient for

14

adult children's schooling was 0.13 (95%CI: 0.11–0.16), suggesting that older parents' episodic memory score increased by 0.13 with every one extra year of adult children's schooling. After covariates were fully adjusted, the coefficient for adult children's schooling changed slightly to 0.12 (95%CI: 0.09–0.14). In terms of covariates, women, White/Caucasian participants, drinkers, and those in a managerial or professional occupation had higher memory scores. Parental education and household income were positively associated with memory scores while number of children was negatively associated with memory. Marital status and smoking were not associated with memory. Those who were currently taking medications or receiving treatments for diabetes or psychological problems had lower memory scores than those without the chronic conditions. Stroke was strongly associated with lower memory scores, regardless of whether the participant was taking medication/treatment. Older parents' episodic memory scores changed with increasing age in a quadratic way. Predicted trajectories of episodic memory with increasing age (by tertiles of adult children's schooling) are shown in Figure 2.

< Insert Table 2 about here >

< Insert Figure 2 about here >

We tested the interaction between adult children's education and parents' marital status and SES (parental education, parental occupation, and household income per person). We found that only parental education was a significant moderator (likelihood ratio test: p-value=0.03). Interaction results in Table 2 show that the association between adult children's education and older parents' cognitive function was stronger for those older parents who had a lower secondary education (coefficient=0.10, 95%CI: 0.03–0.16) or a primary education or below (coefficient=0.08, 95%CI: 0.002–0.16) than for those with first stage of tertiary education or above.

15

Stratified results by parental education are shown in Table 3. After accounting for all covariates, we found that every one extra year of adult children's schooling was associated with 0.08 (95%CI: 0.03–0.12) higher memory score for parents with a first stage of tertiary education or above, 0.12 (95%CI: 0.09–0.15) higher memory score for parents with an upper secondary education, 0.15 (95%CI: 0.10–0.21) for lower secondary education, and 0.16 (95%CI: 0.09–0.22) for primary education or below. Predicted trajectories of episodic memory with adult children's schooling across parental education levels are shown in Figure 3. Older parents with first stage of tertiary education or above had on average the highest memory score (higher intercept), but older parents with lower levels of education benefited more from adult children's schooling (steeper slope): With the increase of adult children's schooling, episodic memory scores increased at quicker rates among older parents with lower levels of education compared with their counterparts with the first stage of tertiary education or above. Adult children's schooling helped to narrow the gap of memory score between older parents with different levels of education.

< Insert Table 3 about here >

< Insert Figure 3 about here >

For sensitivity analysis, Supplementary Table S1 and Table S2 show results for the associations between share of children with a college education, oldest child's years of schooling, and parents' episodic memory, respectively. Older parents with some or all children having a college degree had significantly higher episodic memory scores compared with those who had no children with a college degree (Table S1); and older parents' episodic memory scores increased significantly with the increase of the oldest child's years of schooling (Table S2). Therefore, consistently, we found that different measures of adult children's education, as indicators of children's SES, were all positively associated with episodic memory of older parents in the US.

Supplementary Table S3 presents results for the association between adult children's schooling and episodic memory scores, considering the interaction between race and adult children's schooling. This interaction was statistically nonsignificant (-0.02 [95%CI: -0.07, 0.03], P-value=0.350), suggesting that race was not a moderator in the association between adult children's schooling and older parents' episodic memory scores, and thus, stratified analysis by race was not conducted. Supplementary Table S4 presents results for the association between adult children's schooling and older parents' episodic memory scores, including participants aged 90+. Results for the association between adult children's schooling and episodic memory scores emerged comparable to the original findings. However, the moderating role of parents' own education (parental education × adult children's schooling) was weakened, suggesting that factors contributing to cognitive decline in the oldest-old may differ from causes attributed to cognitive decline in their young-old counterparts.

Discussion

A growing body of work examines the "upward" flow of resources model to understand the extent to which older parents' health is influenced by adult children's resources. We contribute to this literature by assessing the impact of adult children's education on older parents' cognitive health. Importantly, we also investigate whether this relationship between children's education and parents' cognitive performance is moderated by parents' own social and economic resources. Our analyses based on the HRS data reveal that parents with well-educated adult children have higher episodic memory trajectories than their peers whose children are relatively less educated (Hypothesis 1 is supported). We also find that the positive effect of children's education on parents' memory trajectories is even stronger for parents who had lower levels of education. (Hypothesis 2 is partially supported).

Our results are consistent with the recent findings that children's education is negatively and independently associated with cognitive functioning among older parents in the US (Yahirun, Vasireddy and Hayward, 2020), in South Korea (Lee, 2018) and in China (Ma, 2019). They also mirror findings from studies that assess the link between children's schooling and other health outcomes for parents, including depressive symptoms (Lee et al., 2017; Yahirun, Sheehan and Mossakowski, 2020), physiological dysregulation (Lee, 2018), and life expectancy (Friedman and Mare, 2014; Torssander, 2013). Moreover, our findings support the linked lives principle, which refers to the ways in which generations are linked to one another through their shared resources (Elder et al., 2003). Parents, for instance, contribute to their children's health and well-being through their human, social, and cultural capital; and through their genetic makeup, they shape their children's cognitive and noncognitive assets. Parents also, however, make deliberate investments in their children by educating them. They do so knowing that education is the pathway to higher social status, independence, and health. But findings from our study show that the benefits of educating children are not just limited to the children; instead, parents too are able to reap the dividends of this important investment. Future research should consider examining the relevance of children's education while also assessing the educational assets of other family members, including one's siblings and grandchildren. Given that an increasing number of the older adults are parenting their grandchildren (Choi, Sprang and Eslinger, 2016), it would be interesting to discern the extent to which grandchildren's education shapes cognitive health of grandparents.

Based on the resource substitution theory (Ross and Mirowsky, 2006), we assumed that having well-educated children would prove more valuable to socioeconomically disadvantaged than advantaged parents. Our results partially support this hypothesis. The strength of the relationship between children's education and parents' cognitive health varies by parents' SES,

18

namely their own education. Parents with less education benefit more from the increase of adult children's schooling than their peers who are well-educated themselves. One, well-educated parents may already have access to human capital accrued from their own education; two, based on the concept of network homogeneity (McPherson, Smith-Lovin and Cook, 2001), it is reasonable to assume that well-educated parents may have friends who also are similarly educated and form a strong source of support for them; and, three, well-educated parents may refrain from asking for help from their children. Given that received support may undermine parents' sense of worth and independence (Bolger and Amarel, 2007), it is likely that well-educated parents who are in an advantaged position compared to their less educated peers feel reluctant to rely on their children for support.

Although parents' own education acted as a moderator, their income and occupation did not moderate the effect of their children's education on their cognitive health. This may reflect more broadly the differential roles played by education, income, and occupation in shaping health (Herd, Goesling and House, 2007). For instance, while income can slow the progression of health problems by enabling access to quality health care, education delays the onset of health hassles by shaping social and psychological resources, such as social support, mastery, and self-esteem (Ross and Mirowsky 2003), which are known to reduce stress, which correlates with higher cognition (Sandi, 2013; Scott et al., 2015). Also, it is education that is more directly linked to the adoption of healthy lifestyles and the avoidance of risky health behaviours (CDC, 2013; Cutler and Lleras-Muney, 2010; Margerison-Zilko and Cubbin, 2012; Pampel, Krueger and Denny, 2010). It is possible then that these benefits attached to education are shared between generations where parents of well-educated children feel more self-efficacious as they are able to benefit from the health knowledge that their educated children share. Given that education is associated with wider

social network and greater social support (Fischer and Beresford, 2015; Kohli et al., 2009), it also is reasonable to assume then that parents with less education may benefit from the social capital that is accrued to their children who are more educated. Finally, it is not far-fetched to assume that different indicators of socioeconomic status are differentially consequential for cognitive health at varying stages of the life course.

Based on the resource substitution theory, we also expected marital status to moderate the relationship between children's education and parents' cognitive functioning. Research suggests that the positive health consequences of social support are most evident among older adults who are most in need, including those who are single or in poor physical health (Silverstein and Bengtson, 1994). Consequently, we expected having well-educated children would benefit single older adults more than their married counterparts, given that the latter tend to be socially and financially more advantaged than the former (Lillard and Waite, 1995). Contrary to this expectation, however, our study did not find significant interaction between parents' marital status and children's education, and marriage itself was not associated with cognition. This is in line with Lyu and colleagues' (2014) study where marital status is linked to cognition among older adults in South Korea but not the US. This may reflect the reality that the efficacy of the intergenerational exchange of support is predicated on both the individual traits of parents and children and the nature and quality of their relationship. Assessing the extent to which the cognitive health impact of children's personal assets, such as education, varies by parents' marital status may require future research to also consider the ambiguities characteristic of parent-child relations. Moreover, given that geographic closeness is positively associated with parent-child relations and support exchange (e.g., Hank, 2007; Mulder and van der Meer, 2009), future studies should consider the role played

by parent-child geographical proximity, including coresidence, in conditioning the relationship between children's education and parents' cognition and marital status.

In our effort to illuminate the link between children's education and parents' cognitive health, we also adjusted for a variety of conceptually relevant health behaviours (smoking, alcohol consumption, and regular physical exercise) and noncommunicable health conditions (diabetes, stroke, and psychological problems) that are likely related to both children's education and parents' cognitive health. While we found support for assumptions of health-related behaviours including alcohol consumption and vigorous physical activity, as well as assumptions of chronic conditions including diabetes, stroke and psychological problems, findings also revealed that the primary relationship between children's education and older parents' cognitive health did not change distinctly after adjusting for these covariates. Hence, while our findings do not undermine the relevance of health behaviours and lifestyles to later life cognition, they do permit us to conclude with greater confidence that children's education plays a crucial role in shaping their older parents' cognitive health over time.

Limitations

First, while we controlled for several behavioural and sociodemographic variables conceptually relevant to children's education and parents' cognition, our analyses did not account for quality of parent-child relationship and parents' personality. Since data to measure parent-child relationship quality and parents' personality had been collected in HRS only from 2006 onward among two random 50 percent panel subsamples (Smith et al., 2017), the present analysis was precluded from using these measures. It is reasonable to assume that older parents are more likely to rely on their children and that children are more likely to support their parents in a meaningful way if both share a positive relationship. Similarly, parents who score high on certain personality

traits may be better positioned to make the most of having well-educated children. For example, parents who score high on openness may be in a better position to learn new habits, lifestyles, and activities from their children who are well-educated. Similarly, parents who are highly agreeable may be willing to both give and seek help (McCrae and John, 1992). It is possible then that parents who are highly agreeable are better able to garner the advice and support well-educated children are in the position to offer. While the HRS does contain measures for intergenerational transfer of money, which potentially could reflect relationship quality, controlling for this in the analysis was not feasible given the significantly small proportion of participants responding to this question.

Second, we conducted analysis based on complete sample size at baseline (N=11,086, see Figure 1). We excluded respondents represented by a proxy (about 10 per cent of the HRS sample in each wave), as the proxy was only asked to rate respondent's memory subjectively. Therefore, distributions across the covariates and dependent variables of episodic memory might be affected by sample selection over the follow-up period, which may introduce bias in the relationship between children's educational attainment and older parents' episodic memory found in our study. Third, we employed only word recall tests to measure cognitive health. Other cognitive measures in the HRS, such as the numeracy tests, date-naming tests to represent orientation to date, and the vocabulary measure to represent crystallized intelligence, were not considered in our study, since they were measured among those aged 60 and above only from wave 5 onward (e.g., N=17,517 for word recall tests versus N=9,504 for date-naming tests in wave 5) (McCammon et al., 2019).

Conclusion

Despite these limitations, our findings carry important public health implications. Our finding that children's education is associated with parents' better episodic memory highlights that investing in children's education is critical to prolonging parents' cognitive well-being. Put

simply, the more educated children are, the more capable they are to positively shape the cognitive health trajectories of their parents. Moreover, our finding that the positive association between children's education and parents' cognitive health is even stronger for parents with less education underscores the relevance of cultivating education as a family-level resource. These findings are particularly pertinent to a country like the US, where families find it increasingly difficult to invest in their children, given the escalating costs of education (Bleemer et al., 2017); where increasing number of older adults are living with debilitating cognitive illnesses, such as Alzheimer's; and where the relationship between socioeconomic status and health remains strong and long-lasting (Link and Phelan, 1995).

References

Aartsen, M. J., Van Tilburg, T., Smits, C. H. and Knipscheer, K.C. (2004). A longitudinal study of the impact of physical and cognitive decline on the personal network in old age. *Journal of Social and Personal Relationships*, **21**, 249-266.

Ahn, I. S., Kim, J. H., Kim, S., Chung, J. W., Kim, H., Kang, H. S. and Kim, D. K. (2009). Impairment of instrumental activities of daily living in patients with mild cognitive impairment. Psychiatry Investigation, **6**, 180–184.

Amato, P. R. (2000). The consequences of divorce for adults and children. *Journal of Marriage and Family*, **62**, 1269–1287.

Bäckman, L., Jones, S., Berger, A.K., Laukka, E. J. and Small, B. J. (2005). Cognitive impairment in preclinical Alzheimer's Disease: A meta-analysis. *Neuropsychology*, **19**, 520-531.

Bandura, A. (1962). Social learning through imitation. In *Nebraska Symposium on Motivation,* Univer. Nebraska Press, 211-274.

Bleemer, Z., Brown, M., Lee, D. and Strair, K. (2017). Echoes of rising tuition in students' borrowing, educational attainment, and homeownership in post-recession America. Journal of Urban Economics,**122**, 103298.

Bolger, N. and Amarel, D. (2007). Effects of social support visibility on adjustment to stress: experimental evidence. *Journal of Personality and Social Psychology,* **92**, 458–475.

Cadar, D., Stephan, B. C., Jagger, C., Johansson, B., Hofer, S. M., Piccinin, A. M. and Muniz-Terrera, G. (2016). The role of cognitive reserve on terminal decline: a cross-cohort analysis from two European studies: OCTO-Twin, Sweden, and Newcastle 85+, UK. *International journal of geriatric psychiatry*, **31**, 601–610.

Cadar, D., Pikhart, H., Mishra, G., Stephen, A., Kuh, D. and Richards, M. (2012). The role of lifestyle behaviors on 20-year cognitive decline. *Journal of aging research*, **2012**, 304014.

Case, A., Fertig, A. and Paxson, C. (2005). The lasting impact of childhood health and circumstance. *Journal of Health Economics*, **24**, 365–389.

Centers for Disease Control and Prevention (CDC) (2013). Adult participation in aerobic and muscle-strengthening physical activities--United States, 2011. *MMWR. Morbidity and mortality weekly report*, **62**, 326–330.

Choi, M., Sprang, G. and Eslinger, J. G. (2016). Grandparents raising grandchildren: A synthetic review and theoretical model for interventions. *Family & Community Health*, **39**, 120–128.

Clouston, S. A., Kuh, D., Herd, P., Elliott, J., Richards, M. and Hofer, S. M. (2012). Benefits of educational attainment on adult fluid cognition: International evidence from three birth cohorts. *International Journal of Epidemiology*, **41**, 1729–1736.

Clouston, S. A. P., Glymour, M. M. and Terrera, G. M. (2015). Educational inequalities in aging-related declines in fluid cognition and the onset of cognitive pathology. *Alzheimer's & Dementia: Diagnosis, Assessment & Disease Monitoring*, **1**, 303–310.

Cutler, D. M. and Lleras-Muney, A. (2010). Understanding differences in health behaviors by education. *Journal of health economics*, **29**, 1–28.

de Frias, C. M., Lövdén, M., Lindenberger, U. and Nilsson, L.-G. (2007). Revisiting the dedifferentiation hypothesis with longitudinal multi-cohort data. *Intelligence*, **35**, 381–392.

Dye, L., Boyle, N. B., Champ, C. and Lawton, C. (2017). The relationship between obesity and cognitive health and decline. *The Proceedings of the Nutrition Society*, **76**, 443–454.

Elder, G. H., Johnson, M. K. and Crosnoe, R. (2003). The emergence and development of life course theory. In J. T. Mortimer and M. J. Shanahan (Eds.), *Handbook of the Life Course*. Springer US, 3-19.

Fischer, C. S. and Beresford, L. (2015). Changes in support networks in late middle age: The extension of gender and educational differences. *The Journals of Gerontology: Series B*, **70**, 123–131.

Friedman, E. M. and Mare, R. D. (2014). The schooling of offspring and the survival of parents. *Demography*, **51**, 1271–1293.

Greenfield, E. A. and Marks, N. F. (2006). Linked lives: Adult children's problems and their parents' psychological and relational well-being. *Journal of Marriage and Family*, **68**, 442–454.

Ha, J. H. (2008). Changes in support from confidants, children, and friends following widowhood. *Journal of Marriage and Family*, **70**, 306–318.

Ha, J. H., Carr, D., Utz, R. L. and Nesse, R. (2006). Older adults' perceptions of intergenerational support after widowhood: How do men and women differ? *Journal of Family Issues*, **27**, 3–30.

Hank, K. (2007). Proximity and contacts between older parents and their children: A European comparison. *Journal of Marriage and Family*, **69**, 157–173.

Hansson, R. O. and Stroebe, M. S. (2007). *Bereavement in Late Life: Coping, Adaptation, and Developmental Influences*. American Psychological Association, 219.

Harada, C. N., Natelson Love, M. C. and Triebel, K. (2013). Normal cognitive aging. *Clinics in Geriatric Medicine*, **29**, 737–752.

Hayward, M. D. and Gorman, B. K. (2004). The long arm of childhood: The influence of early-life social conditions on men's mortality. *Demography*, **41**, 87–107.

Herd, P., Goesling, B. and House, J. S. (2007). Socioeconomic position and health: The differential effects of education versus income on the onset versus progression of health problems. *Journal of Health and Social Behavior*, **48**, 223–238.

Hogan, D. P. and Eggebeen, D. J. (1995). Sources of emergency help and routine assistance in old age. *Social Forces*, **73**, 917–936.

Holmes, T. H. and Rahe, R. H. (1967). The social readjustment rating scale. *Journal of Psychosomatic Research*, **11**, 213–218.

Hout, M. (2012). Social and economic returns to college education in the United States. *Annual Review of Sociology*, **38**, 379–400.

Kaplan, D. B. and Berkman, B. (2019). Social Issues in the Elderly. In *The Merck Manual for Health Care Professionals: Geriatrics*. Merck Sharp & Dohme Corp.

Kim, J., Park, E. and An, M. (2019). The cognitive impact of chronic diseases on functional capacity in community-dwelling adults. *The Journal of Nursing Research*, **27**, 1–8.

Kohli, M., Hank, K. and Künemund, H. (2009). The social connectedness of older Europeans: Patterns, dynamics and contexts. *Journal of European Social Policy*, **19**, 327–340.

Kuiper, J. S., Zuidersma, M., Zuidema, S. U., Burgerhof, J. G. M., Stolk, R. P., Oude Voshaar, R. C. and Smidt, N. (2016). Social relationships and cognitive decline: A systematic review and meta-analysis of longitudinal cohort studies. *International Journal of Epidemiology*, **45**, 1169–1206.

Lavrencic, L. M., Richardson, C., Harrison, S. L., Muniz-Terrera, G., Keage, H., Brittain, K., Kirkwood, T., Jagger, C., Robinson, L. and Stephan, B. (2018). Is There a Link Between cognitive Reserve and Cognitive Function in the Oldest-Old?. *The journals of gerontology. Series A, Biological sciences and medical sciences*, **73**, 499–505.

Lee, C. (2018). Adult children's education and physiological dysregulation among older parents. *The Journals of Gerontology: Series B*, **73**, 1143–1154.

Lee, C., Glei, D. A., Goldman, N. and Weinstein, M. (2017). Children's education and parents' trajectories of depressive symptoms. *Journal of Health and Social Behavior*, 58(1), 86–101.

Lee, Y. (2018). Adult children's educational attainment and the cognitive trajectories of older parents in South Korea. *Social Science & Medicine*, **209**, 76–85.

Leto, L. and Feola, M. (2014). Cognitive impairment in heart failure patients. *Journal of geriatric cardiology: JGC*, **11**, 316–328.

Levine, D. A., Galecki, A. T., Langa, K. M., Unverzagt, F. W., Kabeto, M. U., Giordani, B. and Wadley, V. G. (2015). Trajectory of Cognitive Decline After Incident Stroke. *JAMA*, **314**, 41–51.

Lillard, L. A. and Waite, L. J. (1995). 'Til death do us part: Marital disruption and mortality. *American Journal of Sociology*, **100**, 1131–1156.

Lin, I. F. and Brown, S. L. (2012). Unmarried boomers confront old age: A national portrait. *The Gerontologist*, **52**, 153–165.

Link, B.G. and Phelan, J.C. (1995). Social conditions as fundamental causes of disease. *Journal of Health and Social Behavior,* 80-94.

Lövdén, M., Fratiglioni, L., Glymour, M. M., Lindenberger, U. and Tucker-Drob, E. M. (2020). Education and Cognitive Functioning Across the Life Span. *Psychological Science in the Public Interest*, **21**, 6–41.

Lyu, J., Lee, C. M. and Dugan, E. (2014). Risk factors related to cognitive functioning: A cross-national comparison of U.S. and Korean older adults. *The International Journal of Aging and Human Development*, **79**, 81–101.

Ma, M. (2019). Does children's education matter for parents' health and cognition? Evidence from China. *Journal of Health Economics*, **66**, 222–240.

Machin, S., Salvanes, K. G. and Pelkonen, P. (2012). Education and mobility. *Journal of the European Economic Association*, 10(2), 417–450.

Maki, Y., Yamaguchi, T., Yamagami, T., Murai, T., Hachisuka, K., Miyamae, F., Ito, K., Awata, S., Ura, C., Takahashi, R. and Yamaguchi, H. (2014). The impact of subjective memory complaints on quality of life in community-dwelling older adults. *Psychogeriatrics*, **14**, 175–181.

Malamud, O. and Wozniak, A. (2012). The impact of college education on geographic mobility. *Journal of Human Resources*, **47**, 913–950.

Mare, R. D. (2011). A multigenerational view of inequality. *Demography*, **48**, 1–23.

Margerison-Zilko, C. and Cubbin, C. (2013). Socioeconomic disparities in tobacco-related health outcomes across racial/ethnic groups in the United States: National Health Interview Survey 2010. *Nicotine & tobacco research: official journal of the Society for Research on Nicotine and Tobacco*, **15**, 1161–1165.

McCammon, R., Fisher, G., Hassan, H., Faul, J., Rogers, W. and Weir, D. (2019). *Health and Retirement Study Imputation of Cognitive Functioning Measures: 1992-2016*. Survey Research Center, University of Michigan.

McCrae, R. R. and John, O. P. (1992). An introduction to the five-factor model and its applications. *Journal of Personality,* **60**, 175-215.

McPherson, M., Smith-Lovin, L. and Cook, J. M. (2001). Birds of a feather: Homophily in social networks. *Annual Review of Sociology*, **27**, 415–444.

Mulder, C. H. and van der Meer, M. J. (2009). Geographical distances and support from family members. *Population, Space and Place*, **15**, 381–399.

Ofstedal, M., Fisher, G. and Herzog, A. R. (2005). *Documentation of Cognitive Functioning Measures in the Health and Retirement Study*. Institute for Social Research, University of Michigan.

Pampel, F. C., Krueger, P. M. and Denney, J. T. (2010). Socioeconomic Disparities in Health Behaviors. *Annual review of sociology*, **36**, 349–370.

Parikh, P. K., Troyer, A. K., Maione, A. M. and Murphy, K. J. (2016). The impact of memory change on daily life in normal aging and mild cognitive impairment. *The Gerontologist*, **56**, 877–885.

Peltz, C. B., Corrada, M. M., Berlau, D. J. and Kawas, C. H. (2011). Incidence of dementia in oldest-old with amnestic MCI and other cognitive impairments. *Neurology*, **77**, 1906–1912.

Pudrovska, T., Schieman, S. and Carr, D. (2006). The strains of singlehood in later life: Do race and gender matter? *Journal of Gerontology: Social Sciences,* **61**, 315-322.

Ross, C. E. and Mirowsky, J. (2011). The interaction of personal and parental education on health. *Social science & medicine*, **72**, 591–599.

Ross, C. E. and Mirowsky, J. (2010). Why education is the key to socioeconomic differentials in health. In C. E. Bird, P. Conrad, A. M. Fremont and S. Timmermans (Eds.), *The Handbook of Medical Sociology* (6th ed.). Vanderbilt University Press, 33–51.

Ross, C. E. and Mirowsky, J. (2006). Sex differences in the effect of education on depression: Resource multiplication or Resource substitution? *Social Science & Medicine*, 63, 1400–1413.

Ross, Catherine and J. Mirowsky. (2003). *Education, Social Status, and Health*. New York: De Gruyter.

Ryff, C. D., Lee, Y. H., Essex, M. J. and Schmutte, P. S. (1994). My children and me: Midlife evaluations of grown children and of self. *Psychology and Aging*, **9**, 195–205.

Sandi, C. (2013). Stress and cognition. *Cognitive Science.* 4, 245–261.

Scott, S. B., Graham-Engeland, J. E., Engeland, C. G., Smyth, J. M., Almeida, D. M., Katz, M. J., Lipton, R. B., Mogle, J. A., Munoz, E., Ram, N. and Sliwinski, M. J. (2015). The Effects of Stress on Cognitive Aging, Physiology and Emotion (ESCAPE) Project. *BMC psychiatry*, **15**, 146.

Shim, J. K. (2010). Cultural health capital: A theoretical approach to understanding health care interactions and the dynamics of unequal treatment. *Journal of Health and Social Behavior*, **51**, 1–15.

Silverstein, M. and Bengtson, V. L. (1994). Does intergenerational social support influence the psychological well-being of older parents? The Contingencies of Declining Health and Widowhood. *Social Science & Medicine*, **38**, 943–957.

Smith, J., Ryan, L. H., Fisher, G. G., Sonnega, A. and Weir, D. R. (2017). *HRS psychosocial and lifestyle questionnaire 2006–2016*. Ann Arbor, MI: Survey Research Center, Institute for Social Research, University of Michigan.

Song, L. and Chang, T.Y. (2012). Do resources of network members help in help seeking? Social capital and health information search. *Social Networks*, **34**, 658–669.

Sonnega, A., Faul, J. D., Ofstedal, M. B., Langa, K. M., Phillips, J. W. and Weir, D. R. (2014). Cohort profile: The Health and Retirement Study (HRS). *International Journal of Epidemiology*, **43**, 576–585.

Stern, Y. (2012). Cognitive reserve in ageing and Alzheimer's Disease. *The Lancet Neurology*, **11**, 1006–1012.

Taylor, C. A., Bouldin, E. D., Greenlund, K. J. and McGuire, L. C. (2020). Comorbid Chronic Conditions Among Older Adults with Subjective Cognitive Decline, United States, 2015-2017. *Innovation in aging*, **4**, igz045.

Torssander, J. (2013). From child to parent? The significance of children's education for their parents' longevity. *Demography*, **50**, 637–659.

Umberson, D., Wortman, C. B. and Kessler, R. C. (1992). Widowhood and depression: Explaining long-term gender differences in vulnerability. *Journal of Health and Social Behavior*, **33**, 10–24.

Utz, R. L., Reidy, E. B., Carr, D., Nesse, R. and Wortman, C. (2004). The daily consequences of widowhood: The role of gender and intergenerational transfers on subsequent housework performance. *Journal of Family Issues*, **25**, 683–712.

Weuve, J., Barnes, L. L., Mendes de Leon, C. F., Rajan, K. B., Beck, T., Aggarwal, N. T., Hebert, L. E., Bennett, D. A., Wilson, R. S. and Evans, D. A. (2018). Cognitive Aging in Black and White Americans: Cognition, Cognitive Decline, and Incidence of Alzheimer Disease Dementia. *Epidemiology*, **29**, 151–159.

Williams, D. R., Priest, N. and Anderson, N. B. (2016). Understanding associations among race, socioeconomic status, and health: Patterns and prospects. *Health Psychology,* **35**, 407–411.

Yahirun, J. J. and Arenas, E. (2018). Offspring migration and parents' emotional and psychological well-being in Mexico: Offspring migration and parents' mental health. *Journal of Marriage and Family*, **80**, 975–991.

Yahirun, J. J., Sheehan, C. M. and Hayward, M. D. (2017). Adult children's education and changes to parents' physical health in Mexico. *Social Science & Medicine*, **181**, 93–101.

Yahirun, J. J., Sheehan, C. M. and Mossakowski, K. N. (2020). Depression in later life: The role of adult children's college education for older parents' mental health in the United States. *The Journals of Gerontology: Series B,* **72***, 389-402.*

Yahirun, J. J., Vasireddy, S., Hayward, M. D. (2020). The education of multiple family members and the life course pathways to cognitive impairment. *The Journals of Gerontology: Series B*, **75**, e113–e128.

Yohannes, A. M., Chen, W., Moga, A. M., Leroi, I. and Connolly, M. J. (2017). Cognitive Impairment in Chronic Obstructive Pulmonary Disease and Chronic Heart Failure: A Systematic Review and Meta-analysis of Observational Studies. *Journal of the American Medical Directors Association*, **18**, 451.e1–451.e11.

Zarit, S. H. and Eggebeen, D. J. (2002). Parent-child relationships in adulthood and later years. In M. H. Bornstein (Ed.), *Handbook of Parenting: Children and Parenting* (2nd ed.). Erlbaum, 135–161.

Zimmer, Z., Hermalin, A. I. and Lin, H. S. (2002). Whose education counts? The added impact of adult-child education on physical functioning of older Taiwanese. *The Journals of Gerontology, Series B,* **57**, S23–S32.

Table 1. Older Parents' Characteristics at Baseline (N=11086)

Variables	%	*p*-value with episodic memory	*p*-value with adult children's schooling
Gender		<0.001	0.014
Men	40.2		
Women	59.8		
Race		<0.001	<0.001
White/Caucasian	83.2		
Black/African American/other	16.8		
Parental education		0.016	<0.001
First stage of tertiary education/above	22.8		
Upper secondary education	54.4		
Lower secondary education	16.7		
Primary education/below	6.1		
Parental occupation		<0.001	<0.001
Managerial/professional	13.4		
Technical/sales/administrative support	12.1		
Service	6.6		
Farming/forestry/fishing	1.2		
Precision production/craft/repair	3.7		
Operators/fabricators/labours	5.1		

Unemployed	1.2		
Retired	41.4		
Disabled	3.2		
Not in labour force	12.1		
Household income per person		<0.001	<0.001
Highest	37.1		
Medium	34.9		
Lowest	28.0		
Marital status		<0.001	<0.001
Married/partnered	71.5		
Separated/divorced/single/spouse absent	12.4		
Widowed	16.1		
Smoking		0.309	0.033
Non-smokers	40.6		
Ex-smokers	43.2		
Current smokers	16.3		
Days of alcohol consumption per week		<0.001	0.036
None	71.0		
1	8.2		
2	5.4		
3	4.2		
4	1.9		
5	1.8		

6	0.9		
7	6.6		
Vigorous physical activity		0.044	<0.001
Yes	46.6		
No	52.4		
High blood pressure		0.571	0.015
No	52.1		
Yes, take medications	41.3		
Yes, no medications	6.6		
Diabetes		0.003	0.583
No	85.1		
Yes, take medications	12.3		
Yes, no medications	2.6		
Lung diseases		0.559	0.820
No	91.8		
Yes, take medications	4.3		
Yes, no medications	3.9		
Heart problems		0.520	0.007
No	85.3		
Yes, take medications	14.7		
Yes, no medications	–		
Stroke		0.123	0.015
No	96.7		

Yes, take medications	1.9		
Yes, no medications	1.4		
Cancer		0.691	0.162
No	91.2		
Yes, take medications	1.4		
Yes, no medications	7.4		
Arthritis		0.379	<0.001
No	44.4		
Yes, take medications	24.9		
Yes, no medications	30.7		
Psychological problems		0.037	0.053
No	92.5		
Yes, take medications	7.0		
Yes, no medications	0.5		
Episodic memory, mean (S.D.)	10.3 (3.6)		
Adult children's schooling, mean (S.D.)	13.6 (2.2)	<0.001	–
Age, mean (S.D.)	65 (7.8)	<0.001	0.003
Number children (S.D.)	3.9 (2.6)	<0.001	<0.001

Source: waves 5 to wave 13 from the Health and Retirement Study; S.D.: standard deviation.

Table 2. Associations Between Adult Children's Schooling and Older Parents' Episodic Memory Scores (N=11086)

	Basic Model		Full Model		Interaction Model	
	Coef (95%CI)	*p*	Coef. (95%CI)	*p*	Coef. (95%CI)	*p*
Adult children schooling	0.13 (0.11, 0.16)	<0.001	0.12 (0.09, 0.14)	<0.001	0.07 (0.03, 0.12)	0.001
Intercept	10.05 (9.69, 10.42)	<0.001	10.39 (10.00, 10.78)	<0.001	11.05 (10.36, 11.74)	<0.001
Age	0.04 (0.03, 0.06)	<0.001	0.04 (0.02, 0.05)	<0.001	0.04 (0.02, 0.05)	<0.001
Age^2	-0.005(-0.005, -0.005)	<0.001	-0.005 (-0.005, -0.004)	<0.001	-0.005 (-0.005, -0.004)	<0.001
Gender						
Men	Ref.		Ref.		Ref.	
Women	1.20 (1.11, 1.28)	<0.001	1.28 (1.18, 1.37)	<0.001	1.28 (1.18, 1.37)	<0.001
Race						
White/Caucasian	Ref.		Ref.		Ref.	
Black/African American/other	-1.05 (-1.16, -0.94)	<0.001	-1.04 (-1.16, -0.93)	<0.001	-1.04 (-1.16, -0.93)	<0.001

Number of children	0.02 (0.00, 0.03)	0.073	0.02 (-0.001, 0.03)	0.058	0.02 (0.001, 0.03)	0.042
Parental education						
First stage of tertiary education/above	Ref.		Ref.		Ref.	
Upper secondary	-0.90 (-1.00, -0.79)	<0.001	-0.85 (-0.95, -0.74)	<0.001	-1.49 (-2.25, -0.74)	<0.001
Lower secondary	-2.05 (-2.19, -1.91)	<0.001	-1.94 (-2.09, -1.79)	<0.001	-3.24 (-4.18, -2.30)	<0.001
Primary education/below	-3.07 (-3.27, -2.87)	<0.001	-2.93 (-3.14, -2.72)	<0.001	-4.03 (-5.07, -2.99)	<0.001
Parental occupation						
Managerial/professional	Ref.		Ref.		Ref.	
Technical/sales/support	-0.03 (-0.16, 0.10)	0.676	-0.05 (-0.18, 0.09)	0.514	-0.05 (-0.19, 0.09)	0.482
Service	-0.11 (-0.27, 0.04)	0.148	-0.22 (-0.38, -0.05)	0.011	-0.22 (-0.39, -0.05)	0.010
Farming/forestry/fishing	-0.27 (-0.56, 0.02)	0.072	-0.45 (-0.76, -0.14)	0.004	-0.46 (-0.77, -0.15)	0.004
Craft/repair	-0.14 (-0.34, 0.05)	0.149	-0.16 (-0.37, 0.05)	0.132	-0.17 (-0.38, 0.05)	0.124
Operators/labours	-0.27 (-0.44, -0.10)	0.002	-0.35 (-0.53, -0.16)	<0.001	-0.35 (-0.54, -0.17)	<0.001
Unemployed	-0.16 (-0.36, 0.04)	0.123	-0.23 (-0.46, -0.01)	0.041	-0.24 (-0.46, -0.01)	0.039
Retired	-0.38 (-0.48, -0.28)	<0.001	-0.41 (-0.52, -0.30)	<0.001	-0.42 (-0.53, -0.30)	<0.001

Disabled	-0.58 (-0.76, -0.41)	<0.001	-0.55 (-0.75, -0.35)	<0.001	-0.55 (-0.74, -0.35)	<0.001
Not in labour force	-0.26 (-0.39, -0.14)	<0.001	-0.32 (-0.46, -0.18)	<0.001	-0.32 (-0.46, -0.18)	<0.001
Household income per person						
Highest	Ref.		Ref.		Ref.	
Medium	-0.15 (-0.21, -0.10)	<0.001	-0.15 (-0.21, -0.09)	<0.001	-0.15 (-0.21, -0.09)	<0.001
Lowest	-0.39 (-0.46, -0.32)	<0.001	-0.40 (-0.48, -0.32)	<0.001	-0.40 (-0.47, -0.32)	<0.001
Marital status						
Married/partnered	Ref.		Ref.		Ref.	
Separated/divorced/single	-0.02 (-0.12, 0.07)	0.635	-0.01 (-0.11, 0.10)	0.898	0.00 (-0.11, 0.10)	0.930
Widowed	0.01 (-0.07, 0.08)	0.863	0.06 (-0.02, 0.15)	0.136	0.06 (-0.02, 0.15)	0.137
Smoking						
Non-smokers			Ref.		Ref.	
Ex-smokers			-0.03 (-0.12, 0.06)	0.506	-0.03 (-0.12, 0.06)	0.496
Current smokers			0.01 (-0.11, 0.12)	0.909	0.01 (-0.11, 0.13)	0.883
Alcohol consumption						

None	Ref.		Ref.	
1	0.10 (0.02, 0.18)	0.013	0.10 (0.02, 0.18)	0.013
2	0.21 (0.11, 0.32)	<0.001	0.22 (0.11, 0.32)	<0.001
3	0.23 (0.11, 0.34)	<0.001	0.23 (0.11, 0.34)	<0.001
4	0.11 (-0.05, 0.27)	0.191	0.11 (-0.05, 0.27)	0.190
5	0.23 (0.07, 0.39)	0.005	0.23 (0.07, 0.40)	0.005
6	0.25 (0.04, 0.47)	0.023	0.26 (0.04, 0.48)	0.022
7 days/week	0.17 (0.06, 0.29)	0.003	0.17 (0.06, 0.29)	0.003
Vigorous physical activity				
Yes	Ref.		Ref.	
No	-0.17 (-0.22, -0.12)	<0.001	-0.17 (-0.22, -0.12)	<0.001
High blood pressure				
No	Ref.		Ref.	
Yes, take medications	-0.01 (-0.07, 0.06)	0.851	-0.01 (-0.07, 0.06)	0.842
Yes, no medications	-0.10 (-0.21, 0.01)	0.084	-0.10 (-0.21, 0.01)	0.084

Diabetes

No	Ref.		Ref.	
Yes, take medications	-0.14 (-0.23, -0.05)	0.003	-0.14 (-0.23, -0.05)	0.002
Yes, no medications	-0.002 (-0.14, 0.13)	0.974	-0.0002(-0.14, 0.13)	0.998

Lung diseases

No	Ref.		Ref.	
Yes, take medications	0.04 (-0.08, 0.16)	0.538	0.04 (-0.08, 0.16)	0.515
Yes, no medications	-0.04 (-0.18, 0.09)	0.531	-0.04 (-0.18, 0.09)	0.543

Heart problems

No	Ref.		Ref.	
Yes, take medications	-0.07 (-0.15, 0.01)	0.092	-0.07 (-0.15, 0.01)	0.095
Yes, no medications	–	–	–	–

Stroke

No	Ref.		Ref.	
Yes, take medications	-0.82 (-0.98, -0.65)	<0.001	-0.82 (-0.98, -0.65)	<0.001
Yes, no medications	-0.66 (-0.86, -0.46)	<0.001	-0.66 (-0.86, -0.46)	<0.001

Cancer

No	Ref.		Ref.	
Yes, take medications	-0.02 (-0.18, 0.14)	0.824	-0.02 (-0.18, 0.14)	0.833
Yes, no medications	0.06 (-0.06, 0.18)	0.317	0.06 (-0.06, 0.18)	0.321

Arthritis

No	Ref.		Ref.	
Yes, take medications	-0.04 (-0.13, 0.05)	0.367	-0.04 (-0.13, 0.05)	0.378
Yes, no medications	0.03 (-0.05, 0.12)	0.431	0.03 (-0.05, 0.12)	0.431

Psychological problems

No	Ref.		Ref.	
Yes, take medications	-0.39 (-0.49, -0.29)	<0.001	-0.39 (-0.49, -0.29)	<0.001
Yes, no medications	-0.17 (-0.37, 0.02)	0.085	-0.17 (-0.37, 0.02)	0.084

Parental education

× adult children's

schooling

|					
First stage of tertiary education/above				Ref.	
Upper secondary		–	–	0.04 (-0.01, 0.09)	0.098
Lower secondary		–	–	0.10 (0.03, 0.16)	0.006
Primary education/below		–	–	0.08 (0.002, 0.16)	0.045
Random effects	*S.D. (95%CI)*		*S.D. (95%CI)*		*S.D. (95%CI)*
Within individuals: residual	*0.008 (0.008, 0.009)*	–	*0.007 (0.006, 0.009)*	–	*0.007 (0.006, 0.009)*	–
Between individuals: intercept	*5.87 (5.41, 6.37)*	–	*5.48 (5.00, 6.02)*	–	*5.48 (5.00, 6.02)*	–
Between individuals: age	*5.23 (5.17, 5.29)*	–	*5.29 (5.22, 5.37)*	–	*5.29 (5.22, 5.37)*	–

Source: waves 5 to wave 13 from the Health and Retirement Study; Coef.: coefficient; Ref.: reference; 95%CI: 95% confidence interval; S.D.: standard deviation.

Table 3. Associations between Adult Children's Schooling and Older Parents' Episodic Memory Scores by Parental Education[*]

	First stage of tertiary education/above (N=2530)		Upper secondary (N=6030)		Lower secondary (N=1852)		Primary education/below (N=674)	
	Coef. (95%CI)	p-value	Coef. (95%CI)	p-value	Coef. (95%CI)	p-value	Coef. (95%CI)	p-value
Intercept	10.84 (10.06, 11.62)	<0.001	9.50 (8.98, 10.01)	<0.001	8.83 (7.75, 9.92)	<0.001	7.28 (5.45, 9.11)	<0.001
Age	0.05 (0.02, 0.08)	<0.001	0.04 (0.02, 0.06)	<0.001	0.01 (-0.03, 0.05)	0.586	0.04 (-0.02, 0.10)	0.239
Age^2	-0.005 (-0.006, -0.004)	<0.001	-0.005 (-0.005, -0.004)	<0.001	-0.004 (-0.005, -0.003)	<0.001	-0.004 (-0.005, -0.002)	<0.001
Adult children's schooling	0.08 (0.03, 0.12)	0.001	0.12 (0.09, 0.15)	<0.001	0.15 (0.10, 0.21)	<0.001	0.16 (0.09, 0.22)	<0.001

*Model additionally adjusted for gender, race, number of children, parental occupation, household income per person, marital status, smoking, days of alcohol consumption, vigorous physical activity, high blood pressure, diabetes, lung diseases, heart problems, stroke, cancer, arthritis, and psychological problems.

Coef.: coefficient; 95%CI: 95% confidence interval.
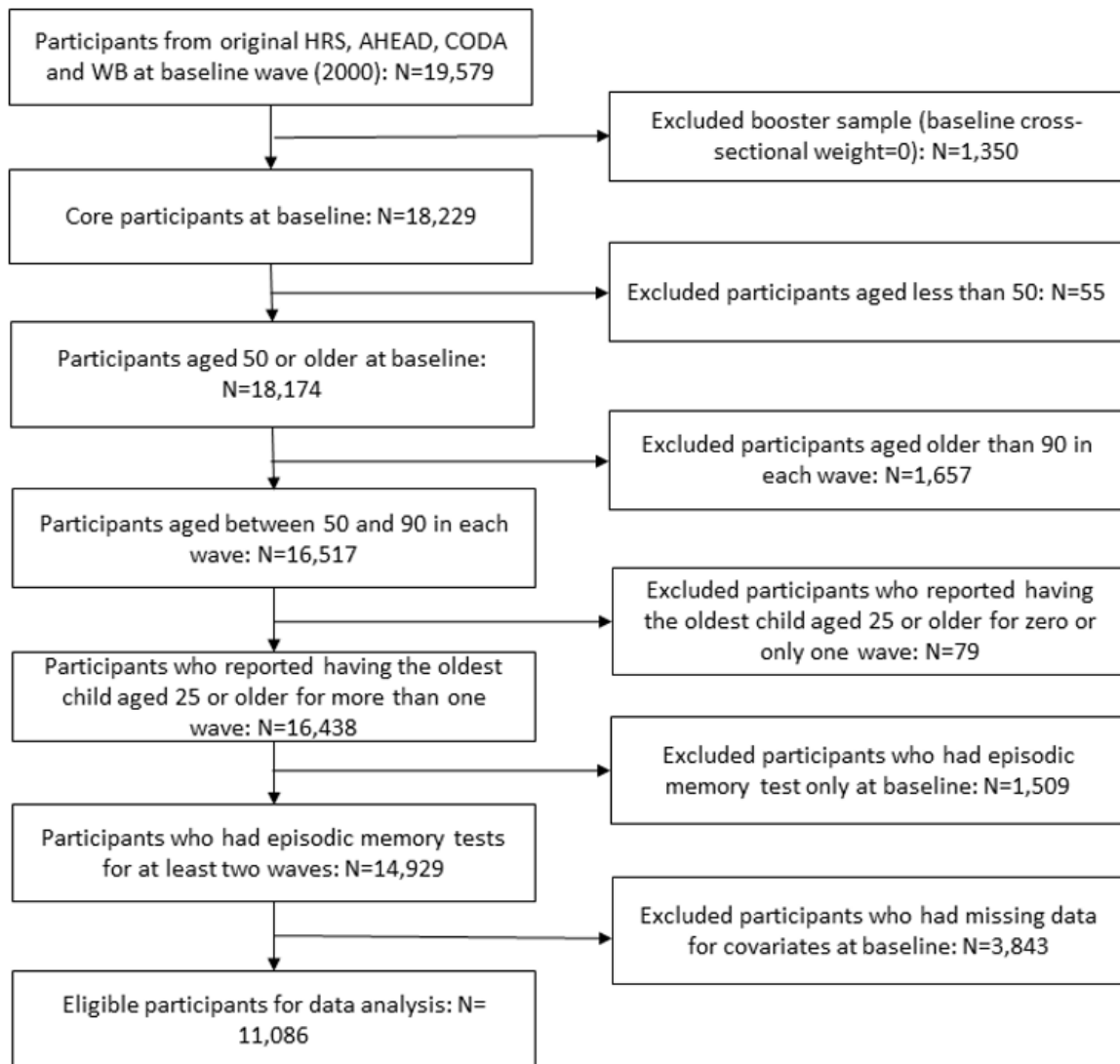
Figure 1. Procedure of Sample Selection

HRS: Health and Retirement Study; AHEAD: Asset and Health Dynamics among the Oldest Old; CODA: Children of the Depression; WB: War Baby
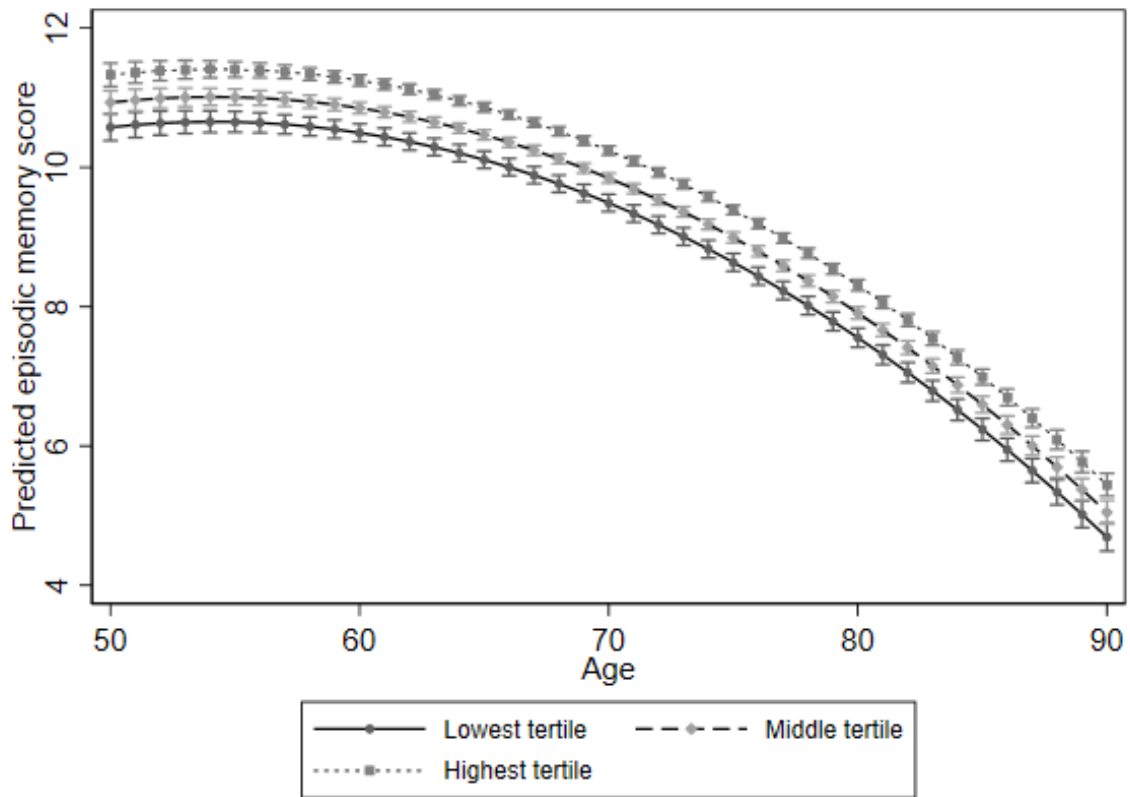
Figure 2. Predicted Trajectories of Parents' Episodic Memory with Parents' Age Stratified by Adult Children's Schooling Tertiles (N=11086). Source: waves 5 to wave 13 from the Health and Retirement Study.
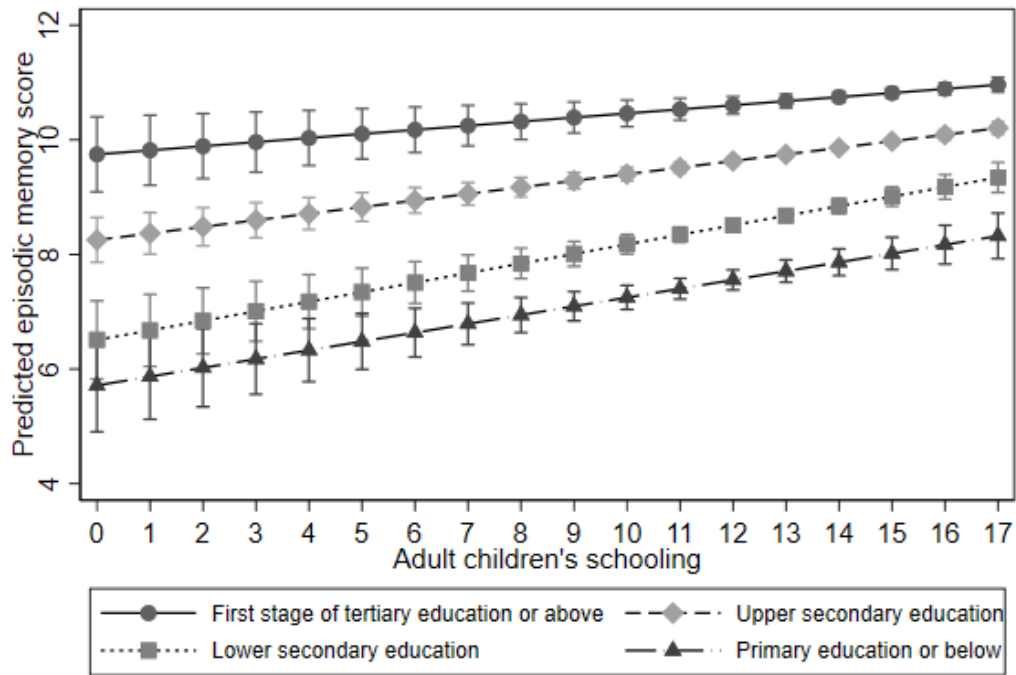
Figure 3. Predicted Trajectories of Parents' Episodic Memory with Increasing Adult Children's Schooling by Parental Education (N=11086) Source: waves 5 to wave 13 from the Health and Retirement Study.

Supplementary materials

Table S1. Results of Multilevel Models for the Relationships between Numbers of Child (≥ Age 25) with College Degree and Episodic Memory Scores (N=10992)[*]

	Coef. (95%CI)	*p*
Intercept	11.83 (11.61, 12.05)	<0.001
Age	0.04 (0.02, 0.05)	<0.001
Age^2	-0.005 (-0.005, -0.004)	<0.001
Children with college degree		
No children	Ref.	
Some children	0.36 (0.27, 0.46)	<0.001
All children	0.54 (0.41, 0.67)	<0.001
Random effects	*S.D. (95%CI)*	
Within individuals: residual	*0.007 (0.006, 0.009)*	-
Between individuals: intercept	*5.52 (5.03, 6.06)*	-
Between individuals: age	*5.30 (5.23, 5.37)*	-

[*]Model additionally adjusted for gender, race, number of children, parental occupation, household income per person, marital status, smoking, days of alcohol consumption, vigorous physical activity, high blood pressure, diabetes, lung diseases, heart problems, stroke, cancer, arthritis, and psychological problems.

Ref.: reference; S.D.: standard deviation; 95%CI: 95% confidence interval.

Table S2. Results of Multilevel Models for the Relationships between First Child's Years of Schooling and Episodic Memory Scores (N=10876)[*]

	Coef. (95%CI)	P
Intercept	10.77 (10.40, 11.14)	<0.001
Age	0.04 (0.02, 0.05)	<0.001
Age^2	-0.005 (-0.005, -0.004)	<0.001
First child's years of schooling	0.09 (0.07, 0.11)	<0.001
Random effects	*S.D. (95%CI)*	
Within individuals: residual	*0.007 (0.006, 0.009)*	-
Between individuals: intercept	*5.49 (5.00, 6.03)*	-
Between individuals: age	*5.28 (5.21, 5.36)*	-

[*]Model additionally adjusted for gender, race, number of children, parental occupation, household income per person, marital status, smoking, days of alcohol consumption, vigorous physical activity, high blood pressure, diabetes, lung diseases, heart problems, stroke, cancer, arthritis, and psychological problems.

Ref.: reference; S.D.: standard deviation; 95%CI: 95% confidence interval.

Table S3 Results of Multilevel Models for the Relationships between Adult Children's Schooling and Episodic Memory Scores, Considering the Interaction Between Race and Adult Children's Schooling (N=11086)

| | Interaction Model | |
	Coef. (95%CI)	p
Adult children schooling	0.07 (0.03, 0.12)	0.001
Intercept	11.02 (10.33, 11.71)	<0.001
Age	0.04 (0.02, 0.05)	<0.001
Age^2	-0.005 (-0.005, -0.004)	<0.001
Gender		
Men	Ref.	
Women	1.28 (1.18, 1.37)	<0.001
Race		
White/Caucasian	Ref.	
Black/African American/other	-0.74 (-1.38, -0.11)	0.022
Number of children	0.02 (0.0005, 0.03)	0.044
Parental education		
First stage of tertiary education/above	Ref.	
Upper secondary	-1.52 (-2.27, -0.76)	<0.001
Lower secondary	-3.31 (-4.26, -2.36)	<0.001
Primary education/below	-4.09 (-5.14, -3.05)	<0.001
Parental occupation		

Managerial/professional	Ref.	
Technical/sales/support	-0.05 (-0.19, 0.09)	0.480
Service	-0.22 (-0.39, -0.05)	0.010
Farming/forestry/fishing	-0.46 (-0.77, -0.15)	0.004
Craft/repair	-0.17 (-0.38, 0.05)	0.124
Operators/labours	-0.35 (-0.54, -0.17)	<0.001
Unemployed	-0.24 (-0.46, -0.01)	0.039
Retired	-0.42 (-0.53, -0.30)	<0.001
Disabled	-0.55 (-0.75, -0.35)	<0.001
Not in labour force	-0.32 (-0.46, -0.18)	<0.001
Household income per person		
Highest	Ref.	
Medium	-0.15 (-0.21, -0.09)	<0.001
Lowest	-0.40 (-0.47, -0.32)	<0.001
Marital status		
Married/partnered	Ref.	
Separated/divorced/single	0.00 (-0.11, 0.10)	0.930
Widowed	0.06 (-0.02, 0.15)	0.136
Smoking		
Non-smokers	Ref.	
Ex-smokers	-0.03 (-0.12, 0.06)	0.501
Current smokers	0.01 (-0.11, 0.13)	0.870
Alcohol consumption		

None	Ref.	
1	0.10 (0.02, 0.18)	0.013
2	0.21 (0.11, 0.32)	<0.001
3	0.22 (0.10, 0.34)	<0.001
4	0.11 (-0.05, 0.27)	0.194
5	0.23 (0.07, 0.39)	0.005
6	0.26 (0.04, 0.48)	0.022
7 days/week	0.17 (0.06, 0.29)	0.003
Vigorous physical activity		
Yes	Ref.	
No	-0.17 (-0.22, -0.12)	<0.001
High blood pressure		
No	Ref.	
Yes, take medications	-0.01 (-0.07, 0.06)	0.851
Yes, no medications	-0.10 (-0.21, 0.01)	0.085
Diabetes		
No	Ref.	
Yes, take medications	-0.14 (-0.23, -0.05)	0.003
Yes, no medications	0.0005 (-0.13, 0.14)	0.995
Lung diseases		
No	Ref.	
Yes, take medications	0.04 (-0.08, 0.16)	0.505
Yes, no medications	-0.04 (-0.18, 0.09)	0.552

Heart problems

No	Ref.	
Yes, take medications	-0.07 (-0.15, 0.01)	0.095
Yes, no medications	–	–

Stroke

No	Ref.	
Yes, take medications	-0.82 (-0.98, -0.65)	<0.001
Yes, no medications	-0.66 (-0.86, -0.46)	<0.001

Cancer

No	Ref.	
Yes, take medications	-0.02 (-0.18, 0.14)	0.831
Yes, no medications	0.06 (-0.06, 0.18)	0.323

Arthritis

No	Ref.	
Yes, take medications	-0.04 (-0.13, 0.05)	0.369
Yes, no medications	0.03 (-0.05, 0.12)	0.432

Psychological problems

No	Ref.	
Yes, take medications	-0.39 (-0.49, -0.29)	<0.001
Yes, no medications	-0.17 (-0.37, 0.02)	0.085

Race x adult children's schooling

Black and others	-0.02 (-0.07, 0.03)	0.350

Parental education

× adult children's schooling

First stage of tertiary education/above	Ref.	
Upper secondary	0.04 (-0.01, 0.10)	0.087
Lower secondary	0.10 (0.03, 0.17)	0.005
Primary education/below	0.09 (0.01, 0.17)	0.036
Random effects	*S.D. (95%CI)*	
Within individuals: residual	*0.007(0.006, 0.009)*	–
Between individuals: intercept	*5.48 (5.00, 6.02)*	–
Between individuals: age	*5.29 (5.22, 5.37)*	–

Ref.: reference; S.D.: standard deviation; 95%CI: 95% confidence interval.

Table S4. Results of Multilevel Models for the Relationships between Adult Children's Schooling and Episodic Memory Scores, including Participants Aged 90+ (N=12138)

	Interaction Model	
	Coef. (95%CI)	*p*
Adult children schooling	0.07 (0.03, 0.11)	<0.001
Intercept	11.17 (10.50, 11.84)	<0.001
Age	0.02 (0.01, 0.04)	0.001
Age²	-0.0041 (-0.0044, -0.0038)	<0.001
Gender		
Men	Ref.	
Women	1.25 (1.16, 1.34)	<0.001
Race		
White/Caucasian	Ref.	
Black/African American/other	-1.04 (-1.16, -0.93)	<0.001
Number of children	0.01 (-0.004, 0.03)	0.149
Parental education		
First stage of tertiary education/above	Ref.	
Upper secondary	-1.44 (-2.17, -0.70)	<0.001
Lower secondary	-3.12 (-4.02, -2.22)	<0.001
Primary education/below	-3.46 (-4.43, -2.47)	<0.001
Parental occupation		
Managerial/professional	Ref.	

Technical/sales/support	-0.05 (-0.18, 0.09)	0.506
Service	-0.23 (-0.39, -0.06)	0.007
Farming/forestry/fishing	-0.44 (-0.74, -0.13)	0.005
Craft/repair	-0.15 (-0.36, 0.06)	0.157
Operators/labours	-0.36 (-0.54, -0.18)	<0.001
Unemployed	-0.24 (-0.46, -0.01)	0.038
Retired	-0.42 (-0.53, -0.31)	<0.001
Disabled	-0.53 (-0.73, -0.34)	<0.001
Not in labour force	-0.30 (-0.44, -0.17)	<0.001
Household income per person		
Highest	Ref.	
Medium	-0.15 (-0.21, -0.09)	<0.001
Lowest	-0.40 (-0.48, -0.33)	<0.001
Marital status		
Married/partnered	Ref.	
Separated/divorced/single	0.01 (-0.10, 0.11)	0.911
Widowed	0.08 (0.01, 0.16)	0.035
Smoking		
Non-smokers	Ref.	
Ex-smokers	-0.05 (-0.13, 0.04)	0.295
Current smokers	-0.01 (-0.13, 0.10)	0.803
Alcohol consumption		
None	Ref.	

1	0.12 (0.04, 0.19)	0.004
2	0.21 (0.11, 0.32)	<0.001
3	0.24 (0.13, 0.35)	<0.001
4	0.12 (-0.04, 0.28)	0.140
5	0.26 (0.10, 0.42)	0.001
6	0.26 (0.04, 0.47)	0.018
7 days/week	0.18 (0.07, 0.29)	0.001
Vigorous physical activity		
Yes	Ref.	
No	-0.18 (-0.23, -0.13)	<0.001
High blood pressure		
No	Ref.	
Yes, take medications	-0.01 (-0.08, 0.05)	0.652
Yes, no medications	-0.10 (-0.20, 0.01)	0.075
Diabetes		
No	Ref.	
Yes, take medications	-0.17 (-0.26, -0.08)	<0.001
Yes, no medications	-0.04 (-0.17, 0.09)	0.539
Lung diseases		
No	Ref.	
Yes, take medications	0.02 (-0.10, 0.13)	0.753
Yes, no medications	-0.04 (-0.17, 0.09)	0.538
Heart problems		

No	Ref.	
Yes, take medications	-0.08 (-0.15, 0.00)	0.048
Yes, no medications	–	–
Stroke		
No	Ref.	
Yes, take medications	-0.85 (-1.01, -0.69)	<0.001
Yes, no medications	-0.67 (-0.86, -0.48)	<0.001
Cancer		
No	Ref.	
Yes, take medications	-0.04 (-0.19, 0.12)	0.653
Yes, no medications	0.07 (-0.04, 0.18)	0.226
Arthritis		
No	Ref.	
Yes, take medications	-0.04 (-0.13, 0.05)	0.393
Yes, no medications	0.05 (-0.03, 0.13)	0.221
Psychological problems		
No	Ref.	
Yes, take medications	-0.39 (-0.49, -0.30)	<0.001
Yes, no medications	-0.29 (-0.48, -0.10)	0.003
Parental education		
× adult children's schooling		
First stage of tertiary education/above	Ref.	
Upper secondary	0.04 (-0.01, 0.09)	0.105

Lower secondary	0.09 (0.03, 0.16)	0.005
Primary education/below	0.04 (-0.03, 0.12)	0.264
Random effects	*S.D. (95%CI)*	
Within individuals: residual	*0.006 (0.005, 0.007)*	–
Between individuals: intercept	*5.42 (4.95, 5.94)*	–
Between individuals: age	*5.30 (5.23, 5.37)*	–

Ref.: reference; S.D.: standard deviation; 95%CI: 95% confidence interval.