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Evaluating interpersonal discrimination and depressive symptoms as partial mediators of the effects of education on cognition: Evidence from the Study of Healthy Aging in African Americans (STAR)

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STRUCTURED ABSTRACT

INTRODUCTION: Education is correlated with late-life cognition, but association is weaker among African Americans. The extent to which exposure to discrimination and depressive symptoms attenuates the education-cognition link has not been investigated.

METHODS: Study of Healthy Aging in African Americans participants (n=764; average age 69 years) completed the Spanish and English Neuropsychological Assessment Scales. We assessed everyday and major lifetime discrimination and depressive symptoms as mediators of education effects on cognition using G-estimation with measurement error corrections.

RESULTS: Education was correlated with greater major lifetime and everyday discrimination but lower depressive symptoms. Accounting for discrimination and depressive symptoms slightly reduced the estimated effect of education on cognition. The estimated total effect of graduate education (vs <bachelor's) was 0.66 (95% CI:0.62,0.68), and the direct effect not mediated by discrimination or depressive symptoms was 0.60 (95% CI:0.43,0.76).

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CONFLICTS OF INTEREST

The authors report no conflicts of interest.

CONSENT STATEMENT

The STAR cohort was approved by the human subjects review boards at Kaiser Permanente Northern California and the University of California Davis; all participants provided informed consent.

DISCUSSION: Education has robust effects on late life cognition after controlling multiple mediating pathways and offsetting mechanisms.

Keywords

cognition; education; psychosocial stress; discrimination; depression; African Americans

1 BACKGROUND

The positive effects of education on later-life cognition are robustly documented.[1,2] Although many possible mechanisms have been posited, none have conclusively been established.[3,4] Some research shows that the health benefits of education are attenuated among African American adults compared to other racial/ethnic groups.[5,6] African Americans may reap diminished returns to education, if systemic racism reduces the socioeconomic benefits of educational credentials (e.g., income) or because education increases exposure to psychosocial stressors, such as interpersonal racism or discrimination.[7-12] In African American populations, discrimination, e.g., has been linked to several adverse health effects in older adulthood, including high blood pressure,[13] higher mortality risk,[14] high C-reactive protein levels[15], poor quality-of-life[16], and short telomere length.[17] However, the extent to which exposure to discrimination attenuates the education-cognition link has not been investigated.

The possible role of increased exposure to interpersonal psychosocial stress can be tested as a mechanism that accounts for the attenuated effect of education on cognition. For example, higher levels of self-reported experiences of everyday and major lifetime discrimination have been associated with poorer cognitive test performance (i.e., lower episodic memory and perceptual speed),[18] lower subjective cognitive function,[19] worse depressive symptoms,[20,21] and faster memory decline,[22] in addition to cardiovascular risk factors and outcomes associated with cognitive impairment[13]. Despite the existing theoretical and empirical support, no prior studies have attempted to quantify how the effects of education on psychosocial stressors may have downstream consequences for later-life cognition among African Americans.

Using data from the Study of Healthy Aging in African Americans (STAR), this analysis evaluated whether the effect of education on cognitive performance was partially mediated by the constructs of discrimination (i.e., everyday and major life) and depressive symptoms in a community-dwelling cohort of middle-aged and older African American adults. To assess the association between education and later-life cognitive function, we used a lifecourse perspective,[23] reflected in our conceptual model (Figure 1). We hypothesized that increased education in early-life might expose African American adults to more interpersonal discrimination, potentially inducing worse depressive symptoms and cognition in late life. Such a pathway would offset the beneficial effect of education on cognition via other mechanisms (i.e., the direct effect of education not mediated by psychosocial risk factors).[7]

2 METHODS

2.1 Participants

The STAR cohort includes 764 community-dwelling older African American adults residing in the San Francisco Bay area of California, primarily the cities of Oakland and Richmond. STAR aims to evaluate how lifecourse vascular and sociocultural factors influence the trajectory of cognitive aging and burden of cognitive impairment among African Americans. Individuals eligible for STAR were long-term members of Kaiser Permanente Northern California, an integrated healthcare delivery system, who identified as African American, were age 50 years or older on January 1, 2018, and had previously participated in Kaiser Permanente multiphasic health checkup exams between 1964-1985. Stratified random sampling by age and educational attainment was used to recruit approximately equal proportions of participants ages 50-64 and 65 and older (range 53-95 years). Exclusion criteria included electronic medical record diagnosis of dementia or other neurodegenerative diseases (frontotemporal dementia, Lewy body disease, Pick's disease, Parkinson's disease with dementia, Huntington's disease) and presence of health conditions that would impede participation in study interviews (defined by hospice activity in the past 12 months, history of severe chronic obstructive pulmonary disease in the past 6 months, congestive heart failure hospitalizations in the past 6 months, and history of end-stage renal disease or dialysis in the past 12 months). The STAR cohort was approved by the human subjects review boards at Kaiser Permanente Northern California and the University of California Davis; all participants provided informed consent.

2.2 Measures

2.2.1 Educational attainment—Educational attainment was self-reported as the highest level of school completed for credit and categorized for the current analyses as: those with less than a bachelor's degree (including those with high school education or less or a GED credential); a bachelor's degree; or a graduate degree (i.e., master's or professional).

2.2.2 Cognitive functioning outcomes—Cognition was assessed during in-person interviews with the Spanish and English Neuropsychological Assessment Scales (SENAS).[24] The SENAS is a battery of cognitive tests with evidence of construct validity across racial/ethnic and linguistically diverse groups.[24,25] Language administration (English or Spanish) was determined with an algorithm that considered both preferred language and everyday language usage in several settings (e.g., language at home, language outside the home, listening to radio or television, and language for reading). We considered three SENAS domains: verbal episodic memory, semantic memory, and executive function. A multi-trial word-list learning test was employed to derive scores on the verbal episodic memory domain. The semantic memory measure is a composite of verbal (object naming) and nonverbal (picture association) tasks that are strongly correlated. The executive function composite comprises category fluency, phonemic (letter) fluency, and working memory (digit span backward, list sorting) tasks.[26] Our primary outcome was the z-score standardization of the average across the three domain-specific z-scores (we refer to this

as *composite later-life cognition*). We also consider each of the domain-specific z-scores as secondary outcomes.

2.2.3 Mediators

2.2.3.1 Major lifetime discrimination: The major lifetime discrimination scale was developed to measure perceived unfair treatment instances in consequential (major) life events (e.g., housing, the labor market, and education).[27] Instances of major lifetime discrimination involve self-reported experiences such as being unfairly denied a bank loan or job promotion. The nine dichotomous (yes/no) items for major lifetime discrimination are reported in Appendix Table A.1. We allowed for any attribution of major lifetime discrimination (e.g., gender or race). The Cronbach's alpha for the nine items in this sample was 0.74.

2.2.3.2 Everyday discrimination: The nine-item everyday discrimination scale assessed participants' self-reported frequency of being treated unfairly in everyday situations.[27] The measure has been validated in previous samples of older adult populations.[18] Respondents indicated how often they experienced each of nine instances of discrimination. The nine instances or items are reported in Appendix Table A.1. Everyday discrimination was measured using a 6-point Likert response scale (1=Never; 2=Less than once a year; 3=A few times a year; 4=A few times a month; 5=At least once a week; 6=Almost every day). We allowed for any attribution of everyday discrimination (e.g., gender or race). The Cronbach's alpha for the nine items in this sample was 0.88.

2.2.3.3 Depression: The eight items on the Patient-Reported Outcomes Measurement Information System (PROMIS) depression measure assessed participants' frequency of self-reported negative moods, views of self-worth, and social cognition, as well as positive affect and engagement over the past 7 days (Appendix Table A.1), which we refer to as "recent depressive symptoms".[28] PROMIS measures were validated as part of a National Institutes of Health (NIH) roadmap program to promote the clinical use of patient-reported outcomes.[28, 29] Depression was measured using a 5-point Likert response scale (1=Never; 2=Rarely; 3=Sometimes; 4=Often; 5=Always). The Cronbach's alpha for the eight items was 0.91.

2.2.4 Early- and Late-life Confounders—The confounders were selected as factors that may have influenced the exposure/mediators (educational attainment, discrimination, or depression) and the outcome (cognitive test performance). We distinguished between early-life confounders, which would not likely have been influenced by education, and later-life confounders, which may have been influenced by education. The early-life confounders included age, gender, self-reported childhood financial status (pretty well off, above average, and poor or it varied), maternal education (0-12 years, some college or associate's, bachelor's degree, and master's or professional degree), paternal education (0-12 years, some college or associate's, bachelor's degree, and master's or professional degree), maternal employment (employed mostly full-time and employed mostly part-time or not employed), and paternal employment (employed mostly full-time and employed mostly part-time or not employed).

The late-life confounders in this study included alcohol consumption (In the last three months, on the days you drink, about how many drinks do you have? -- no alcohol, 1-2 drinks, 3 or more drinks), marital status (currently married, not currently married), income worry – ("how often do you worry about not meeting your expenses with your current income?" -- always or often, sometimes or never), income worry in the past 30 days (always or often, sometimes or never), and income range (assessed in 13 categories, recoded to the midpoint and natural logged). The highest income category [150K and over] was coded as $156,744, which is 0.2 standard deviations above 150K using the standard deviation of the remaining 12 categories. We used both income worry and income worry in the past 30 days because the former represents a more general concern about financial burden, whereas the latter represents a more recent or temporary concern.

2.3 Statistical analyses

Descriptive analyses were conducted to compare the prevalence of discrimination and depressive symptoms by level of educational attainment. We evaluated discrimination and depressive symptoms as potential mediators of the education-cognition association. Evaluating multiple mediators requires specifying a temporal sequence. We assumed a temporal order consistent with Figure 1: early-life confounders influenced both education and late-life confounders; education influenced late-life confounders; major lifetime discrimination preceded everyday discrimination and recent depressive symptoms; and everyday discrimination preceded recent depressive symptoms.

In four separate models, one for each of the cognitive outcomes (i.e., composite later-life cognition, verbal episodic memory, semantic memory, or executive function), we adjusted for potential early-life and late-life confounders using a two-stage G-estimation approach that allows for latent variable measurement error correction.[30] G-estimation[31] (explained in more detail below) enabled us to correctly account for *exposure-induced or post-exposure confounding*, i.e., confounders of the mediator-outcome association that may have been influenced by exposure.[30] Here, the late-life confounders are potentially influenced by education and may confound the relationship between the psychosocial mediators and cognitive outcomes. Traditional or standard regression methods, including traditional structural equation modeling with latent variables, cannot adjust correctly for post-exposure confounding and may result in substantial bias.[30-32] Measurement error in the mediators is another potential bias. We corrected for measurement error in the everyday discrimination and depression measures using Fuller's method, a "method-of-moments" approach to parameter estimation in linear regression models with error in either dependent or independent variables.[30] In this approach, we assumed a reflective measurement model[33] for the everyday discrimination and depression measures. We did not treat major lifetime discrimination with a reflective measurement model but instead assumed a formative measurement model.[33] The rationale for the latter decision is that we preferred treating experiences of major lifetime discrimination as an index without including measurement errors.

We first used linear regression to estimate the total effect of education on later-life cognition. We then used a two-stage G-estimation approach with latent everyday discrimination and

depression measures to estimate the controlled direct effect (CDE) of education on cognition if the discrimination and depression measures were set to their sample averages. In the first stage, Bartlett factor scores are computed using confirmatory factor analysis.[34] In the second stage, the method estimates potential outcomes for cognition by sequentially backing out the estimated effects of late-life confounders, mediators, early-life confounders, and education. Each of these estimated effects (e.g., the effect of discrimination on cognition, $\beta_{discrimination}$) is estimated with linear regression using Fuller's method that accounts for measurement errors in latent everyday discrimination and depression.[30] The potential cognitive outcome setting any exposure, mediator, or confounder variable to zero is then estimated for each individual *i* by subtracting the product of the regression coefficient and individual *i*'s actual value of the variable from individual *i*'s actual cognition (e.g., $cognition_i$-$\beta_{discrimination}$*$discrimination_i$). Using this technique successively, we can calculate the potential cognitive outcomes for any combination of exposures and mediators while controlling for confounders. The direct effects of education on cognition are estimated by comparing the average values of the potential outcomes expected if education took different values, but the psychosocial mediators were held to the sample average. See supplemental materials for further information on the two-stage G-estimation (section I and II) as well as additional tables (section III).

Percentile bootstrap confidence intervals (CIs) were constructed using 2000 resamples with replacement.[35] Modification of the direct effect of education by gender, everyday or major-life discrimination, or depressive symptoms was evaluated, but none of the interactions were statistically significant. Therefore, we omitted these interactions from the respective outcome models. Lastly, we used predictive mean matching[36] to impute missing data as part of the 2000 bootstrap samples. We used the median of the 2000 bootstrapped parameter estimates for our OLS point estimates.[37] We also computed the correlations between education, the psychosocial mediators, and the cognitive outcomes. All analyses were conducted using R 4.1.0.[38] Code is provided in the supplemental materials (section IV).

3 RESULTS

3.1 Participant characteristics

Participants (N = 764) were a mean age of 68.9 years (SD = 8.9); 65.3% had less than a bachelor's degree; and 68.3% were female (Table 1). Both everyday discrimination and major lifetime discrimination z-scores were lowest among participants with less than a bachelor's degree compared to those with more education. Depression z-scores scores were highest on average among those with less than a bachelor's degree. Those with less than a bachelor's degree averaged the lowest later-life scores on composite cognition, verbal episodic memory, semantic memory, and executive function. For descriptive statistics on the imputed bootstrap samples and information on missing data patterns see the supplemental materials (Appendix Table A.2).

3.2 Correlations of exposure, mediators, and cognitive outcomes

Education was correlated with better cognitive outcomes and fewer depressive symptoms. However,education was correlated with more experiences of major lifetime discrimination and everyday discrimination (Appendix Table A.3). Depressive symptoms were negatively associated with all the later-life cognition outcomes. Major lifetime discrimination and everyday discrimination were both associated with higher depressive symptoms and with higher cognition on each of the cognitive outcomes (i.e., verbal memory, semantic memory, and executive function).

3.2 Education, psychosocial stress, and cognition

The estimated total effect of completing a Bachelor's or Graduate degree (versus less than a bachelor's degree) was substantial and positive for later-life cognition overall ($\beta_{Bachelor's}$ = 0.47 [95% CI: 0.44, 0.49]; $\beta_{Graduate}$ = 0.66 [95% CI: 0.62, 0.68] (Table 2, Panel A). Associations were positive for each domain: verbal episodic memory ($\beta_{Bachelor's}$ = 0.28 [95% CI: 0.25, 0.30]; $\beta_{Graduate}$ = 0.33 [95% CI: 0.30, 0.35]), semantic memory ($\beta_{Bachelor's}$ = 0.38 [95% CI: 0.35, 0.40]; $\beta_{Graduate}$ = 0.56 [95% CI: 0.53, 0.60]), and executive function ($\beta_{Bachelor's}$ = 0.49 [95% CI: 0.47, 0.50]; $\beta_{Graduate}$ = 0.71 [95% CI: 0.69, 0.74]).

We next estimated the effect of educational attainment on each of the psychosocial stressors hypothesized as mediators (Table 2, Panel B) and the effects of the mediators on one another. Both bachelor's degree completion and graduate education (compared to less than a bachelor's degree) were estimated to substantially increase exposure to major lifetime discrimination ($\beta_{Bachelor's}$ = 0.24 [95% CI: 0.20, 0.35]; $\beta_{Graduate}$ = 0.38 [95% CI: 0.23, 0.42]). Both bachelor's degree completion and graduate education (compared with less than a bachelor's degree) were estimated to decrease exposure to everyday discrimination, albeit the results for bachelor's were not statistically significant ($\beta_{Bachelor's}$ = −0.02 [95% CI: − 0.05, 0.01]; $\beta_{Graduate}$ = −0.09 [95% CI: −0.013, −0.04]). The estimated direct effect of educational attainment on depressive symptoms was negative and substantial ($\beta_{Bachelor's}$ = −0.18 [95% CI: −0.22, −0.14]; $\beta_{Graduate}$ = −0.39 [95% CI: −0.44, −0.32]). Major lifetime discrimination was estimated to increase depressive symptoms ($\beta_{MajorLife}$ = 0.21 [95% CI: 0.19, 0.22]) and similar results were observed for everyday discrimination ($\beta_{Everyday}$ = 0.33 [95% CI: 0.32, 0.35]).

When major lifetime discrimination, everyday discrimination, and depression levels were set to their sample means, the estimated CDE of Bachelor's or Graduate degree completion (versus less than a bachelor's degree) on later-life cognition was positive and substantial (Table 2, Panel C), especially for a Graduate degree ($\beta_{Bachelor's}$ = 0.42 [95% CI: 0.26, 0.58]; $\beta_{Graduate}$ = 0.60 [95% CI: 0.43, 0.76];). There were similarly positive and substantial CDEs of education on verbal episodic memory ($\beta_{Bachelor's}$ = 0.26 [95% CI: 0.07, 0.44]; $\beta_{Gaduate}$ = 0.29 [95% CI: 0.12, 0.47]), semantic memory ($\beta_{Bachelor's}$ = 0.34 [95% CI: 0.18, 0.51]; $\beta_{Graduate}$ = 0.52 [95% CI: 0.34, 0.70]), and executive function ($\beta_{Bachelor's}$ = 0.45 [95% CI: 0.29, 0.61]; $\beta_{Graduate}$ = 0.65 [95% CI: 0.49, 0.81]). Complete results for the early-life and late-life confounders can be found in the supplemental materials (Appendix Table A.4).

4 DISCUSSION

In this sample of middle-aged and older African American adults, higher educational attainment predicted better later-life cognition, verbal episodic memory, semantic memory, and executive function. The results imply that more education is better for later life cognition. Education was correlated with higher exposure to major lifetime discrimination and everyday discrimination,but lower depressive symptoms. If discrimination and depression were held to the sample mean, the CDE of attaining a bachelor's or graduate degree on cognitive functioning was estimated as less than the total effect of bachelor's or graduate education for each of the cognition outcomes. These results indicate that the psychosocial stressors may partially mediate the relationship between education and later-life cognition, with education triggering multiple pathways to later-life cognition. However, the CIs for the CDEs are large and contained the point estimates for the total effect suggesting education effects are substantial and may not be explained by carefully evaluated mediators and confounders in this sample. For example, study participants were long-term members of Kaiser Permanente, and this may have some impact on their later life cognition. Further investigation is needed.

Few studies have evaluated the association between education and discrimination, but our results are consistent with the limited evidence among individuals from racial/ethnic minority groups; greater education is associated with higher levels of self-reported experiences of discrimination.[7,8,39,40] Research in the Health and Retirement Study (HRS) did not find that education was associated with differences in experiences of discrimination, but this analysis included predominantly White individuals.[22] Research evaluating discrimination in health care settings in HRS found that higher SES protected White and Latino individuals from experiences of discrimination but had little benefit for Black respondents.[41] Two studies suggested that education increases exposure to interpersonal discrimination for African Americans, Mexican, and Asian Americans.[8,39] In this context, both attaining higher education and reaping the socioeconomic benefits of education may expose minority group members to more interpersonal discrimination and require effortful coping as described by the "John Henryism" hypothesis (i.e., high levels of effort and coping are needed for African Americans to overcome interpersonal stressors).[7,12] As suggested by some, highly educated African Americans challenge historical and existing racial hierarchies, and such status challenges may be met with racial hostility by individuals seeking to preserve those hierarchies.[42-44]

The substantial psychological effort and stress triggered by discrimination encountered by minoritized individuals – especially when accumulated across the lifecourse – may have adverse cognitive consequences.[7] More attention needs to be paid to what has anecdotally been referred to as the "paradox" of education for African Americans (i.e., educational attainment is a key to socioeconomic mobility but also entails increased exposure to interpersonal stressors).[45-47] In our sample, individuals who reported higher levels of major lifetime discrimination averaged better later-life cognition (see Table 2, panel C). This association is both inconsistent and consistent with prior evidence on the harms of interpersonal discrimination, for example, evidence that greater levels of everyday discrimination are associated with lower baseline memory and faster memory decline among

participants aged 51 and older in HRS.[22] In the KHANDLE cohort, for which participants were recruited from the same health care system as the current STAR cohort, experiences of major lifetime discrimination were also found to be associated with higher cognitive test scores among Black participants but not Asian, White, or Latino participants.[48]

One explanation for this unexpected association is that this study's major lifetime discrimination measure is so tightly linked with education and socioeconomic status among African Americans that associations are confounded. If African American people encountered major discriminatory events because of their pursuit of resources that enhanced their health: i.e., in the course of securing health-promoting job opportunities, health care, or housing, older African American people experienced severe discrimination, the harms of discrimination may be offset by the advantages of the other resources. Another possibility is that the discrimination measures are not measuring the same experiences for people with different educational levels. For instance, if the major lifetime discrimination measure over-estimates discrimination (formative here) for college degree participants and under-estimates it for non-degree college degree participants, then observed score differences may not accurately reflect true differences in the quantity being measured.[49]

The G-estimation methods are premised on the correct specification of the mediator and outcome models. Misspecification of either the outcome or mediator model may bias results. These methods are based on an assumed temporal order, which cannot be confirmed without repeated measures across the lifecourse. We used validated self-reported measures of interpersonal discrimination, but individuals could not report on covert discriminatory actions that may have adversely affected them. Thus, our measures of discrimination likely underestimate actual experiences. Likewise, our study did not directly evaluate the role of structural racism (e.g., policies and processes which restrict access to critical health-promoting resources such as education based on race), and interpretation of our results requires consideration of the intersection of structural and interpersonal racism. As for any observational study, our models assume that there are no unmeasured confounders of education and cognition or the mediators and cognition.

Despite these limitations, this study has several strengths elaborating potential mechanisms by which education may influence later-life cognition. Our findings show that among this cohort of older African Americans, education may have increased exposure to discrimination but the overall estimated effect of education, even accounting for discrimination and depression mechanisms, was large and beneficial. Our work is part of emerging literature painting a more nuanced picture of educational experiences and cognitive outcomes in old age. The G-estimation method in this study, which allows for measurement error corrections while correctly accounting for complex time-varying confounding, is new and has not yet been widely implemented in practice. Our study is the first application related to social determinants of cognitive aging. This study provides a novel demonstration of G-estimation methods that can correct for measurement error with latent variables and allow for possible feedback between exposures of interest (in this study, education) and early and late-life confounders.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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REFERENCES

1. Harrati A, Glymour MM. Lifecourse epidemiology matures: Commentary on Zhang et al. “Early-life socioeconomic status, adolescent cognitive ability, and cognition in late midlife.” Social Science & Medicine. 2020;244:112645. doi:10.1016/j.socscimed.2019.112645 [PubMed: 31722818]
2. Opdebeeck C, Martyr A, Clare L. Cognitive reserve and cognitive function in healthy older people: a meta-analysis. Aging, Neuropsychology, and Cognition. 2016;23(1):40–60. doi:10.1080/13825585.2015.1041450
3. Nguyen TT, Tchetgen Tchetgen EJ, Kawachi I, Gilman SE, Walter S, Glymour M. Comparing alternative effect decomposition methods: the role of literacy in mediating educational effects on mortality. Epidemiology. 2016;27(5):670–676. doi:10.1097/EDE.0000000000000517 [PubMed: 27280331]
4. Vable AM, Cohen AK, Leonard SA, Glymour MM, Duarte C d. P, Yen IH. Do the health benefits of education vary by sociodemographic subgroup? Differential returns to education and implications for health inequities. Annals of Epidemiology. 2018;28(11):759–766.e5. doi:10.1016/j.annepidem.2018.08.014 [PubMed: 30309690]
5. Fuller-Rowell TE, Curtis DS, Doan SN, Coe CL. Racial Disparities in the Health Benefits of Educational Attainment: A Study of Inflammatory Trajectories Among African American and White Adults. Psychosomatic Medicine. 2015;77(1):33–40. doi:10.1097/PSY.0000000000000128 [PubMed: 25490696]
6. Assari S. Unequal Gain of Equal Resources across Racial Groups. Int J Health Policy Manag. 2017;7(1):1–9. doi:10.15171/ijhpm.2017.90
7. Ward JB, Feinstein L, Vines AI, Robinson WR, Haan MN, Aiello AE. Perceived discrimination and depressive symptoms among US Latinos: the modifying role of educational attainment. Ethn Health. 2019;24(3):271–286. doi:10.1080/13557858.2017.1315378 [PubMed: 28399649]
8. Zhang W, Hong S. Perceived Discrimination and Psychological Distress Among Asian Americans: Does Education Matter? J Immigr Minor Health. 2013;15(5):932–943. doi:10.1007/s10903-012-9676-5 [PubMed: 22767300]
9. Hudson DL, Bullard KM, Neighbors HW, Geronimus AT, Yang J, Jackson JS. Are benefits conferred with greater socioeconomic position undermined by racial discrimination among African American men? J Mens health. 2012;9(2):127–136. doi:10.1016/j.jomh.2012.03.006 [PubMed: 22707995]
10. Kaplan G, Ranjit N, Burgard S. Lifting Gates–Lengthening Lives: Did Civil Rights Policies Improve the Health of African-American Women in the 1960’s and 1970’s? In: Russell Sage; 2008.
11. Peterson RL, Butler EA, Ehiri JE, Fain MJ, Carvajal SC. Mechanisms of Racial Disparities in Cognitive Aging: An Examination of Material and Psychosocial Well-Being. The Journals of Gerontology: Series B. 2021;76(3):574–582. doi:10.1093/geronb/gbaa003
12. James SA, Strogatz DS, Wing SB, Ramsey DL. Socioeconomic status, John Henryism, and hypertension in blacks and whites. Am J Epidemiol. 1987;126(4):664–673. doi:10.1093/oxfordjournals.aje.a114706 [PubMed: 3631056]
13. Lewis TT, Barnes LL, Bienias JL, Lackland DT, Evans DA, Mendes de Leon CF. Perceived discrimination and blood pressure in older African American and white adults. J Gerontol A Biol Sci Med Sci. 2009;64(9):1002–1008. doi:10.1093/gerona/glp062 [PubMed: 19429703]

14. Barnes LL, de Leon CFM, Lewis TT, Bienias JL, Wilson RS, Evans DA. Perceived Discrimination and Mortality in a Population-Based Study of Older Adults. Am J Public Health. 2008;98(7):1241–1247. doi:10.2105/AJPH.2007.114397 [PubMed: 18511732]
15. Lewis TT, Aiello AE, Leurgans S, Kelly J, Barnes LL. Self-reported experiences of everyday discrimination are associated with elevated C-reactive protein levels in older African-American adults. Brain, Behavior, and Immunity. 2010;24(3):438–443. doi:10.1016/j.bbi.2009.11.011 [PubMed: 19944144]
16. Coley SL, Mendes de Leon CF, Ward EC, Barnes LL, Skarupski KA, Jacobs EA. Perceived discrimination and health-related quality-of-life: gender differences among older African Americans. Qual Life Res. 2017;26(12):3449–3458. doi:10.1007/s11136-017-1663-9 [PubMed: 28744665]
17. Lee DB, Kim ES, Neblett EW. The link between discrimination and telomere length in African American adults. Health Psychology. 2017;36(5):458–467. doi:10.1037/hea0000450 [PubMed: 28425738]
18. Barnes LL, Lewis TT, Begeny CT, Yu L, Bennett DA, Wilson RS. Perceived Discrimination and Cognition in Older African Americans. J Int Neuropsychol Soc. 2012;18(5):856–865. doi:10.1017/S1355617712000628 [PubMed: 22595035]
19. Coogan P, Schon K, Li S, Cozier Y, Bethea T, Rosenberg L. Experiences of racism and subjective cognitive function in African American women. Alzheimer's & Dementia: Diagnosis, Assessment & Disease Monitoring. 2020;12(1). doi:10.1002/dad2.12067
20. Qin W, Nguyen AW, Mouzon DM, Hamler TC, Wang F. Social Support, Everyday Discrimination, and Depressive Symptoms Among Older African Americans: A Longitudinal Study. Innovation in Aging. 2020;4(igaa032). doi:10.1093/geroni/igaa032 [PubMed: 32995567]
21. Nadimpalli SB, James BD, Yu L, Cothran F, Barnes LL. The Association Between Discrimination and Depressive Symptoms Among Older African Americans: The Role of Psychological and Social Factors. Experimental Aging Research. 2015;41(1):1–24. doi:10.1080/0361073X.2015.978201 [PubMed: 25494668]
22. Zahodne LB, Kraal AZ, Sharifian N, Zaheed AB, Sol K. Inflammatory mechanisms underlying the effects of everyday discrimination on age-related memory decline. Brain, Behavior, and Immunity. 2019;75:149–154. doi:10.1016/j.bbi.2018.10.002 [PubMed: 30367930]
23. Marden JR, Tchetgen Tchetgen EJ, Kawachi I, Glymour MM. Contribution of Socioeconomic Status at 3 Life-Course Periods to Late-Life Memory Function and Decline: Early and Late Predictors of Dementia Risk. American Journal of Epidemiology. 2017;186(7):805–814. doi:10.1093/aje/kwx155 [PubMed: 28541410]
24. Mungas D, Reed BR, Crane PK, Haan MN, González H. Spanish and English Neuropsychological Assessment Scales (SENAS): Further Development and Psychometric Characteristics. Psychological Assessment. 2004;16(4):347–359. doi:10.1037/1040-3590.16.4.347 [PubMed: 15584794]
25. Mungas D, Widaman KF, Reed BR, Farias ST. Measurement Invariance of Neuropsychological Tests in Diverse Older Persons. Neuropsychology. 2011;25(2):260–269. doi:10.1037/a0021090 [PubMed: 21381830]
26. Meyer OL, Eng CW, Ko MJ, et al. Generation and age of immigration on later-life cognitive performance in KHANDLE. Int Psychogeriatr. Published online December 23, 2020:1–12. doi:10.1017/S1041610220003774
27. Williams DR, Yu Yan null, Jackson JS, Anderson NB. Racial Differences in Physical and Mental Health: Socio-economic Status, Stress and Discrimination. J Health Psychol. 1997;2(3):335–351. doi:10.1177/135910539700200305 [PubMed: 22013026]
28. Fries J, Bruce B, Cella D. The promise of PROMIS: Using item response theory to improve assessment of patient-reported outcomes. Clinical and experimental rheumatology. 2005;23:S53–7.
29. Cook KF, Jensen SE, Schalet BD, et al. PROMIS measures of pain, fatigue, negative affect, physical function, and social function demonstrated clinical validity across a range of chronic conditions. J Clin Epidemiol. 2016;73:89–102. doi:10.1016/j.jclinepi.2015.08.038 [PubMed: 26952842]

30. Loh WW, Moerkerke B, Loeys T, Poppe L, Crombez G, Vansteelandt S. Estimation of Controlled Direct Effects in Longitudinal Mediation Analyses with Latent Variables in Randomized Studies. Multivariate Behavioral Research. 2020;55(5):763–785. doi:10.1080/00273171.2019.1681251 [PubMed: 31726876]
31. Robins JM. Marginal Structural Models versus Structural nested Models as Tools for Causal inference. In: Halloran ME, Berry D, eds. Statistical Models in Epidemiology, the Environment, and Clinical Trials. The IMA Volumes in Mathematics and its Applications. Springer; 2000:95–133. doi:10.1007/978-1-4612-1284-3_2
32. Cole SR, Hernán MA. Fallibility in estimating direct effects. International Journal of Epidemiology. 2002;31(1):163–165. doi:10.1093/ije/31.1.163 [PubMed: 11914314]
33. Ellwart T, Konradt U. Formative Versus Reflective Measurement: An Illustration Using Work–Family Balance. The Journal of Psychology. 2011;145(5):391–417. doi:10.1080/00223980.2011.580388 [PubMed: 21902009]
34. DiStefano C, Zhu M, Mîndrilã D. Understanding and Using Factor Scores: Considerations for the Applied Researcher. Practical Assessment, Research, and Evaluation. 2019;14(1). doi:10.7275/da8t-4g52
35. Efron B, Tibshirani RJ. An Introduction to the Bootstrap. CRC Press; 1994.
36. Zhang Z. Multiple imputation with multivariate imputation by chained equation (MICE) package. Ann Transl Med. 2016;4(2). doi:10.3978/j.issn.2305-5839.2015.12.63
37. Schomaker M, Heumann C. Bootstrap inference when using multiple imputation. Statistics in Medicine. 2018;37(14):2252–2266. doi:10.1002/sim.7654 [PubMed: 29682776]
38. R: The R Project for Statistical Computing. Accessed March 9, 2021. https://www.r-project.org/
39. NW 1615 L. St, Suite 800Washington, Inquiries D 20036USA202 419 4300 | M 857 8562 | F 419 4372 | M. For black Americans, experiences of racial discrimination vary by education level, gender. Pew Research Center. Accessed June 15, 2021. https://www.pewresearch.org/fact-tank/2019/05/02/for-black-americans-experiences-of-racial-discrimination-vary-by-education-level-gender/
40. Barnes LL, De Leon CFM, Wilson RS, Bienias JL, Bennett DA, Evans DA. Racial Differences in Perceived Discrimination in a Community Population of Older Blacks and Whites. J Aging Health. 2004;16(3):315–337. doi:10.1177/0898264304264202 [PubMed: 15155065]
41. Nguyen TT, Vable AM, Glymour MM, Nuru-Jeter A. Trends for Reported Discrimination in Health Care in a National Sample of Older Adults with Chronic Conditions. J GEN INTERN MED. 2018;33(3):291–297. doi:10.1007/s11606-017-4209-5 [PubMed: 29247435]
42. Everson-Rose SA, Skarupski KA, Barnes LL, Beck T, Evans DA, Mendes de Leon CF. Neighborhood socioeconomic conditions are associated with psychosocial functioning in older black and white adults. Health Place. 2011;17(3):793–800. doi:10.1016/j.healthplace.2011.02.007 [PubMed: 21421335]
43. Wingfield AH, Chavez K. Getting In, Getting Hired, Getting Sideways Looks: Organizational Hierarchy and Perceptions of Racial Discrimination. Am Sociol Rev. 2020;85(1):31–57. doi:10.1177/0003122419894335
44. Anderson E “The White Space.” Sociology of Race and Ethnicity. 2015;1(1):10–21. doi:10.1177/2332649214561306
45. For middle-class blacks, success can be a double-edged sword. Chicago Reporter. Published May 29, 2017. Accessed June 15, 2021. https://www.chicagoreporter.com/for-middle-class-blacks-success-can-be-a-double-edged-sword/
46. Breaking the Silence: The Paradox and Agony of Education | ASCCC. Accessed June 15, 2021. https://asccc.org/content/breaking-silence-paradox-and-agony-education
47. Feagin JR, Vera H, Imani N. The Agony of Education: Black Students at a White University. Routledge; 2014.
48. Meza E, Peterson R, Gilsanz P, et al. Perceived Discrimination, Nativity, and Cognitive Performance in a Multiethnic Study of Older Adults: Findings From the Kaiser Healthy Aging and Diverse Life Experiences Study. Newman AB, ed. The Journals of Gerontology: Series A. Published online June 14, 2021:glab170. doi:10.1093/gerona/glab170
49. Millsap RE. Statistical Approaches to Measurement Invariance. Routledge; 2012.

RESEARCH IN CONTEXT

1. Systematic review: Literature was reviewed using traditional sources (e.g., PubMed). Because few studies have examined the contribution of education to cognition mediated by psychosocial stressors in African American adults, research describing relationships among education, cognition, discrimination, or depression in African American adults was used to inform hypotheses in this study.
2. Interpretation: Our findings suggest that education may influence late life cognition through multiple mechanisms. Some mechanisms, such as increased exposure to discrimination, may be harmful even though the overall estimated effect of education is beneficial.
3. Future directions: Additional studies are warranted that examine the lifecourse factors contributing to racial disparities in late life cognitive outcomes, evaluating more comprehensive characterizations of educational experiences and dementia risk, and the intersection of structural and interpersonal racism on protective factors including how psychosocial stress affects brain integrity or cognitive reserve in older African American adults.

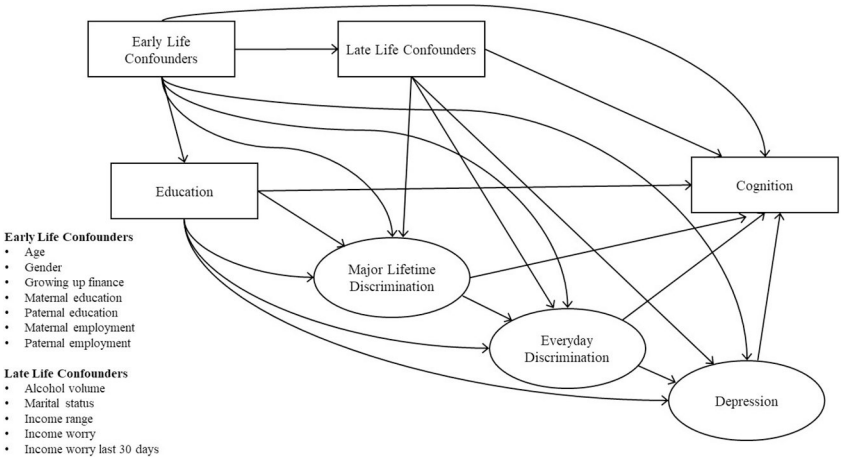

Figure 1. A lifecourse model for cognition in later-life

Note. Squares indicate manifest variables, whereas ovals represent latent variables. The model shown here is for a cognition outcome of interest (i.e., either composite later-life cognition, verbal episodic memory, semantic memory, or executive function).

Table 1

Descriptive statistics stratified by education and for the entire STAR sample

	≤ Bachelor's n=499(65.31%)	Bachelor's n=131(17.14%)	Graduate n=134(17.54%)	Whole Sample (n = 764)
Continuous Variables	**Mean(SD)**	**Mean(SD)**	**Mean(SD)**	**Mean(SD)**
Age in years	68.9 (8.93)	66.7 (8.08)	70.0 (8.63)	68.7(8.78)
Income Range (logarithmic units)	10.9 (0.68)	11.2 (0.60)	11.4 (0.51)	11.1 (0.67)
Later-life Cognition Z-Score	−0.23 (0.98)	0.40 (0.86)	0.45 (0.93)	0.00 (1.00)
Verbal Episodic Memory Z-Score	−0.13 (0.98)	0.30 (1.01)	0.18 (1.00)	0.00 (1.00)
Semantic Memory Z-Score	−0.19 (1.01)	0.28 (0.80)	0.43 (0.96)	0.00 (1.00)
Executive Function Z-Score	−0.24 (0.97)	0.41 (0.87)	0.48 (0.93)	0.00 (1.00)
Depression Z-Score	0.06 (1.05)	−0.04 (0.84)	−0.16 (0.93)	0.00 (1.00)
Major Lifetime Discrimination Z-Score	−0.13 (0.96)	0.21 (1.00)	0.25 (1.07)	0.00 (1.00)
Everyday Discrimination Z-Score	−0.03 (1.00)	0.10 (0.98)	0.00 (1.02)	0.00 (1.00)
Categorical Variables				
Gender	**n (%)**	**n (%)**	**n (%)**	**n (%)**
Female	337 (44.1)	97 (12.7)	88 (11.5)	522 (68.3)
Male	162 (21.2)	34 (4.5)	46 (6.0)	242 (31.7)
Growing-up Financial Position				
Pretty well off	49 (6.4)	8 (1.1)	20 (2.6)	77 (10.1)
About average	270 (35.3)	86 (11.3)	73 (9.6)	429 (56.2)
Poor or It varied	169 (22.1)	36 (4.7)	39 (5.1)	244 (31.9)
Maternal Education				
0-12 Years	291 (38.1)	80 (10.5)	68 (8.9)	439 (57.5)
Some college/Associate's	78 (10.2)	27 (3.5)	25 (3.3)	130 (17.0)
Bachelor's	29 (3.8)	11(1.4)	20 (2.6)	60 (7.9)
Master's or Professional	8 (1.1)	6 (0.80)	13 (1.7)	27 (3.5)
Paternal Education				
0-12 Years	276 (36.2)	81 (10.6)	74 (9.7)	431 (56.4)
Some college/Associate's	47 (6.2)	15 (2.0)	16 (2.1)	78 (10.2)
Bachelor's	15 (2.0)	8 (1.1)	15 (2.0)	38 (5.0)
Master's or Professional	11 (1.4)	8 (1.1)	14 (1.8)	33 (4.3)
Maternal Employment				
Mostly Full-Time	249 (32.6)	76 (10.0)	76 (10.0)	401 (52.5)
Mostly Part-Time or Not Employed	234 (30.6)	53 (6.9)	55 (7.2)	342 (44.8)
Paternal Employment				
Mostly Full-Time	427 (55.9)	118 (15.5)	124 (16.2)	669 (87.6)
Mostly Part-Time or Not Employed	22 (2.9)	3 (0.4)	3 (0.4)	28 (3.7)
Worry About Meeting Expenses				
Always or Often	65 (8.5)	12 (1.6)	11 (1.4)	88 (11.5)
Sometimes or Never	399 (52.2)	118 (15.5)	121 (15.8)	638 (83.5)
Worry About Meeting Expenses- Past 30 Days				
All or Nearly all the time	310 (40.6)	78 (10.2)	96 (12.6)	484 (63.4)

	≤ Bachelor's n=499(65.31%)	Bachelor's n=131(17.14%)	Graduate n=134(17.54%)	Whole Sample (n = 764)
Sometimes, Hardly ever, or Never	158 (20.7)	52 (6.8)	35 (4.6)	245 (32.1)
Currently Married				
Yes	173 (22.6)	45 (5.9)	63 (8.3)	281 (36.8)
No	311 (40.71)	84 (11.0.99)	69 (9.0)	464 (60.7)
Alcohol Volume Past 3 Months				
None	232 (30.4)	51 (6.7)	50 (6.5)	333 (43.59)
1-2 drinks on days drinking	226 (29.6)	66 (8.6)	77 (10.1)	369 (48.3)
3 or more drinks on days drinking	35 (4.6)	13 (1.7)	7 (0.9)	55 (7.2)

Note. SD – Standard deviation.

Table 2

Estimated total effect of educational attainment on cognitive outcomes and controlled direct effect of education on cognitive outcomes not mediated by depressive symptoms or everyday or major lifetime discrimination (N = 764)

	Panel A: Estimated Total Effect of Education on Cognitive Outcomes*			
	Composite Cognition	**Verbal Episodic Memory**	**Semantic Memory**	**Executive Function**
	β (95% CI)	**β (95% CI)**	**β (95% CI)**	**β (95% CI)**
<Bachelor's	**REF**	**REF**	**REF**	**REF**
Bachelor's	0.47(0.44,0.49)	0.28(0.25,0.30)	0.38(0.35,0.40)	0.49(0.47,0.50)
Graduate	0.66(0.62,0.68)	0.33(0.30,0.35)	0.56(0.53,0.60)	0.71(0.69,0.74)
	Panel B: Estimated Effect of Education on the Psychosocial Stressors*			
	Major Lifetime Discrimination	**Everyday Discrimination**	**Depression**	
	β (95% CI)	**β (95% CI)**	**β (95% CI)**	
<Bachelor's	**REF**	**REF**	**REF**	
Bachelor's	0.24(0.20,0.35)	−0.02(−0.05,0.01)	−0.18(−0.22,−0.14)	
Graduate	0.38(0.23,0.42)	−0.09(−0.13,−0.04)	−0.39(−0.44,−0.32)	
Major Lifetime Discrimination		0.51(0.49,0.52)	0.21(0.19,0.22)	
Everyday Discrimination			0.33(0.32,0.35)	
	Panel C: Controlled Direct Effect of Education on Cognition†			
	Composite Cognition	**Verbal Episodic Memory**	**Semantic Memory**	**Executive Function**
	β (95% CI)	**β (95% CI)**	**β (95% CI)**	**β (95% CI)**
<Bachelor's	**REF**	**REF**	**REF**	**REF**
Bachelor's	0.42(0.26,0.58)	0.26(0.07,0.44)	0.34(0.18,0.51)	0.45(0.29,0.61)
Graduate	0.60(0.43,0.76)	0.29(0.12,0.47)	0.52(0.34,0.70)	0.65(0.49,0.81)
Major Lifetime Discrimination	0.11(0.04,0.17)	0.03(−0.05,0.10)	0.13(0.06,0.02)	0.10(0.03,0.17)
Everyday Discrimination	−0.01(−0.09,0.07)	0.04(−0.05,0.12))	−0.04(−0.13,0.05)	−0.02(−0.10,0.06)
Depression	−0.06(−0.14,0.01)	−0.08(−0.15,0.00)	0.00(−0.09,0.09)	−0.08(−0.16,−0.01)

Note.

*-- after controlling for early-life confounders.

†-- after two-stage g-estimation including early-life and late life confounders. Everyday discrimination and depression are measured as latent variables.