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Article

Cognitive test score and 25-Year mortality risk; Does race matter?

Shervin Assari¹

¹ Department of Family Medicine, Charles R. Drew University of Medicine and Science, Los Angeles, CA 90095, USA

* Correspondence: assari@umich.edu.

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Abstract:

Objectives: Despite our knowledge on the effect of cognitive test score on subsequent risk of mortality, few studies have compared Blacks and Whites for this association. The current study was conducted on Black-White differences in the magnitude of the association between baseline cognitive test score and all-cause mortality in a nationally representative sample of adults in the United States over 25 years. **Methods:** We used data of the Americans' Changing Lives Study (ACL), 1986 – 2011, a national prospective cohort in U.S. The study followed 3,361 adults (2,205 White and 1,156 Blacks), age 25 and older, for up to 25 years. The independent variable was cognitive test score measured at baseline (1986) using the 4-item version of the Short Portable Mental Status Questionnaire, treated in two different ways (as a dichotomous and as a continuous variable). The dependent variable was time to death (due to all causes) during the follow up period. Covariates included baseline age, gender, education, income, number of chronic diseases, self-rated health, and depressive symptoms. Race (Black versus White) was the focal effect modifier. We used a series of Cox proportional hazards models in the total sample, and by race, in the absence and presence of health variables. **Results:** Overall, cognitive test score predicted mortality risk. A significant interaction was found between race and baseline cognitive test score suggesting that baseline cognitive test score has a weaker protective effect against all-cause mortality for Blacks un comparison to Whites. In race-stratified models, cognitive test score at baseline predicted risk of all-cause mortality for Whites but not Blacks, in the absence and presence of baseline socio-economic and health variables. The results were similar regardless of how we treated baseline cognitive test score. **Conclusions:** In the United States, baseline cognitive test score has a weaker protective effect against all-cause mortality over a long period of time for Blacks than Whites. The finding is in line with the Minorities Diminished Returns theory and is probably due to structural and interpersonal racism.

Keywords: Race; Ethnicity; Ethnic Groups, Blacks; African Americans, Whites; Cognition; Population Groups, Cognitive test score, Mortality, Life Expectancy; Death

1. Introduction

It is well established that particular cognitive abilities decline with aging¹ and this decline is associated with morbidity² and mortality.³ Longitudinal studies have shown that cognitive test score at baseline predicts future morbidity⁴ and mortality.⁵ Due to the association between baseline cognitive test score and life expectancy,³ high cognitive function is expected to protect populations against risk for premature mortality.⁶

Despite the well-defined link between baseline cognitive function and subsequent all-cause mortality,^{3,7-9} it is not known whether or not diverse population groups differ in this relationship, as very few studies have ever tested predictive ability of cognitive limitation on long term mortality among racial and ethnic minority populations. Of the few studies that have been conducted among racial and ethnic minorities, most have enrolled Hispanics.^{6,10} In a study among older Mexican Americans, baseline and also 2-year decline in cognitive functioning independently predicted risk of all-cause mortality.⁶ In another study among Mexican Americans, although frailty and cognitive test score were risk factors for mortality separately, the effect of cognitive impairment on mortality disappeared by controlling for frailty.¹⁰ Unfortunately, compared to Whites or even Hispanics, less is known about this association among Black Americans.¹¹

2. Aim

To fill the gap in the literature, and to better understand whether race interferes with the role of cognitive test score on life expectancy in the United States, we conducted this study on Black- White differences in the magnitude of the protective effect of baseline cognitive test score on subsequent all-cause mortality, using a nationally representative sample. In line with the Minorities Diminished returns theory⁸⁵⁻⁹³ and also some other empirical evidence on ethnic differences in predictive role of baseline risk and protective factors on long term outcomes,¹²⁻¹⁴ we hypothesized a stronger effect for Whites compared to Blacks.

3. Methods*3.1. Design and Setting.*

Americans' Changing Lives study (ACL; 1986–2011), is a 25 year- prospective longitudinal study of American adults (aged 25 years and over). This study recruited a national (representative) sample of U.S. residents. Although more information on the methods and sampling is published elsewhere, we briefly explain some of the aspects of the study here.¹⁵⁻¹⁷

3.2. Ethics.

University of Michigan (UM) Ethical committee (also known as the Institutional Review Board; UM-IRB) approved the study protocol. Written informed consent was received from all participants of the ACL.

3.3. Participants and sampling.

Using stratified multistage sampling, the ACL recruited a probability sample of U.S. adults who were at least 25 years old. The study participants were 3,617 adults who were living in the continental U.S. Inclusion criteria included being non-institutionalized. The ACL oversampled older adults (age 60 years or more) and African Americans / Blacks. Wave 1 data included 70% and 68% of the sampled households and individuals.

3.4. Analytical Sample.

Current analysis is only limited to Europeans / Whites and African Americans / Blacks (analytic N = 3,361 who were either White [n = 2,205] or Blacks [n = 1,156].)

3.5. Process

All the baseline data were gathered via face-to-face interviews (first wave; year 1986). Death certificates were used to assess date of death.

3.6. Measures.

Baseline demographic factors, socio-economic characteristics, SRH, depressive symptoms, and chronic medical conditions were measured in 1986 to adjust for possible confounding. The main outcome was time to the death (due to any causes) during a 25 year follow up period.

Race / Ethnicity. In this study race was the focal effect modifier, treated as a dichotomous variable: Black 1 versus White 0 (referent category). Participant's self-identified race and ethnicity in 1986 (wave 1) with multiple items that measured race and ethnicity. Responses of these items informed our racial / ethnic categories: "Non-Hispanic White", "Non-Hispanic Black", "Non-Hispanic Native American", "Non-Hispanic Asian", and "Hispanic". The current analysis only included two racial / ethnic groups: Non-Hispanic White and Non-Hispanic Black. Thus, this analysis does not include any Hispanic individual.

Cognitive test score. The ACL survey adopted the 4-item Short Portable Mental Status Questionnaire (SPMSQ) for measurement of cognitive test score. The SPMSQ assesses the following aspects of cognition: knowledge of current events, memory, as well as the ability to perform some basic mathematical tasks. SPMSQ is designed to identify cognitive performance of community and institutionalized sample.^{18,19} The SPMSQ measure had the following four items: a) "What is the date today—month, day, and year?" b) "What day of the week is it?" c) "What is the name of the president of the United States?" d) "Subtract 3 from 20 and tell me the number you get. Then, keep subtracting 3 from this number and each new number you get, telling me the results as you go (Stop when the answer is 2 or less)." Each item was coded as 0 "correct" or 1 "incorrect", with a total cognitive score ranged between 0 and 4, with a higher score indicating worse cognitive performance.²⁰ A score of 2 or more (participants who had 2+ errors) were considered as low cognitive score.^{21,22}

Demographics. Demographic characteristics included age (a continuous variable) and gender (a dichotomous variable with male as the referent category) collected at 1986.

Socioeconomic status (SES). This study collected baseline educational attainment (years of schooling) and income level (an ordinal variable) at 1986 as the SES measures.

Number of chronic diseases. Baseline number of chronic medical conditions was measured based on he self-reported data. Individuals were asked if a health care provider had ever informed them regarding the presence of the following seven chronic conditions: diabetes, hypertension, chronic lung disease, stroke, heart disease, cancer, and arthritis. Response items for which chronic conditions were on a dichotomous scale. Number of chronic diseases was an interval variable ranging from 0 to 7.^{16,17}

Self-rated health (SRH). Participants' SRH were measured using a single item with the following five categories: excellent, very good, good, fair, and poor. In this study, SRH was treated as a dichotomous measure. The five categories were collapsed into the following two categories: excellent / very good / good 0 versus fair/poor 1. This cutoff is commonly used in the literature.^{23,24} The single item SRH measure is shown very high test-retest reliability as well as validity. Poor SRH is a strong predictor of mortality risk net of confounders.^{25,26}

Depressive Symptoms. Symptoms of depression were captured using the 11-item Center for Epidemiological Studies-Depression scale (CES-D).²⁷ CESD measures the degree to which the participant felt depressed, sad, lonely, restless, etc. Some of the CES-D items are positively worded which are reverse-coded. Short versions of the CES-D scale have acceptable reliability and validity.²⁸⁻³⁰ Items are on a response scale ranging from 1 to 3. As a result, the CES-D score in this study ranged from 11 to 33, with a higher score indicated more depressive symptoms.

Mortality. Mortality data were primarily gathered either from death certificates or from the National Death Index (NDI). Overall 1,402 deceased participants were detected, while 1,959 individuals survived. Collected death data included date of death, as well as primary and underlying causes of death. In the United States, death certificates are filled out by doctors as soon as possible after individuals are deceased. Cause of death was not used for this study. For the 1,402 deceased cases, month of death was obtained from NDI or death certificates.¹²

4. Statistical analysis.

Due to the survey design, we used Stata-13 (Stata Corp., College Station, Texas, United States) to calculate design based standard errors (SE) based on sampling and non-response weights at baseline. Taylor series linearization was used to estimate standard errors. Survey linear, logistic and Cox proportional hazards models were used for data analysis. Hazard ratios (HR), Standardized regression coefficient (B), odds ratios (OR) with their SEs and 95% confidence intervals (CI) are reported.

In the first step, and to test the cross-sectional association between baseline age, gender, education, income, number of chronic diseases, SRH, and symptoms of depression with baseline cognitive test score, we used three logistic regression models (Model 1 to 3) where the outcomes was cognitive test score treated as a dichotomous measure. For the same aim, we also ran three linear regressions (Model 4 to 6) where the outcome was cognitive test score treated as a continuous measure. First, we used the pooled sample with main effect of race in the model (Model 1 and 4). Then we ran models that were stratified by race / ethnicity to test if demographic, socio-economic, and health factors predict cognitive test score (a continuous score) at baseline among Whites (Model 2 and 5) and Blacks (Model 3 and 6).

In the next step, and to assess the effect of cognitive test score on mortality, we used a series of Cox proportional hazards models. Baseline cognitive test score, the independent variable, was measured at 1986, and was treated in two ways: a dichotomous and a continuous measure. The dependent variable was time to death for any cause between 1986 and 2011. Covariates included age, gender, education, income, number of chronic diseases, SRH, and symptoms of depression, which were entered to the model in a step-wise fashion. First, we used the pooled sample of Blacks and White to evaluate the effects of baseline cognitive test score on mortality, while covariates were being added gradually. Then we ran models stratified by race to test if cognitive test score at baseline differently predicts time to death over up to 25 years of follow up among Whites and Blacks.

5. Results

Table 1 presents a summary of descriptive statistics for all study variables overall and based on race. Age and gender were not significantly different between racial groups. Blacks had significantly lower education and income and worse SRH, number of chronic medical conditions, and depressive symptoms. Blacks also had higher cognitive test score at baseline than Whites.

Table 1. Descriptive Statistics for the analytic sample, stratified by race and overall.

All		Whites		Blacks	
Mean (SE)	95% CI	Mean (SE)	95% CI	Mean (SE)	95%

Age	47.77(.534)	46.69-48.84	47.96(.601)	46.75-49.17	46.33(.717)	44.89-47.78
Education*	12.53(.096)	12.34-12.73	12.69(.105)	12.48-12.90	11.37(.233)	1.90-11.84
Income*	5.41(.093)	5.22-5.60	5.57(.101)	5.36-5.77	4.25(.183)	3.88-4.62
CMC*	.79(.028)	.74-.85	.78(.031)	.71-.84	.91(.052)	.81-1.02
SRH*						
Good-Excellent	85.06(.008)	83.33-86.64	85.97(.009)	84.15-87.60	78.38(.017)	74.68-81.68
Poor-Fair	14.94(.008)	13.36-16.67	14.03(.009)	12.40-15.85	21.62(.017)	18.32-25.32
CESD*	-.03(.025)	-.08-.02	-.07(.025)	-.13--.02	.28(.051)	.18-.38
Cognitive test score *	.70(.03)	.63-.76	.65(.04)	.58-.73	1.01(.05)	.91-1.11
	% (SE)	95% CI	% (SE)	95% CI	% (SE)	95% CI
Gender						
Male	47.26(.012)	44.86-49.68	47.82(.013)	45.12-5.52	43.18(.022)	38.79-47.69
Female	52.74(.012)	5.32-55.14	52.18(.013)	49.48-54.88	56.82(.022)	52.31-61.21
Cognitive test score*						
Intact	84.37(.01)	82.29-86.25	86.14(.01)	83.77-88.21	71.38(.02)	67.53-74.95
Impaired	15.63(.01)	13.75-17.71	13.86(.01)	11.79-16.23	28.62(.02)	25.05-32.47

* P< .05 for all comparisons between Blacks and Whites; CMC; Chronic Medical Conditions; CES-D; Center for Epidemiologic Studies Depression.

Table 2 shows three logistic and three linear regressions with binary and continuous cognitive test score as the outcomes. With a similar pattern among Whites and Blacks, age, education, income, and depressive symptoms but not gender, and number of chronic medical conditions were associated with baseline cognitive impairment. Whites and Blacks, however, showed different pattern of associations between SRH, and depressive symptoms with cognitive test score at baseline.

Table 2. Predictors of baseline cognition impairment based on race using linear regression.

	All		Whites		Blacks	
	OR (SE)	95% CI	OR (SE)	95% CI	OR (SE)	95% CI
	Model 1		Model 2		Model 3	
Cognitive function as a continuous measure						
Race (Black)	2.01(.27)***	1.52-2.64	-	-	-	-
Gender (Female)	.87(.10)	.69-1.10	.81(.12)	.60-1.10	1.16(.22)	.79-1.71
Age	1.01(.00)***	1.01-1.02	1.01(.00)***	1.01-1.02	1.02(.01)*	1.00-1.03
Education	.49(.09)***	.34-.70	.46(.10)***	.30-.70	.63(.15)#	.38-1.03
Income	.92(.02)**	.88-.97	.92(.03)**	.87-.98	.93(.04)	.86-1.02
CMC	1.01(.07)	.88-1.15	1.00(.08)	.85-1.16	1.08(.11)	.87-1.33
SRH (Poor/Fair)	1.18(.18)	.86-1.61	1.10(.22)	.74-1.64	1.47(.30)#	.98-2.21
CESD-11	1.14(.07)*	1.01-1.31	1.14(.08)#	.99-1.31	1.15(.12)	.93-1.42
	B (SE)	95% CI	B (SE)	95% CI	B (SE)	95% CI
	Model 4		Model 5		Model 6	

Cognitive function as a dichotomous measure						
Race (Black)	.24(.06)***	.12-.36	-	-	-	-
Gender (Female)	-.01(.04)	-.09-.07	-.03(.05)	-.12-.06	.16(.07)*	.01-.30
Age	.01(.00)***	.00-.01	.01(.00)**	.00-.01	.01(.00)**	.00-.02
Education	-.38(.07)***	-.52--.24	-.38(.08)***	-.54--.22	-.34(.10)**	-.54--.13
Income	-.02(.01)***	-.04--.01	-.02(.01)**	-.04--.01	-.04(.02)*	-.07-.00
CMC	.00(.02)	-.05-.04	-.01(.02)	-.05-.04	.01(.05)	-.09-.10
SRH (Poor/Fair)	.09(.05)	-.01-.19	.05(.06)	-.07-.16	.30(.08)***	.14-.46
CESD-11	.06(.02)**	.02-.09	.05(.02)**	.01-.09	.09(.04)*	.01-.17

* P<.05, ** P<.01, *** P<.001, CMC; Chronic Medical Conditions, CES-D; Center for Epidemiologic Studies Depression.

Table 3 summarizes the results of several proportional hazards models that were performed in the pooled sample (Models 1,2,3,8,9,10), as well as Whites (Model 4,5,11,12) and Blacks (Model 6,7,13,14), in the absence of health conditions in the model. According to this table, in the pooled sample, higher baseline cognitive test score was correlated with higher mortality risk. There was also a significant interaction between race and baseline cognitive test score on the outcome, suggesting that the effect of baseline cognitive test score on mortality is stronger for Whites than Blacks, when demographic and baseline socio-economic factors are controlled (Model 4,5,11,12). Race-specific models showed that baseline cognitive test score only predicts mortality among Whites but not Blacks

Table 3. Effect of baseline cognition test score on all-cause mortality based on race using Cox proportional hazard models in the absence of health variables in the model.

	HR (SE)	95% CI	HR (SE)	95% CI	HR (SE)	95% CI	HR (SE)	95% CI	HR (SE)	95% CI	HR (SE)	95% CI	HR (SE)	95% CI
	All						Blacks							
	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6		Model 7	
Race (Black)	1.35 (.09)***	1.18-1.55	1.15 (.09)#	.99-1.34	1.30 (.13)*	1.07-1.60	-	-	-	-	-	-	-	-
Gender (Female)	.60 (.04)***	.53-.68	.56 (.04)***	.49-.64	.56 (.04)***	.49-.64	.58 (.04)***	.51-.67	.54 (.04)***	.47-.63	.75 (.08)**	.61-.92	.67 (.07)***	.54-.82
Age	1.09 (.00)***	1.09-1.10	1.09 (.00)***	1.08-1.09	1.09 (.00)***	1.08-1.09	1.10 (.00)***	1.09-1.10	1.09 (.00)***	1.08-1.10	1.08 (.00)***	1.07-1.08	1.07 (.00)***	1.06-1.08
Education			.82 (.05)**	.72-.94	.82 (.05)**	.72-.94			.81 (.06)*	.70-.94			.88 (.11)	.68-1.15
Income			.92 (.01)***	.89-.94	.92 (.01)***	.89-.94			.92 (.01)***	.89-.95			.91 (.03)***	.86-.96
Cognition impairment as a dichotomous measure	.73 (.09)**	.54-.90	.84 (.09)*	.65-1.00	.76 (.10)**	.55-.95	.66 (.11)***	.43-.86	.77 (.10)**	.55-.95	.98 (.10)	.75-1.17	.93 (.10)	.84-1.26
Cognition impairment x Black					1.30 (.10)*	1.07-1.48								
	Model 8		Model 9		Model 10		Model 11		Model 12		Model 13		Model 14	
Race (Black)	1.33 (.09)***	1.15-1.53	1.14 (.09)#	.98-1.33	1.40 (.16)**	1.11-1.76	-	-	-	-	-	-	-	-
Gender (Female)	.60 (.04)***	.53-.68	.55 (.04)***	.49-.63	.56 (.04)***	.49-.64	.58 (.04)***	.50-.67	.54 (.04)***	.47-.63	.74 (.07)**	.60-.91	.67 (.07)***	.54-.82
Age	1.09 (.00)***	1.09-1.10	1.09 (.00)***	1.08-1.09	1.09 (.00)***	1.08-1.09	1.10 (.00)***	1.09-1.10	1.09 (.00)***	1.08-1.10	1.08 (.00)***	1.07-1.08	1.07 (.00)***	1.06-1.08
Education			.83 (.05)**	.73-.95	.83 (.05)**	.73-.95			.82 (.06)*	.71-.95			.89 (.11)	.68-1.15
Income			.92 (.01)***	.89-.94	.92 (.01)***	.89-.94			.92 (.01)***	.89-.95			.91 (.02)***	.86-.96
Cognitive test score as a continuous measure	.87 (.03)***	.81-.93	.92 (.03)**	.86-.98	.88 (.04)**	.81-.95	.83 (.04)***	.76-.91	.88 (.04)**	.81-.96	.97 (.04)	.88-1.06	1.02 (.04)	.94-1.10

Cognitive test score ×	1.15 (.05)**	1.05-
Black		1.25

* P<.05, ** P<.01, *** P<.001, CMC; Chronic Medical Conditions, CES-D; Center for Epidemiologic Studies Depression.

Table 4 provides the results of Cox proportional hazards models in the pooled sample (Models 1,2 5,6) and among Whites (Models 3,7) and Blacks (Models 4,8), while health variables are also controlled. In this table, in the overall (pooled) sample, a statistically significant interaction effect was found between race and baseline cognitive test score suggesting stronger effect of baseline cognitive test score on mortality for Whites relative to Blacks (Models 2,6). Race-specific models confirmed our finding, as cognitive test score at baseline predicted mortality among Whites but not Blacks.

Table 4. Effect of baseline cognition impairment on all-cause mortality based on race using Cox proportional hazard models while health is controlled.

	HR (SE)	95% CI	HR (SE)	95% CI	HR (SE)	95% CI	HR (SE)	95% CI
	All			Blacks				
	Model 1		Model 2		Model 3		Model 4	
Race (Black)	1.08(.08)	.92-1.24	1.27(.12)*	1.04-1.55	-	-	-	-
Gender (Female)	.54(.04)***	.47-.62	.54(.04)***	.47-.62	.52(.04)***	.45-.60	.66(.08)**	.52-.83
Age	1.08(.00)***	1.08-1.09	1.08(.00)***	1.08-1.09	1.09(.00)***	1.08-1.09	1.06(.01)***	1.05-1.07
Education	.91(.06)	.80-1.03	.91(.06)	.80-1.03	.92(.06)	.79-1.04	.92(.12)	.70-1.19
Income	.93(.01)***	.91-.96	.93(.01)***	.91-.96	.94(.01)	.91-.97	.91(.03)**	.86-.97
CMC	1.15(.02)***	1.10-1.20	1.15(.03)***	1.10-1.20	1.15(.03)***	1.10-1.21	1.13(.05)*	1.02-1.24
SRH (Poor/Fair)	1.49(.11)***	1.28-1.74	1.51(.11)***	1.30-1.76	1.59(.13)***	1.35-1.88	1.14(.11)	.93-1.38
CESD-11	1.04(.04)	.97-1.12	1.04(.04)	.97-1.12	1.06(.05)	.97-1.15	.95(.04)	.87-1.04
Cognition impairment as a dichotomous measure	.86(.09)#	.67-1.11	.75(.10)**	.54-.93	.76(.10)***	.54-.94	1.10(.10)	.86-1.29
Cognition impairment × Black	-	-	1.39(.09)***	1.18-1.54	-	-	-	-
	Model 5		Model 6		Model 7		Model 8	
Race (Black)	1.06(.08)	.90-1.24	1.39(.15)**	1.11-1.74	-	-	-	-
Gender (Female)	.54(.04)***	.47-.61	.54(.04)***	.47-.62	.52(.04)***	.45-.60	.66(.08)**	.52-.83
Age	1.08(.00)***	1.08-1.09	1.08(.00)***	1.08-1.09	1.09(.00)***	1.08-1.09	1.06(.01)***	1.05-1.07
Education	.92(.06)	.81-1.04	.92(.06)	.81-1.04	.92(.06)	.80-1.06	.92(.12)	.70-1.19

Income	.93(.01)***	.91-.96	.93(.01)***	.90-.96	.93(.02)	.90-.97	.91(.03)**	.86-.96
CMC	1.15(.02)***	1.10-1.20	1.15(.03)***	1.10-1.20	1.15(.03)***	1.10-1.21	1.12(.05)*	1.02-1.24
SRH (Poor/Fair)	1.49(.11)***	1.27-1.73	1.51(.11)***	1.29-1.76	1.58(.13)***	1.34-1.87	1.14(.11)	.94-1.39
CESD-11	1.04(.04)	.97-1.12	1.04(.04)	.97-1.12	1.06(.05)	.97-1.15	.95(.04)	.87-1.03
Cognition test score as a continuous measure	.93(.03)*	.88-.99	.88(.03)**	.81-.95	.89(.03)***	.82-.95	1.03(.04)	.95-1.11
Cognition impairment × Black	-	-	.80(.05)***	.72-.90	-	-	-	-

* P<.05, ** P<.01, *** P<.001, CMC; Chronic Medical Conditions, CES-D; Center for Epidemiologic Studies Depression.

6. Discussion

Our study had three main findings. On the main aim of the study, major Black- White differences were found in the predictive role of baseline cognitive function on long-term mortality. The study also showed lower cognitive function at baseline for Blacks, and Black and White similarities in role of age and socio-economic status on cognitive function. These findings contribute to the existing literature on health disparities in the United States, as stated by Moody-Ayers and colleagues in 2005, “efforts to understand cognitive function may enhance our understanding of Black - White disparities in health outcomes.”¹¹

The Black - White variation in the predictive role of baseline cognitive score on mortality may be considered in line with some other studies suggesting that baseline characteristics fail to predict long term mortality among Blacks.^{12,13,31} In two studies in 2015, baseline SRH and depression which predict mortality of Whites failed to predict the same outcome for Blacks.^{12,13} In 2001 Ferraro and Kelley-Moore showed that although SRH as a time-varying covariate predicts mortality among Blacks, baseline SRH is not as good predictor of long-term mortality for Blacks as Whites.³¹ Other studies have also shown that SRH may lose its predictive validity for mortality among individuals with lower socio-economic status.^{32,33} This is again in support of our findings, given race is a strong proxy of social class and socio-economic status in US.³⁴

Regarding the main effect of race on cognitive ability, a number of studies in U.S. have shown that Blacks have lower unadjusted scores on cognitive function than Whites.^{11,35} This difference in large is due to lower socio-economic status³⁵ and also more accelerated decline in health³⁶ among Blacks compared to Whites. In both races, higher socio-economic status such as education was associated with lower cognitive decline, a finding which is supported by the literature.^{37,38} It has been shown that years of schooling is a strong predictor of cognitive reserve.³⁹

Research on the association between baseline cognitive impairment, cognitive decline over time, and long term mortality has provided mixed findings.⁶ While the effect of severe cognitive impairment on mortality stays significant above and beyond the effects of demographic, socio-economic, and health status,⁴⁰⁻⁴³ the long-term effect of mild cognitive impairment at baseline as a predictor of mortality may be more debatable, as shown only by some^{44,45} but not all^{40,46} studies. Similarly, findings are mixed regarding the effect of cognitive decline over time on subsequent mortality which is shown by some⁴⁰ but not all⁴¹ studies.

Among Whites, higher risk of mortality with cognitive impairment at baseline was independent of demographics, socio-economic status, physical health, and depressive symptoms. This finding is in line with the literature.^{3,5,6} Previous population-based studies have shown that risk of death is about 50% higher among those with low comparison to high cognitive test scores at baseline.⁴⁷⁻⁵⁰

Among Blacks, however, baseline cognitive test score at baseline failed to predict long-term all-cause mortality, similarly in the absence or presence of baseline demographics, socio-economics, and health status.

Interestingly, some^{51,52} if not all^{7,53} studies have shown higher survival of Blacks with Alzheimer's disease compared to their Whites counterparts. In a study among individuals with Alzheimer's disease, cognitive impairment had a stronger effect on mortality among Blacks than Whites, which is in contrast to our results.⁵³

We showed that Black-White differences in the cognitive function – mortality link is not due to racial differences in baseline socio-economic or health status, as the interaction between race and baseline cognitive test score on mortality remained significant with potential confounders (or mediators) in the model. The exact mechanism by which baseline cognitive ability predicts mortality is still unknown. As poor health status is associated with both cognitive impairment and mortality, it may confound or mediate the cognitive ability – mortality association. Several chronic medical conditions that adversely affect cognitive test score⁵⁴ also increase risk of mortality.^{53,55} Longitudinal studies have shown that cognitive impairment at baseline predicts incident dementia⁵⁶ which reduces survival.^{9,55} According to population-based studies,⁵⁷⁻⁶³ individuals with Alzheimer's disease are up to 3 times more likely to die than those without the condition.⁵³ Thus, studies on the link between cognition and mortality require adjustment for chronic diseases. As explained above, higher socio-economic status is another major determinant of cognitive function inside and across populations.³⁷⁻³⁹

The result of our study has clinical and public health implications. Cognitive function is a modifiable risk factor for premature mortality, and some policies and interventions such as education may improve cognitive functioning of the populations.^{51,53,75-77} For instance, ACTIVE trial has shown significant benefits for memory, reasoning, and processing speed training at 5 and even 10 years in cognitively intact older adults.^{76,77} However, some methodological issues should be addressed.⁷⁸ However, some promising results have suggested that cognitive function can be enhanced.⁷⁹⁻⁸⁴ As cognitive ability plays different role in predicting mortality of Blacks and Whites,^{5,7,8} interventions that enhance cognitive reserve of the communities may differently benefit populations' survival. Design and development of community-based and clinical interventions that use cognitive maintenance / enhancement as a strategy to reduce mortality of populations will be improved by similar research-based information on the magnitude of the relationship between cognitive test score and long-term mortality across population groups. Such information may be used to decide between universal or population-specific programs that wish to promote longevity of the public through enhancement of cognitive reserve.⁵⁵

Our findings are relevant to the complex causes of Black – White economic and health gap in the United States.¹¹ We argue that it is not race *or* risk factors and race *and* risk factors that cause disparities. In a study in 2005, Moody-Ayers et al., measured cognitive function and functional decline among 779 Black and 4,892 White community sample of older adults (age 70 or older) and showed that cognitive function may mediate the higher functional decline among Blacks.⁵⁵

Findings are also in line with the Black - White health paradox, defined as disproportionately lower prevalence of a wide range of undesired subjective health outcomes, despite higher levels of objective health problems such as chronic disease among Black Americans, in comparison to White Americans.^{17,64-68} Based on the Black-White health paradox, Blacks do not show some of the expected associations that are commonly found among Whites.^{17,64-68} The results are also in line with the Minorities Diminished returns theory⁸⁵⁻⁹³ and also other studies that have shown resources better serve Whites than Blacks,¹²⁻¹⁴ and the predictive role of baseline risk and protective factors on long term outcomes are larger for Whites than Blacks. These patterns may be due to measurement,⁹⁴ or racism.⁹⁵⁻⁹⁹

Our study had some limitations that need attention. First, cognitive ability is subject to change, however, this study did not model cognitive decline over time. This is particularly important because both baseline and decline in cognitive ability are shown to predict mortality.⁶⁹⁻⁷² Another limitation of this study is how we measured cognitive function which may cause some measurement bias, which may itself depend on culture, ethnicity, or race.^{35,73} The study did not control for specific chronic neurological (e.g. dementia, Alzheimer's disease) or psychiatric disorders (e.g. major clinical depression) conditions that impair cognitive abilities. Using a nationally representative sample and having a 25 year follow up period were, however, major strengths of this study.

To conclude, baseline cognitive test score predicts long-term all-cause mortality among Whites but not Blacks. Future research should explore factors that may explain why minority ethnic differences exist in the role of cognitive test score on all-cause mortality risk in the United States. It is likely that socio-economics, physical health, and mental health factors differently confound or mediate the links between baseline cognitive test score and subsequent mortality across race. Culture, access to health care, resources utilization,

pattern of comorbid conditions, and health risk behaviors are also other potential explanatory factors behind Black-White differences in the cognitive test score - mortality link.

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