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Income, wealth, and Black-White disparities in cognition

Dana A. Glei[a,*], Chioun Lee[b], Maxine Weinstein[a]

[a] Center for Population and Health, Georgetown University, USA
[b] Department of Sociology, University of California, Riverside, USA

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ABSTRACT

We investigated the contributions of income and wealth (beyond education) to Black–White disparities in cognition and evaluated whether the role of socioeconomic status (SES) varies by age. Based on data from a national survey of Americans (aged 23–94), we used regression models to quantify the overall racial disparities in episodic memory, executive function, and overall cognition, adjusted for sex and age. Potential mediators (i.e., measures of childhood environment, educational attainment, marital status, occupation, income, and wealth) were added in subsequent models. The age- and sex-adjusted Black–White differential in overall cognitive function was around one standard deviation (SD) between ages 25 and 50, but declined to 0.6 SD by age 80. Executive function followed a similar pattern, but the racial disparity in episodic memory declined more rapidly between ages 35 (0.7 SD) and 80 (0.2 SD). Childhood environment and the respondent's educational attainment accounted for 20–25% of the racial disparities in overall cognition. The incremental contribution of household income was small (1–5%). Although wealth had only a small effect at younger ages, the contribution grew with age. Wealth was much more important than income in explaining Black–White disparities in cognition at older ages. Childhood environment, marital status, and SES (including wealth) accounted for one-third of the racial disparity in overall cognition at ages 35–65, but an even greater share at age 80. Our study is the first to demonstrate that, with increasing age, wealth explains more of the Black–White disparity in cognition. A widening racial gap in wealth and the disproportionate financial impact of the Great Recession and the COVID-19 pandemic on minorities do not bode well for Black-White differentials in cognition. Working-age Americans suffered the brunt of the economic impact of those events; the impact on cognition may increase as those cohorts grow older.

1. Introduction

Among Americans, there are enormous racial disparities in cognitive function (e.g., Schwartz et al., 2004; Weuve et al., 2018; Zahodne et al., 2016), the prevalence of dementia, and Alzheimer's Disease (e.g., Mayeda et al., 2016; Mehta and Yeo, 2017; Weuve et al., 2018). Recent estimates of cognitive life expectancy indicate that the number of years living with dementia is more than twice as high for Blacks (3.9 years for women, 3.1 years for men) than Whites (1.6 & 1.1, respectively) (Garcia et al., 2019). Thus, Blacks bear more of the economic and social burdens of cognitive impairment (e.g., costs of medical and long-term care, reduced quality of life, time costs, and other stressors imposed on unpaid caregivers) than Whites.

A substantial share of the Black-White differential in cognition may result from disparities in socioeconomic status (SES). Fundamental Cause Theory (Link and Phelan, 1995) views SES as a "fundamental cause" because it is a key determinant of access to resources, may operate via many mechanisms to affect multiple disease outcomes, and the association with health is likely to persist even if the intervening mechanisms change. Phelan and Link (2015) further argue that racial differences in SES are a fundamental cause of racial disparities in health. In particular, educational attainment plays a key role in explaining racial disparities in cognition. According to the cognitive reserve hypothesis, education directly affects brain structure early in life, promoting reserve capacity (Beydoun et al., 2014; Cabeza et al., 2018), which enables individuals to better withstand age-related neural decline and can delay the onset of cognitive impairment (Mungas et al., 2018). Peterson et al. (2021) reported that education accounts for about one-fifth of the Black–White differential in cognition. Other studies have also found education to account for a substantial share of racial disparities (Mehta et al., 2004; Walsemann et al., 2022; Weuve et al., 2018; Zahodne et al., 2017).

* Corresponding author. 5985 San Aleso Court, Santa Rosa, CA, USA.
E-mail address: dag77@georgetown.edu (D.A. Glei).

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The pathways through which other SES measures affect cognition are more likely to be indirect. The effects of occupation, income, and wealth on cognition may operate via access to resources (e.g., knowledge, health care, nutrition, treatment for hearing loss, social networks) and exposure to risk (e.g., health behaviors, stressors, environmental hazards). Few studies have examined the role of these SES measures in explaining racial disparities in cognition, and the results have been mixed. For example, Zahodne et al. (2017) found that income was second only to education in explaining racial disparities, but they did not account for the role of wealth. Another study found no evidence that income or wealth mediated the racial disparity in cognition after controlling for education (Peterson et al., 2021). Other studies included occupation, income, and/or wealth, but did not quantify the incremental contributions to racial disparities in cognition (Hale, 2017; Karlamangla et al., 2009; Schwartz et al., 2004).

There are huge, longstanding racial disparities in wealth in the US (Aliprantis and Carroll, 2019) that are even larger than the corresponding disparities in income. In 2019, median household income among Whites ($76,057) was 1.7 times that of Blacks ($45,438) (U.S. Census Bureau, 2020), whereas median net wealth of White families ($188,200) was 7.8 times that of Black families ($24,100) (Bhutta et al., 2020). Wealth generally increases with age, as do the absolute Black–White differentials in wealth (Bhutta et al., 2020). Wealth is especially important after retirement when it becomes a major determinant of income. To our knowledge, no previous study has investigated whether wealth accounts for a larger share of the Black–White differential in cognition at older ages than at younger ages.

It is also important to consider whether the effects of various measures of SES on cognition differ by race. Previous work has demonstrated that Blacks derive greater cognitive benefit from education than Whites; thus, the racial disparity in cognition diminishes at higher levels of education (Barnes et al., 2011; Díaz-Venegas et al., 2016; Jean et al., 2019; Sherman-Wilkins and Thierry, 2019; Weuve et al., 2018), which is consistent with the notion that the effects of minority status and low SES are multiplicative. In contrast, the Diminishing Returns hypothesis (Farmer and Ferraro, 2005) implies that racial disparities in health will be wider at higher levels of SES because minorities obtain diminished returns to human capital as a result of racial discrimination, unequal employment opportunities, lower quality education, and other stressors related to minority status (Barnes et al., 2011; Sherman-Wilkins and Thierry, 2019). Consistent with this hypothesis, results from some studies suggested that the cognitive benefit of income and/or wealth may be limited to Whites (Cagney and Lauderdale, 2002; Peterson et al., 2021).

The objective of this paper is to investigate the incremental contributions of income and wealth, beyond educational attainment, to Black–White disparities in cognition. We predict that the role of income and wealth in explaining racial differences in cognition changes with age. We hypothesize that income will be more important at working ages than it is in later life, whereas we expect the opposite for wealth. In particular, wealth is likely to become increasingly important above age 65 when many people are no longer employed in the paid labor force.

2. Methods

2.1. Data

Wave 1 of the Midlife in the United States (MIDUS) study began in 1995–96. In Wave 2, they recruited a new oversample of African Americans in Milwaukee, and at the refresher wave, MIDUS again sampled African Americans in Milwaukee (see S1 of Supplementary Material for more details). The cognitive battery was administered starting at Wave 2; thus, we used data from Waves 2 (2004–05) and 3 (2013–14) for the longitudinal cohort as well as data for the refresher cohort (2011–14). Cognitive assessments were completed by 4512 participants at Wave 2 and 3291 at Wave 3 for the longitudinal cohort; and 2763 at the refresher Wave (R1). We restricted our analysis to those who completed both the self-administered questionnaire and cognitive assessments: 3973 at Wave 2; 2884 at Wave 3; and 2376 from the refresher (Table S1). Finally, we excluded from the analysis those who identified as Latina/o (104 at Wave 2; 80 at Wave 3; and 91 at the refresher) and those who reported a race other than White or Black (94 at Wave 2; 58 at Wave 3; and 166 at the refresher) because those subgroups were too small to obtain stable estimates. The final analysis sample comprised 8844 observations for 6232 respondents aged 23–94: 7667 observations for non-Latina/o Whites (hereafter referred to as "Whites"; 3387 at Wave 2 and 2447 at Wave 3 from the longitudinal cohort; and 1833 from the refresher) and 1177 observations for non-Latina/o Blacks (hereafter referred to as "Blacks"; 433 at Wave 2 and 404 at Wave 3 from the longitudinal cohort; and 340 from the refresher).

2.2. Measures

2.2.1. Cognitive function

The Brief Test of Adult Cognition by Telephone (BTACT) was administered separately from the main phone interview. Prior confirmatory factor analyses (Lachman et al., 2014) indicated that the seven cognitive tasks represented two factors: episodic memory (EM), which comprised immediate and delayed recall of 15 words based on the Rey Auditory Verbal Learning Test (Lezak, 1995; Rey, 1964); and executive function (EF), which included backward digit span (Wechsler, 1997), category verbal fluency (Borkowski et al., 1967; Tombaugh et al., 1999), Stop and Go Switch Task (Lachman and Tun, 2008), number series (Salthouse and Prill, 1987; Schaie, 1996), and the 30 Seconds and Counting Task, a measure of processing speed (Lachman and Tun, 2008). We standardized the scores for each cognitive task based on the distribution of the pooled sample. EM was computed as the average of the standardized scores for immediate and delayed word recall (Cronbach's $\alpha = 0.88$), while EF was calculated as the average of standardized scores from the other five tasks (Cronbach's $\alpha = 0.72$). The composite score was based on the average of the standardized scores from all seven tasks (Cronbach's $\alpha = 0.78$). Convergent and discriminant validity has been demonstrated among a subsample of individuals who were administered both the BTACT and an approximately 90-min in-person comprehensive cognitive battery (Lachman et al., 2014).

2.2.2. Demographic control variables

We controlled for age, sex, and race (Black vs. White), all of which have well-established relationships with cognition. Age was measured at the time of the cognitive assessments. Respondents were asked, "Which do you feel best describes your racial background? White; Black or African American; American Indian or Alaska Native; Asian; Native Hawaiian or Pacific Islander?" We retained those who identified with the first two response categories, but as noted above, the remaining categories were excluded from the analysis. Those who self-identified as Latina/o ("Are you of Spanish, or Hispanic or Latino descent, that is, Mexican, Mexican American, Chicano, Puerto Rican, Cuban or some other Spanish origin?) were also excluded from the analysis.

2.2.3. Potential mediators

We included measures of childhood environment, marital status, and adult SES as potential mediators of the racial disparity in cognition (see S2 of Supplementary Material for more details), all of which differed by race and were expected to affect cognition. Childhood environment was measured at the initial survey wave for each participant (Wave 1 for the original cohort; Wave 2 for the Milwaukee cohort; Wave R1 for the refresher cohort) and included: whether the respondent was foreign-born, the metropolitan status of the area where the respondent lived during most of childhood (rural, small town, medium-sized town, suburbs, city, moved around); absence of a female head of household during childhood; absence of a male head of household during childhood; educational attainment and occupation of mother/female head of household and father/male head of household; and whether the respondent's family was ever on welfare. Nativity affects early life experiences, which may influence cognitive development (Garcia et al., 2020). The percentage of Americans who are foreign-born is higher among Blacks than Whites (National Center for Education Statistics, 2019). Previous studies have demonstrated that individuals who grew up in a rural area scored lower on cognition (Hermida et al., 2019) and may be at higher risk for developing dementia or Alzheimer's disease (Russ et al., 2012). Racial differences in urban versus rural residence are well-known (Economic Research Service, 2020). Childhood family structure and SES also vary dramatically by race and may have important implications for cognition. Lee et al. (2020) showed that individuals who grew up with a single parent had lower levels of cognitive function in later life than those who lived with both parents or in a multigenerational household. The cognitive reserve hypothesis proposes that education directly affects cognitive capacity. SES may also affect cognition indirectly via access to resources and exposure to risk as posited by Fundamental Cause Theory (Link and Phelan, 1995).

Current marital status and adult SES were measured at each wave (i.e., they are time-varying for longitudinal respondents). Our SES measures included educational attainment, current/previous occupation, income, and current net wealth (i.e., total value of all assets including savings, stocks, bonds, home, other real estate, vehicles, and other possessions minus any debts owed on mortgage(s), other loans, credit cards, etc.) of the respondent and his/her spouse/partner. In the US, marriage and SES differ greatly by race. Marital status is also associated with SES, particularly income and wealth, which may, in turn, affect cognition.

2.3. Analytic strategy

All analyses were conducted in Stata 16.1. We used standard practices of multiple imputation (Rubin, 1996; Schafer, 1999) to handle missing data. We began by graphing the smoothed cognitive scores by age for Blacks versus Whites to visualize the age pattern. Based on prior work (Aartsen et al., 2019; Hale, 2017), we expected the relationship between age and cognition to be non-linear with accelerated decline at older ages.

To formally test how cognition varies by age and race, we fit a linear mixed model with an individual-level random intercept to account for intra-individual correlation. We also used a robust variance estimator to correct for family-level clustering. In Model 1, we controlled only for demographic characteristics: sex, age (using a quadratic specification), race, and an interaction between race and age (linear and quadratic terms) to test whether the age pattern of cognition differs by race. This model quantified the overall racial disparities in cognition and tested the significance of the patterns observed graphically.

In the remaining models, we added potential mediators to evaluate how the Black–White disparities change after adjusting for various covariates. Measures of the childhood environment were added first because they clearly precede the adult measures (Model 2). Among the adult measures, it is impossible to determine the temporal ordering of completion of education, marriage, and occupation, the order of which varies from one person to the next. In Model 3, we entered educational attainment followed by marital status (Model 4) and then occupation (Model 5). Finally, we added income (Model 6) and wealth (Model 7). Among those who are no longer employed (30% of the sample is retired and another 14% are neither employed nor retired), one might argue that (previous) occupation should be entered before current marital status. When we used that alternative ordering in a sensitivity analysis, it affected the results only minimally.

For the respondent's educational attainment, we tested both ordinal and categorical (i.e., less than GED/HS graduate; GED/HS graduate; some college; college graduate; post-graduate degree) specifications. The categorical specification yielded the best model fit (based on the Bayesian Information Criteria, BIC). Given prior evidence that the effect of education on cognition is greater for Blacks than Whites (Barnes et al., 2011; Díaz-Venegas et al., 2016; Jean et al., 2019; Sherman-Wilkins and Thierry, 2019; Weuve et al., 2018), we tested an interaction between race and education. However, the interaction terms were not significant (even jointly) and thus were omitted from final models.

We also tested various specifications for income and wealth: linear, inverse hyperbolic sine (IHS)-transformed (see S2 of Supplementary Material for more details), deciles, quintiles, quartiles, and tertiles. The quartile specification yielded the best model fit (i.e., lowest BIC) for income, whereas tertiles fit slightly better for wealth. In the interest of comparability, we used the quartile specification for both income and wealth. To test whether the effects of income and wealth differed by race, we added interactions between race and income/wealth in preliminary models, but they were not significant for any outcome. Consequently, we omitted those interactions from the final models.

3. Results

Table 1 shows the descriptive statistics for analysis variables by race and age group. On average, Blacks scored much lower than Whites on cognitive function; in particular, scores for EF differed by about one SD. Blacks were more likely than Whites to have lived in a city during childhood and less likely to have grown up in a suburb. Blacks were more disadvantaged than Whites in numerous ways. During childhood, they were much more likely than Whites to have had no father figure and their family was more likely to have been on welfare. Educational attainment of the respondent and his/her parents was substantially lower for Blacks than Whites. Blacks (and their parents) were also more likely than their White counterparts to work in a manual occupation. Blacks were less likely than Whites to be currently married and had lower income and less wealth. Furthermore, the racial gap in the percentage of respondents with high wealth (i.e., $437,000 or more, which represents the top quartile of the overall sample) increases with age: below age 50, 15% of Whites but only 1% of Blacks have high wealth; at ages 65 and older, the corresponding figures are 38% vs. 5%. In contrast, there is no evidence that the racial gap in income widens with age.

The age pattern of cognition was non-linear, with a small increase between ages 25 and 35, followed by decline after age 35, which accelerated above age 65 among Whites (Fig. S1). There also appeared to be a racial difference in the age pattern. The Black–White differential in cognition was widest around age 35. Levels of EM converged between Blacks and Whites at the oldest ages because age-related decline in EM was faster for Whites than Blacks. There was less convergence in EF: the Black–White gap narrowed somewhat above age 65, although Blacks still had lower EF than Whites even above age 85. The observed pattern is similar to that described by Aartsen et al. (2019, p. 5483): "there comes a time when the neuronal loss can no longer be compensated by cognitive reserve, and we observed an accelerated decline, as if advantaged respondents were catching up, a result that is in line with reserve theory."

The full model results are shown in Supplementary Table S2 (overall cognition), S3 (episodic memory), and S4 (executive function). It is difficult to discern the magnitude of the racial disparities in cognition from those tables because of the interaction between age and race (i.e., the racial disparity in cognition varies by age). For easier interpretation, Table 2 shows the predicted Black–White disparity in cognition at age 35, 50, 65, and 80. Model 1, which controls for sex, race, age, and the interaction between race and age, quantified the overall magnitude of the racial disparity in cognition before controlling for potential mediators. The results confirmed that cognitive decline accelerated with age but more so for Whites than Blacks (see Fig. 1). The interactions between race and age (and its quadratic) were jointly significant, indicating that age-related decline in cognition differed significantly by race. Above age 50, the racial differences in cognition narrowed. For example, the Black–White differential in overall cognitive function was greater than one SD at age 50, but declined to 0.9 SD at age 65 and 0.6 SD by age 80

Table 1
Descriptive statistics by race and age group, Americans aged 23–94.

	Total	Aged <50		Aged 50–64		Aged 65+	
		Whites	Blacks	Whites	Blacks	Whites	Blacks
Overall Cognition, mean (SD)[a]	0.0 (1.0)	0.6 (0.8)	−0.4 (0.9)	0.2 (0.8)	−0.7 (0.9)	−0.4 (0.9)	−1.1 (0.9)
Episodic Memory, mean (SD)[a]	0.0 (1.0)	0.4 (0.9)	−0.2 (1.0)	0.2 (0.9)	−0.3 (1.0)	−0.3 (1.0)	−0.5 (1.0)
Executive Function, mean (SD)[a]	0.0 (1.0)	0.6 (0.9)	−0.4 (0.9)	0.2 (0.8)	−0.8 (0.9)	−0.4 (0.9)	−1.2 (0.9)
Age (23–94), mean (SD)	58.4 (13.2)	41.9 (5.8)	40.8 (6.6)	57.4 (4.3)	56.7 (4.3)	72.9 (5.9)	72.4 (5.8)
Female, %	55.9	55.1	63.7	54.1	65.6	54.1	70.4
Foreign-born, %	3.0	2.6	3.0	3.2	2.3	3.3	2.3
Metro status of childhood residence							
Rural, %	22.7	19.5	10.6	21.6	17.8	28.1	31.3
Small town, %	23.8	22.8	11.5	24.3	18.3	26.7	23.4
Medium town, %	11.4	14.5	4.7	12.4	6.5	10.4	5.2
Suburbs, %	16.6	25.8	8.9	20.9	4.0	10.0	3.4
City, %	21.1	11.8	58.7	16.2	50.7	20.8	35.3
Moved around, %	4.5	5.6	5.6	4.7	2.7	4.0	1.5
No mother figure during childhood, %	0.6	0.2	1.6	0.4	1.3	0.7	0.7
Mother's education[b]							
Less than GED/high school graduate, %	31.1	14.6	31.2	24.8	50.1	43.4	62.9
GED/high school graduate, %	39.8	42.2	35.2	46.5	32.2	34.3	24.3
Some college, %	15.1	18.6	18.1	15.1	11.0	13.5	8.5
College graduate, %	10.4	16.9	11.4	10.3	4.9	7.2	3.8
Post-graduate degree, %	3.6	7.8	4.1	3.2	1.8	1.7	0.4
Mother's occupation[b]							
Never employed, %	45.7	36.4	20.9	49.6	28.8	56.1	34.0
Manual, %	12.4	8.4	18.5	10.1	20.5	14.5	23.3
Service/sales/clerical, %	27.8	33.3	38.0	27.4	39.0	20.0	34.8
Management/business/financial, %	3.8	5.6	3.2	3.5	2.0	3.3	1.2
Professional, %	10.3	16.3	19.4	9.3	9.7	6.2	6.8
No father figure during childhood, %	6.3	5.4	24.8	4.0	15.0	4.4	13.1
Father's education[c]							
Less than GED/high school graduate, %	38.6	18.6	35.1	33.9	60.2	52.5	69.2
GED/high school graduate, %	29.8	32.7	41.5	32.3	27.3	25.0	18.8
Some college, %	12.1	14.6	13.2	13.0	7.7	10.4	6.5
College graduate, %	11.8	19.7	6.9	13.1	2.7	7.3	3.8
Post-graduate degree, %	7.8	14.4	3.3	7.8	2.1	4.9	1.8
Father's occupation[c]							
Never employed, %	1.7	2.0	4.0	1.2	4.3	1.4	2.4
Manual, %	51.7	39.1	68.7	49.7	71.8	55.7	75.0
Service/sales/clerical, %	18.7	19.4	12.9	19.9	13.3	18.7	15.6
Management/business/financial, %	16.5	22.0	9.7	17.1	7.5	15.4	2.9
Professional, %	11.4	17.6	4.6	12.2	3.2	8.7	4.1
Family never on welfare, %	91.9	92.7	64.0	95.3	73.7	95.6	87.2
Education							
Less than GED/high school graduate, %	5.9	2.7	10.2	3.4	12.9	7.2	24.5
GED/high school graduate, %	24.3	17.6	30.8	24.0	27.6	28.0	25.6
Some college, %	29.5	28.7	35.1	28.8	37.0	27.9	32.5
College graduate, %	22.7	30.2	14.5	24.2	12.2	20.1	7.3
Post-graduate degree, %	17.7	20.8	7.5	19.6	10.4	16.7	10.2
Marital status							
Married, %	64.9	74.2	28.4	73.3	30.5	63.8	33.6
Partnered, %	4.0	6.0	10.7	2.9	7.6	2.2	2.6
Widowed, %	8.6	0.7	1.1	3.7	6.2	19.0	33.2
Divorced/separated, %	13.5	9.1	17.9	13.9	31.7	11.2	23.7
Never married, %	9.0	10.1	41.9	6.2	24.0	3.9	6.9
Current/previous occupation							
Never employed, %	0.3	0.2	0.3	0.2	0.2	0.5	0.1
Manual, %	17.3	14.0	22.6	16.3	26.2	17.9	22.6
Service/sales/clerical, %	36.3	31.7	50.1	33.5	46.1	38.0	48.7
Management/business/financial, %	20.2	22.8	10.7	21.7	11.7	20.7	10.3
Professional, %	25.9	31.4	16.3	28.4	15.8	23.2	18.4
Income[d]							
Less than $26,475	25.0	17.2	54.7	16.8	48.5	28.4	53.6
$26,475–48,759	25.0	28.1	22.0	22.5	21.6	27.0	21.5
$48,760–80,609	25.0	29.2	14.3	27.7	18.0	22.8	13.8
$80,610 or more	25.0	25.5	8.9	33.1	11.9	21.8	11.2
Net wealth[e]							
In debt/Net $0	29.0	33.8	70.6	22.6	64.5	17.8	54.9
$1–106,399	21.1	27.1	23.3	20.1	22.5	16.1	27.9
$106,400–436,999	25.0	25.5	5.1	28.8	9.1	27.7	11.8
$437,000 or more	24.9	14.6	1.1	28.5	3.0	38.4	5.4
Number of observations	8844	2007	374	2970	529	2690	274

Note. SD: Standard Deviation.
[a] Standardized to have a mean of 0 and SD of 1 among the pooled sample.
[b] Among those with a female head of household during childhood.
[c] Among those with a male head of household during childhood.

[d] Annual household income is converted to 2014 dollars, equivalence-adjusted, and categorized into quartiles.
[e] Net wealth of the respondent and spouse/partner is converted to 2014 dollars and categorized into quartiles.

Table 2
Predicted Black–White differential in cognition[a] (and percentage reduction in the differential relative to Model 1)[b] at ages 35, 50, 65, and 80 adjusted for various covariates, Americans.

	At Age 35	At Age 50	At Age 65	At Age 80
Overall Cognition				
Model 1	−0.99***	−1.03***	−0.90***	−0.58***
Model 2	−0.83*** (16)	−0.89*** (14)	−0.78*** (13)	−0.52*** (11)
Model 3	−0.75*** (24)	−0.82*** (20)	−0.72*** (20)	−0.44*** (25)
Model 4	−0.69*** (30)	−0.77*** (25)	−0.68*** (24)	−0.42*** (28)
Model 5	−0.68*** (31)	−0.76*** (26)	−0.67*** (25)	−0.42*** (28)
Model 6	−0.67*** (32)	−0.74*** (28)	−0.65*** (27)	−0.40*** (31)
Model 7	−0.65*** (34)	−0.69*** (33)	−0.58*** (35)	−0.33*** (43)
Episodic Memory				
Model 1	−0.65***	−0.57***	−0.42***	−0.19*
Model 2	−0.57*** (13)	−0.50*** (13)	−0.36*** (13)	−0.17 (9)
Model 3	−0.52*** (21)	−0.46*** (20)	−0.32*** (23)	−0.11 (43)
Model 4	−0.48*** (27)	−0.42*** (26)	−0.30*** (28)	−0.11 (44)
Model 5	−0.47*** (28)	−0.42*** (27)	−0.30*** (29)	−0.11 (43)
Model 6	−0.46*** (30)	−0.40*** (30)	−0.28*** (33)	−0.09 (49)
Model 7	−0.45*** (31)	−0.38*** (34)	−0.24*** (42)	−0.06 (71)
Executive Function				
Model 1	−0.96***	−1.06***	−0.97***	−0.68***
Model 2	−0.80*** (17)	−0.91*** (14)	−0.85*** (13)	−0.60*** (11)
Model 3	−0.72*** (25)	−0.85*** (20)	−0.78*** (19)	−0.53*** (22)
Model 4	−0.66*** (31)	−0.79*** (25)	−0.74*** (23)	−0.51*** (25)
Model 5	−0.65*** (32)	−0.78*** (26)	−0.73*** (24)	−0.51*** (25)
Model 6	−0.64*** (33)	−0.76*** (28)	−0.72*** (26)	−0.49*** (28)
Model 7	−0.62** (36)	−0.71*** (33)	−0.64*** (34)	−0.41** (39)

Note. All models are based on the full analysis sample (8844 observations). Full results from the models are shown in Tables S2–S4. Model 1 includes only sex, age (quadratic specification), race, and an interaction between race and age (quadratic), which allows the racial disparity to vary by age. Potential mediators are added sequentially in subsequent models: childhood environment in Model 2; educational attainment in Model 3; marital status in Model 4; occupation in Model 5; income in Model 6; and wealth in Model 7.
*p < 0.05; **p < 0.01; ***p < 0.001.
[a] The predicted Black–White differentials (measured in standard deviation units) is computed by combining the main effect for race (which represents the racial disparity at age 35) and the interactions between race and age (linear and quadratic terms). For example, the differential for age 80 is the sum of the main effect for race (e.g., −0.99 for Overall Cognition, Model 1 from Table S2), 4.5 (i. e., (80–35)/10 because age is scaled in decades from age 35) times the interaction between race and linear age (−0.09), and 20.25 (i.e., 4.5^2) times the interaction with age-squared (0.04), yielding a differential of −0.58.
[b] The percentage reduction in the Black–White differential (relative to Model 1) is shown in parentheses. It is calculated by dividing the predicted racial differential for the specified model by the corresponding differential from Model 1 and subtracting from one. For example, in the case of overall cognition at age 80, the percentage reduction in the race differential for Model 7 relative to Model 1 is: $1 - \left(\frac{-0.33}{-0.58}\right) = 0.43 = 43\%$.

(Table 2, Model 1). The convergence was especially strong for episodic memory, where the racial disparity was no longer significant by age 82.

Variables that could potentially mediate the relationship between race and cognitive function were added incrementally in the remaining models. Adding measures of childhood environment (Model 2) reduced the Black–White differential in overall cognition by 11–16%.

Not surprisingly, educational attainment was a major contributor to Black–White disparities in cognition (Model 3). For example, adjustment for the respondent's own educational attainment reduced the Black–White differential in overall cognition at age 80 from 0.52 in Model 2 to 0.44 in Model 3 (i.e., an additional 14% reduction). Altogether, childhood environment (which includes educational attainment of the respondent's parents) and the respondent's own educational attainment accounted for 20–25% of the racial disparities in overall cognition.

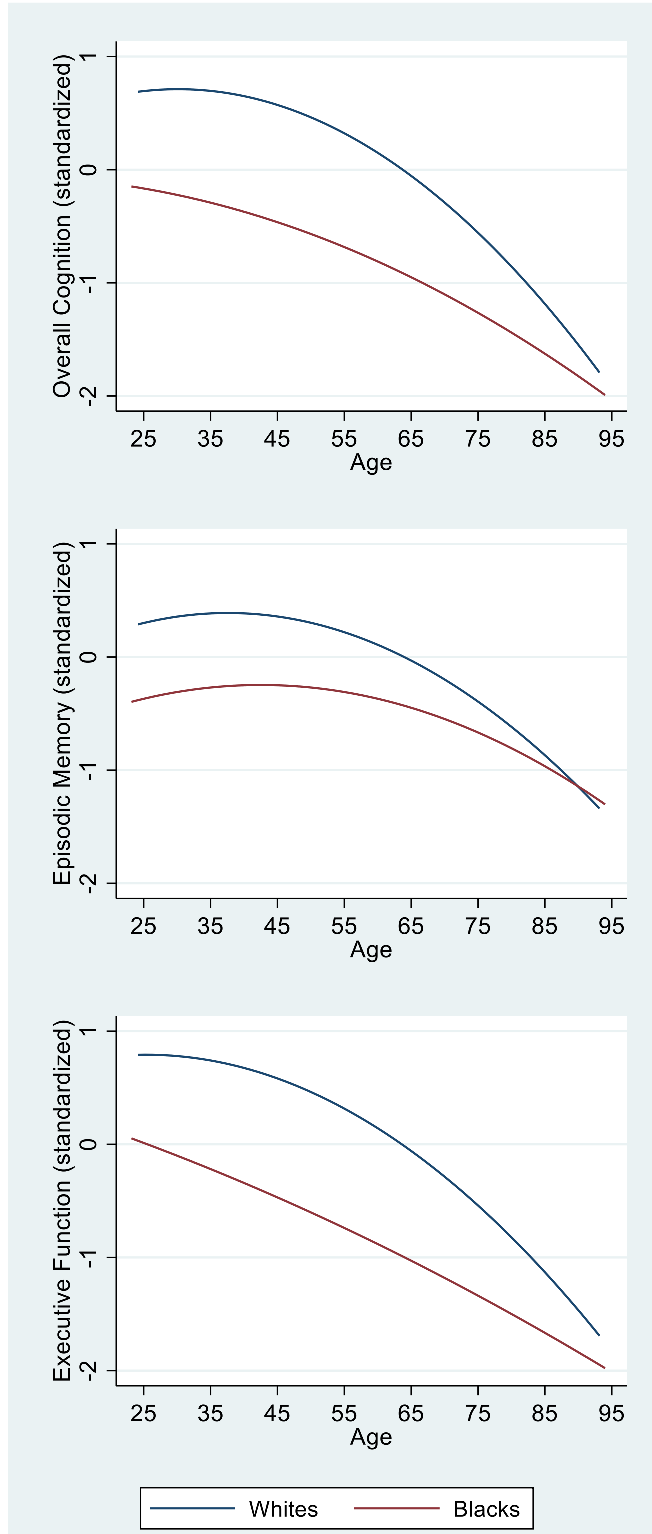

Fig. 1. Model-based Predicted Cognition by Age for Whites vs. Blacks.
Note. Predicted values are based on Model 1 from Tables S2–S4 with the percentage female set to the sample mean.

Further adjustment for marital status (Model 4) yielded a notable reduction in the racial disparity, particularly at younger ages (additional 6% reduction at age 35), but occupation (Model 5) produced a negligible reduction (at most, an additional 1%). Income (Model 6) produced a small incremental reduction (1–5%). The final model (Model 7) tested whether wealth contributed further explanatory power beyond income, education, and all the other covariates included in Model 6. The results indicated that wealth accounted for a small share of the racial disparity in cognition at younger ages, but the contribution rose with age (Table 2, Model 7). For example, incremental adjustment for wealth reduced the racial disparity in overall cognition at age 35 from 0.67 SD in Model 6 to 0.65 SD in Model 7 (i.e., an additional reduction of 2%), but the Black–White differential at age 80 was reduced from 0.40 SD to 0.33 SD (i.e., additional reduction of 12%). At older ages, wealth was much more important than income in explaining Black–White disparities in cognition.

Altogether, childhood environment, marital status, and measures of adult SES accounted for about one-third of the Black–White disparity in overall cognition at age 35–65, but 43% of the (smaller) disparity at age 80. These mediators explained a larger share of the disparity at age 80 because the contribution of wealth increased with age. In contrast, the percent reduction in the racial disparity was similar across these ages (27–32%) before adding wealth (in Model 6).

3.1. *Sensitivity analyses*

Most prior studies measured years of schooling as a linear variable, whereas MIDUS measured degree completion. In auxiliary analyses, we specified the 12 response categories for education as ordinal, but found there was a significant race-by-education interaction (i.e., education was more beneficial for Blacks than Whites) when using this specification: the estimated racial disparity was smaller at higher levels of education. Adjusted for childhood environment and the respondent's own education (treated as ordinal), the predicted Black–White differentials when education was set to the median (i.e., 3 or more years of college with no degree) were only slightly lower than the estimates presented in Table 2, yielding a negligible difference in terms of the percentage reduction in the racial disparity relative to Model 1. However, the adjusted racial disparity was larger for high school graduates (e.g., −0.87 for overall cognition at age 50) and smaller for college graduates (e.g., −0.75 for overall cognition at age 50). Thus, the corresponding percentage reduction in the racial disparity relative to Model 1 was *smaller* for high school graduates (15%) than for college graduates (28%). However, the categorical specification still yielded better model fit even without the race-by-education interaction.

The IHS-transformed values for income produced the second-best model fit after quartiles. The percent mediated using the IHS-transformed values was similar to the results presented here.

For wealth, neither the linear nor the IHS-transformed specification fit nearly as well as categorical specification. When the models were refit using the tertile specification (which yielded the best model fit), the percentage mediated remained similar to the results based on quartiles. We also explored whether the effect of wealth increases with age, as has been shown for mortality (Glei et al., 2022), but the interaction between age and wealth was not significant nor did it improve model fit.

4. Discussion

It is no surprise to find that educational attainment is a major contributor to Black–White disparities in cognition. However, Manly and Mayeux (2004) argued that controlling for education does not take into account potential differences in educational quality. Various studies have suggested that measures of literacy or educational quality may be better predictors of later-life cognitive function than educational attainment per se (Carvalho et al., 2015; Manly et al., 2005; Sisco et al., 2015). Among Whites and Blacks aged 50 and older who grew up in the South, Walsemann et al. (2022) revealed that a more refined measure of school duration that takes into the account state-level differences in school attendance and length of the school term for White- vs. Black-segregated schools accounts for a much larger share (45%) of Black–White disparities in overall cognition than years of schooling (30–32%). Thus, the role of education may be even greater than it appears to be in our analysis, where we only have measures of degree completion.

Contrary to our expectations, the incremental contribution of income was small even at working ages. This finding seems to counter earlier results by Zahodne et al. (2017), who reported that income was a notable contributor to racial disparities in cognition and that the indirect effect via income diminished with age. The discrepancies between our results and theirs may owe to differences in the analysis sample (i.e., they included data only from MIDUS Wave 2, where the age range was more restricted); the specification of age (i.e., they did not allow for a non-linear age pattern nor did they permit the age pattern to differ by race although their previous study demonstrated that the racial disparities in cognition diminished with age; Zahodne et al., 2016); the measure of income (i.e., they did not make an equivalence adjustment to account for differences in household size); and/or inclusion of potential confounders (i.e., they did not control for measures of the childhood environment or marital status, both of which may confound the relationship between adult SES and cognition).

As expected, with increasing age, wealth explained more of the Black–White disparity in cognition. Consequently, wealth was much more important than income in explaining racial disparities in cognition at older ages. After retirement, income becomes more dependent on wealth. Another important difference between income and wealth is that income measures the flow of financial resources during a particular period, whereas wealth is a cumulative stock that is affected by a lifetime of prior decisions and influences (Killewald et al., 2017). Cognition, like other dimensions of health, is also a stock measure that carries traces of prior experience (Killewald et al., 2017). Thus, given their cumulative nature, it makes sense that the association between wealth and cognition might become stronger over the life course.

Racial disparities in wealth have widened over the last three decades (Aladangady and Forde, 2021), which does not bode well for corresponding disparities in health. The Great Recession (2007–09) and the COVID-19 pandemic (2020–) imposed additional economic challenges, particularly for cohorts who were in prime working ages during those periods and for minorities, who suffered a disproportionate share of the financial impact (Kochhar and Fry, 2014; Monte and Perez-Lopez, 2021). As those cohorts grow older and retire from the workforce, the consequences of those economic and social stressors may exacerbate racial differentials in cognition.

Policies that improve educational attainment among minorities are likely to be an important means for reducing racial disparities in cognition throughout life, but our findings suggest that wealth inequality may exacerbate racial disparities in cognition. Wealth may capture additional variation in SES (above and beyond educational attainment), especially later in life and after retirement. As a colleague (Carlos Mendes de Leon, personal communication, 5/18/2022) explains, "For example, accumulated wealth may be a marker of the occupational, social, and lifestyle experiences during adulthood that contribute to the *maintenance* of cognitive reserve built earlier in life through education and the quality of the childhood social environment." One question that our study cannot answer is: what are the mechanisms by which wealth may contribute to racial disparities in cognition during late life? Access to quality health care, including treatment for hearing loss, is one candidate. Among 12 potentially modifiable risk factors for dementia (Livingston et al., 2020), six pertain to specific health conditions (hearing impairment, depression, traumatic brain injury, hypertension, obesity, and diabetes). Wealth may also influence the degree of social isolation, which rivaled depression and smoking in terms of the estimated population attributable fraction for dementia (Livingston et al., 2020). Social engagement is thought to enhance cognitive reserve and encourage beneficial behaviors, although isolation may also be a result of dementia (Livingston et al., 2020). Finally, wealth may reduce exposure to environmental hazards (e.g., air pollution, lead exposure, and circumstances that increase the risk of head injury).

4.1. Limitations

The first limitation of our findings is that reverse-causality may bias our estimates. We cannot determine whether wealth affects cognition or whether cognitive impairment may deplete wealth. Auxiliary analyses among the longitudinal cohort revealed that higher wealth at Wave 2 predicted smaller subsequent declines in overall cognition and EF between Wave 2 and 3, but we found no evidence of a significant association between cognition at Wave 2 and subsequent declines in wealth. These results support the notion that wealth affects cognition rather than the reverse. Nonetheless, it remains possible that the association between wealth and cognition is over-estimated because of endogeneity. An instrumental variable approach can be used to address such endogeneity but requires that we have a valid instrument (i.e., a variable that is well-correlated with wealth, but does not directly affect cognition). Unfortunately, to the best of our knowledge, MIDUS does not include an appropriate instrument.

Second, there is potential bias from non-response and misreporting. Minorities and those with lower SES are less likely to participate in surveys, but richer individuals are more likely than poorer people to under-report their income (Lustig, 2019). If misreporting of wealth follows a similar pattern and/or varies by race, it could bias our results.

Third, our measures of occupation are crude. MIDUS has recently created measures of occupational complexity, but those variables are available only for respondents who are currently employed. By Wave 3 (when the longitudinal cohort was aged 43–92), only 55% of the sample was still employed.

Fourth, given the relatively small number of minorities in the sample, our power to detect racial differences in the effect of particular covariates (e.g., education, income, wealth) or to evaluate cognition among other racial/ethnic groups (e.g., Latina/o, Asian/Pacific Islanders, Native Americans) is limited. When we treated education as categorical, we found no evidence of a racial difference in the effect of education on cognition (i.e., none of the interaction terms were significant, although the direction and magnitude of the coefficients suggested that, if there is a racial difference, it may be restricted to the effect of a college or post-graduate degree). However, the interaction appeared to be sensitive to the specification of education; as noted above, when education was treated as ordinal, the race-by-education interaction was significant and followed the pattern shown by earlier studies (most of which used years of schooling as a linear variable).

Finally, the generalizability of our findings is unclear because most Blacks in the MIDUS sample come from the Milwaukee subsample, which may not be representative of US Blacks nationally. Blacks from the Milwaukee subsample have lower overall cognition and EF, are more likely to have grown up in a city, are less likely to be married, and have lower SES than other Blacks in the MIDUS sample.

5. Conclusions

Few prior studies have quantified the extent to which wealth accounts for racial disparities in cognition. Our study is the first to demonstrate that the contribution of wealth rises with age. Altogether, we found that childhood environment, marital status, and measures of adult SES (i.e., educational attainment, occupation, income, wealth) explained up to 43% of the Black–White differentials in overall cognitive function. Given that both wealth and cognition are affected by a lifetime of prior experiences, it makes sense that the association between them may increase with age. A widening racial gap in wealth and the disproportionate financial impact of the Great Recession and the COVID-19 pandemic on minorities do not bode well for Black-White differentials in cognition. The working age population suffered the brunt of the economic impact of those historical events, and the full consequences for cognitive decline may not become evident until those cohorts grow older. Only the future can tell whether the huge racial inequalities in wealth and in cognition will grow even wider as recent history exacts its toll.

Author contribution

Dana A. Glei: Conceptualization, Methodology, Formal analysis, Writing – original draft, Visualization. Chioun Lee: Writing – review & editing. Maxine Weinstein: Writing – review & editing, Project administration, Funding acquisition.

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Declaration of competing interest

The authors declare no conflict of interest.

Data availability

The original data used for this analysis are available from ICPSR (https://www.icpsr.umich.edu/web/ICPSR/series/203). See S3 of Supplementary Material for more details.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.socscimed.2022.115298.

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