Racial Differences in the Association of Education With Physical and Cognitive Function in Older Blacks and Whites

Lisa L. Barnes,1,2,3 Robert S. Wilson,1,2,3 Liesi E. Hebert,4 Paul A. Scherr,5 Denis A. Evans,2,4,6 and Carlos F. Mendes de Leon4,6

1Rush Alzheimer’s Disease Center, 2Department of Neurological Sciences, and 3Department of Behavioral Sciences, 4Rush Institute for Healthy Aging, Rush University Medical Center, Chicago, Illinois. 5National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, Atlanta, Georgia. 6Department of Internal Medicine, Rush University Medical Center, Chicago, Illinois.

Objectives. Few studies have explicitly tested whether the health disadvantage among older Blacks is consistent across the entire range of education. We examined racial differences in the cross-sectional association of education with physical and cognitive function performance in older adults.

Methods. Participants included over 9,500 Blacks and Whites, aged ≥65 years, from the Chicago Health and Aging Project (64% Black, 60% women, mean age = 73.0 (standard deviation [SD] = 6.9), mean education = 12.2 ([SD = 3.5]). Physical function was assessed using 3 physical performance tests, and cognitive function was assessed with 4 performance-based tests; composite measures were created and used in analyses.

Results. In multiple regression models that controlled for age, age-squared, sex, and race, and their interactions, Whites and those with higher education (>12 years) performed significantly better on both functional health measures. The association of education with each indicator of functional health was similar in older Blacks and Whites with low levels (≤12 years) of education. However, at higher levels of education, there was a significantly more positive association between years of education and these functional health outcomes among Blacks than Whites.

Discussion. Results from this biracial population-based sample in the Midwest suggest that Blacks may enjoy greater returns in functional health for additional education beyond high school.

Key Words: Education—Functional health—Health disparities—Race.

It is well established that substantial disparities in health status exist between Blacks and Whites in U.S. society. Although there has been increasing focus on eliminating the disparities (Dankwa-Mullan et al., 2010), existing evidence indicates that they continue to be a large and serious problem (Keppel, Pearcy, & Wagener, 2002; Rashid et al., 2009). Most explanations for disparities in health have tended to focus on differences in socioeconomic status (SES), one’s position in a social hierarchy generally measured by education, income, wealth, or occupation (e.g., Mendes de Leon, Barnes, Bienias, Skarupski, & Evans, 2005; Williams & Collins, 1995); on disproportionate experiences of social injustice suffered by minority populations, and by Blacks in particular (e.g., Brondolo et al., 2003; Harrell, Hall, & Taliaferro, 2003); and on cultural factors that may influence the differential exposure to and adoption of unhealthy lifestyles (e.g., Trinaeity et al., 2009; Troxel, Matthews, Bromberger, & Sutton-Tyrrell, 2003). Although the origins of racial disparities in health in this country are undoubtedly the result of a complex interaction of various historical, cultural, and social forces, the substantial inequalities in socioeconomic resources between Blacks and Whites are generally regarded as a key determinant of racial disparities in health.

Blacks tend to experience, on average, lower levels of educational attainment, have higher rates of unemployment, and are more likely to live in segregated poverty-stricken neighborhoods (Braveman et al., 2005; Williams, 1999; Williams & Collins, 1995). Furthermore, Blacks who lack these material resources tend to have higher rates of overall mortality (Wong, Shapiro, Boscardin, & Ettner, 2002), morbidity (Bravata et al., 2005), and a greater loss of overall functioning (Hirsch et al., 2006; Kelley-Moore & Ferraro, 2004; Mendes de Leon et al., 2005) than persons at the higher end of the SES ladder. Although there is substantial evidence that SES is an important predictor of health, other literature suggests that differences in SES do not fully account for observed health disparities. Disparities often persist when Blacks and Whites are matched on SES, including at the middle and upper levels of SES (e.g., Geronimus, Bound, Waidmann, Hillemeier, & Burns, 1996; Geronimus, Hicken, Keene, & Bound, 2006; James, Keenan, Strogatz, Browning, & Garret, 1992; James et al., 2006). Thus, some have argued that factors independent of SES or interacting with SES (e.g.,
weathering or John Henryism) may need to be considered in understanding the health disadvantages for Blacks.

One major complicating factor in this area of research is that race and SES are so closely intertwined in the United States, that is has been difficult to determine the actual mechanisms by which racial disparities in health may play out. One possibility, as many researchers have postulated, is that being poor and minority may represent a unique disadvantage to health due to the multiplicative effects of poverty and race, also known as “double jeopardy” (e.g., Clark & Maddox, 1992; Ferraro & Farmer, 1996). According to one interpretation of the double jeopardy framework, occupying two stigmatized states (i.e., Black and poor) is associated with a bigger disadvantage than would be expected from a simple addition of the health risks associated with being poor and with being Black. Thus, one would expect to see greater racial disparities with low SES because the effects of powerlessness and economic deprivation associated with poverty is compounded by the effects of social disadvantage associated with minority status and experiences of lifelong discrimination.

Another possible pattern of the intersection of race and SES is greater racial disparities in health at the highest levels of SES. National data indicate that at each level of education, Blacks have a lower mean income level, and for each level of income, they have a lower level of net worth than Whites (Braveman et al., 2005). In other words, Blacks appear to experience diminishing returns on obtained resources due to such factors as racial discrimination, unequal employment opportunities, differences in educational quality, and other stressors associated with being a visible minority in the United States (Farley, 1984; Hayward, Crimmins, Miles, & Yang, 2000). Thus, one could argue that because they do not experience the same returns for higher SES achievement as Whites do, perhaps they might not obtain the same health benefits typically associated with high SES, a pattern consistent with the notion of “diminishing returns” (e.g., Farmer & Ferraro, 2005). Although a growing number of studies have provided data consistent with a diminishing returns pattern (Cummings & Braboy Jackson, 2008; Schoendorf, Hogue, Kleinman, & Rowley, 1992), relatively few studies have specifically examined conditional effects of race and SES; and of those that have, the findings have been mixed. Some studies have reported greater racial disparities in health at lower levels of SES, and others have reported greater disparities at higher levels of SES (e.g., Cockerham, 1990; Cummings & Braboy Jackson, 2008; Farmer & Ferraro, 2005; Hayward et al., 2000; Kessler & Neighbors, 1986; Smith & Kington, 1997; Waitzman & Smith, 1994). Even fewer studies have examined the interactive effects of race and SES in the context of late-life health (e.g., Farmer & Ferraro, 2005; Smith & Kington, 1997). For example, Farmer and Ferraro (2005) found significant interactions between race and education and race and employment status for several self-rated health measures in a population of older adults. To our knowledge, no study has examined how race and SES vary in old age using performance-based measures of health.

A better understanding of disparities in late-life health, in particular, more salient aspects of late-life health is warranted given the rapid growth of the aging population and the persistent health inequalities seen at older ages. For example, a number of studies have shown that compared with older Whites, older Blacks tend to have a higher prevalence of disability (Kelley-Moore & Ferraro, 2004; Mendes de Leon et al., 2005), cognitive impairment and Alzheimer’s disease (Schwartz et al., 2004; Tang et al., 2001), and mortality (Ng-Mak, Dohrenwend, Abraido-Lanza, & Turner, 1999; Pappas, Queen, Hadden, & Fisher, 1993). We sought to build on previous research in this area and specifically examine the race by SES interaction to determine whether the health disadvantages for older Blacks relative to older Whites are greater at lower levels of SES or at higher levels of SES. To address this question, we examined the race by SES interaction for two functional health outcomes that are among the major reasons for poor health in old age—physical function and cognitive function. Impairments in these domains can lead to disability, dementia-related outcomes, and mortality.

In this paper, we focus exclusively on education as a marker of SES in an older population. Although SES is multifaceted and can be measured in various ways (e.g., income, education, occupation, and wealth), investigation of SES effects on health among older populations can be challenging due to a number of important factors including: changes in occupational status post-retirement; the fact that many women from this age cohort were homemakers and did not have an income separate from their spouse; and the potential reverse causation effects that declining health in adulthood may have had on income or occupation (e.g., Marmot & Wilkinson, 1999; Melzer, Izmirlian, Leveille, & Guralnik, 2001). Education as a marker of SES among older populations, however, may be less problematic because it tends to be completed relatively early in life and thus not changed by declining health in later life and is more closely related to long-term economic position than other indicators (Kington & Smith, 1997; Jagger, Matthews, Melzer, Matthews, & Brayne, 2007; Matthews, Jagger, Miller, Brayne, & MRC CFAS, 2009). In fact, as noted by Ladin (2008), “education presents a robust indicator of SES and influences life chances through multiple pathways, including via income, social position, social support, health behaviors, social mobility, and literacy” (Ladin, 2008). Thus, in the context of education as a marker of SES, support for “double jeopardy” would be revealed by larger Black–White differences in the association of education and function at lower levels of education due to the double disadvantage of being a minority and having restricted resources engendered by low education. By contrast, support for “diminishing returns” would be revealed by larger Black–White
differences in the relationship of education and function at higher levels of education, due to the dissimilarity of social and economic benefits associated with high education across race. The data for the present study come from a large population-based study of urban older Blacks and Whites. We examined the association between education and each functional health outcome to determine whether the magnitude of racial differences in the association of education and physical and cognitive function differs at lower or higher levels of education.

METHODS

Sample

Participants were residents of a geographically defined area on the south side of Chicago who enrolled in the Chicago Health and Aging Project (CHAP), an ongoing population-based longitudinal study of risk factors for Alzheimer’s disease and other common age-related conditions. It is a biracial community with a wide range of education in both Blacks and Whites. The study started with a complete census of all households in the community area. All of the residents aged 65 or older identified in the census were asked to participate. Of the 7,813 eligible residents, 6,158 (78.9%) did so. Details of the study design have been described previously (Bienias, Beckett, Bennett, Wilson, & Evans, 2003). Briefly, in-home baseline interviews were conducted from 1993 to 1997, followed by successive interview cycles at approximately 3-year intervals. Beginning with the third cycle (2000–2002), residents who had turned 65 since the inception of the study have also been invited to participate on a rolling basis. As they entered the study, each of these new participants received the same baseline interview as the original cohort members and is also re-interviewed at approximate 3-year intervals. Data for the current manuscript come from each person’s baseline interview only.

The interviews consisted of structured questions to elicit information on a wide range of demographic characteristics, psychosocial variables, medical history, and physical and cognitive performance tests. The study was approved by the Rush University Medical Center Institutional Review Board, and all participants provided written informed consent.

Measures

Physical function.—Physical function was assessed by three performance tests that focus on lower extremity strength, balance, and gait—including tandem stand, measured walk, and repeated chair stands as previously described (Mendes de Leon et al., 2005). Briefly, tandem stand measures the amount of time that a full tandem stand can be maintained (up to 10 s). Measured walk tests the time to complete an 8-foot walk, and chair stand measures the time to rise from a chair to standing position five times. Performance times were converted into quintiles with an additional category for those who were unable to complete the task (e.g., Guralnik et al., 1994; Mendes de Leon et al., 2005). This resulted in scores ranging from 0 to 5, which were summed across the three tests for an overall composite measure of physical function. Higher scores indicated a higher level of physical function. Because of their reliance on direct observation of actual performance, the tests have high face validity and have also been shown to have good internal consistency and reliability, and interrater reliability (Guralnik et al., 1994; Jette, Jette, Ng, Plotkin, & Bach, 1999; Tager, Swanson, & Satariano, 1998).

Cognitive function.—The interview included administration of four brief tests of cognitive function. There were two measures of episodic memory: immediate and delayed recall of 12 ideas contained in the East Boston Story (Albert et al., 1991; Wilson, Beckett, et al., 2002). There was one test of perceptual speed: the oral version of the Symbol Digit Modalities Test (Smith, 1982) in which participants are given 90 s to identify as many digit-symbol matches as possible. The fourth test was the Mini-Mental State Examination (Folstein, Folstein, & McHugh, 1975), a commonly used measure of global cognition. Because the tests loaded on a single factor that accounted for approximately 75% of the variance in a previous factor analysis (Wilson et al., 1999), we constructed a composite measure of global cognition based on all four tests. As previously described, raw scores on each test were converted to z scores, using the population mean and standard deviation (SD), and the z scores were averaged to yield the composite measure (Wilson et al., 1999). Higher scores reflect higher cognitive function.

Race, Education, and Covariates

Race was self-reported using the 1990 U.S. Census questions. As of August 3, 2009, a total of 10,318 participants had completed a baseline interview. Of these, 580 were of either Hispanic ethnicity or Asian/Pacific race and excluded from the analysis. Another 204 were excluded due to missing education, physical function, or cognitive function data, leaving a total of 9,534 participants for the present analysis. Educational attainment was used as the indicator for SES and was assessed by asking the participants the number of years of schooling completed, and ranged from 0 years to 30 years, but was truncated to 4–24 years for analyses. Other variables used in the analysis include age (based on date of birth) and sex. As part of the medical history examination, seven medical conditions were identified in at least 5% of the population: heart disease, stroke, hypertension, diabetes, cancer, thyroid disease, and shingles or herpes zoster. As in previous research (Wilson, Bennett, et al., 2002), we used the number of conditions present as an indicator of chronic illness.
Data Analysis

The analysis consisted of three steps. First, descriptive statistics were used to characterize the sample on basic demographics and both performance based outcome measures. Next, we explored potential departures from a linear relationship between years of education and both functional outcomes. Specifically, we first computed the predicted value of each outcome (predicted(y)) as a function of age, age-squared, sex, and an age by sex interaction term, and included all data for both Blacks and Whites. We computed the residuals of this model, and plotted these as a function of years of education, to explore the association between education and each outcome, controlling for the effects of age and sex. In these plots, we then graphed LOESS smoothed lines through the residuals using separate lines for Blacks and Whites. Data for fewer than 4 years of education were truncated at 4 years to avoid the undue influence of the few participants with very low levels of education. The LOESS plots revealed nonlinearity in the association between education and each outcome at approximately 12–13 years of education. Thus, in the final step, we performed a piece-wise linear regression analysis. In this approach, there is one line for number of years of education up to and including 12 years (4–12 years and set to 0 for those with more than 12 years of education) and another line for number of years beyond 12 (13–24 years and equal to 0 for those with 12 or fewer years). A particular strength of the piece-wise regression approach is it allows us to model the effect of years of education as a continuous measure along the full spectrum while allowing different effects at the low and high ends of education. Subsequent models included a term for chronic diseases.

We also performed a series of secondary analyses to determine whether the results for cognitive function may have been influenced by including those with cognitive impairment. To do so, we excluded participants with the lowest 10% of global cognitive function summary scores and repeated the core model for cognitive function. Next, we conducted models to determine whether the results for cognitive function were independent of physical function; and to determine whether results were influenced by birth cohort effects. Models were validated graphically and analytically. Programming was done in SAS Institute Inc (2004) version 9.

Results

Participant Characteristics

Sample characteristics for the full sample and by race are presented in Table 1. The sample was 64% Black and 60.4% women. On average, participants were 73.0 years old (SD = 6.9) with 12.2 years (SD = 3.5) of education. The average physical function score was 10.2 (SD = 3.8), and the average cognitive function score was 0.16 (SD = 0.83). Blacks were on average, younger, had fewer years of education, and performed at a lower level on the physical and cognitive performance-based tests.

Race, Education, and Physical Function

We used a piece-wise regression model to test racial differences in the association between years of education and each outcome, with a separate test for low (4–12 years) and high (>12 years) levels of education. The main term for years of education ≤12 years was significantly associated (estimate = 0.134, p = .009) with physical function (Table 2, Model 1). This coefficient represents the effect of years of education ≤12 years among Whites and indicates that each additional year of education up until 12 years is associated with a 0.134 unit predicted increase in physical function score in this group. The interaction term of years of education ≤12 years and race was not significant (estimate = 0.013, p = .810), indicating that the effect of education in this range on physical function did not differ by race. The main term for years of education >12 years was also significantly associated with physical function, indicating that among Whites each additional year of education beyond 12 years was associated with a 0.134 unit predicted increase in physical function score in this group. The interaction effect for this term with race was significant (estimate = 0.140, p < .001), indicating that the effect of years of education >12 years was different in Blacks compared with Whites. In Blacks, the effect of years of education in this range on predicted physical function scores is 0.201 (0.061 + 0.140). In other words, each additional year of education beyond high school is associated with a 0.2-point increase in predicted physical function scores of Black and White Participants in the Chicago Health and Aging Project

Table 1. Demographic Characteristics and Functional Scores of Black and White Participants in the Chicago Health and Aging Project

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Black (n = 6,083)</th>
<th>White (n = 3,451)</th>
<th>Total (n = 9,534)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age, years (SD)</td>
<td>71.8 (6.2)</td>
<td>75.3 (7.5)</td>
<td>73.0 (6.9)</td>
</tr>
<tr>
<td>Mean education, years (SD)</td>
<td>11.3 (3.4)</td>
<td>13.7 (3.2)</td>
<td>12.2 (3.5)</td>
</tr>
<tr>
<td>0–8 years, number</td>
<td>1259</td>
<td>175</td>
<td>1434</td>
</tr>
<tr>
<td>9–12 years, number</td>
<td>3075</td>
<td>1364</td>
<td>4439</td>
</tr>
<tr>
<td>13–15 years, number</td>
<td>1196</td>
<td>940</td>
<td>2136</td>
</tr>
<tr>
<td>16–19 years, number</td>
<td>461</td>
<td>760</td>
<td>1211</td>
</tr>
<tr>
<td>≥20 years, number</td>
<td>92</td>
<td>212</td>
<td>304</td>
</tr>
<tr>
<td>Women, %</td>
<td>60.5</td>
<td>60.2</td>
<td>60.4</td>
</tr>
<tr>
<td>MMSE, mean (SD)</td>
<td>25.4 (5.3)</td>
<td>27.4 (4.1)</td>
<td>26.1 (5.0)</td>
</tr>
<tr>
<td>Physical function, mean (SD)</td>
<td>9.8 (3.8)</td>
<td>10.9 (3.6)</td>
<td>10.2 (3.8)</td>
</tr>
<tr>
<td>Global cognition, mean (SD)</td>
<td>−0.006 (0.8)</td>
<td>0.44 (0.7)</td>
<td>0.16 (0.83)</td>
</tr>
</tbody>
</table>

Note: MMSE = Mini-Mental State Examination (Folstein et al., 1975).
scores in this population. The main effect for race (estimate = -2.112, \( p < .001 \)) indicates that at 4 years of education, predicted physical function scores are 2.112 points lower in Blacks than in Whites. In sum, these results indicate that there are substantial racial differences in physical function between Blacks and Whites. For persons at lower levels of education, up until the equivalent of a high school diploma, these differences remain intact, even though in each racial group each additional year of education results in better physical function in late life. For persons with an education beyond high school the picture changes. Each additional year of education appears to result in a continued gain in physical function levels among Blacks but not among Whites, with the net effect of attenuating racial differences in late-life physical function among persons with higher levels of education.

Figure 1 shows the predicted scores for the full range of education in our sample, separately for Blacks and Whites, and adjusted for age and sex derived from a linear regression model. As can be seen in Figure 1, the association of education and physical function appears to rise more steeply for Blacks with increasing levels of education beyond 12 years compared with Whites. That is, differences in the association of education and physical function between Blacks and Whites are greater post-high school, despite large differences in physical function scores at lower levels of education.

In subsequent models that added a term for chronic illness, the results were essentially the same (see Table 2, Model 2).

### Race, Education, and Cognitive Function

A similar pattern emerged when cognitive function was the outcome (see Table 2, Model 1). There are significant differences in the association of education and cognitive function between Blacks and Whites. For persons at lower levels of education, up until the equivalent of a high school diploma, these differences remain intact, even though in each racial group each additional year of education results in better cognitive function in late life. For persons with an education beyond high school the picture changes. Each additional year of education appears to result in a continued gain in cognitive function levels among Blacks but not among Whites, with the net effect of attenuating racial differences in late-life cognitive function among persons with higher levels of education.

### Table 2. Piece-wise Regression Models of Physical and Cognitive Function Scores by Years of Education in Blacks and Whites

<table>
<thead>
<tr>
<th></th>
<th>Physical function</th>
<th>Cognitive function</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model 1</td>
<td>Model 2</td>
</tr>
<tr>
<td>Age centered at 75</td>
<td>-0.230 (0.010)**</td>
<td>-0.219 (0.010)**</td>
</tr>
<tr>
<td>years</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age squared</td>
<td>-0.004 (0.001)**</td>
<td>-0.004 (0.001)**</td>
</tr>
<tr>
<td>Male sex</td>
<td>0.642 (0.119)**</td>
<td>0.737 (0.116)**</td>
</tr>
<tr>
<td>Age × Sex</td>
<td>0.045 (0.011)**</td>
<td>0.040 (0.011)**</td>
</tr>
<tr>
<td>Black race</td>
<td>-2.112 (0.632)**</td>
<td>-1.946 (0.618)**</td>
</tr>
<tr>
<td>Race × Age</td>
<td>0.003 (0.011)</td>
<td>-0.004 (0.011)</td>
</tr>
<tr>
<td>Race × Sex</td>
<td>0.572 (0.153)**</td>
<td>0.352 (0.150)*</td>
</tr>
<tr>
<td>Education ≤ 12</td>
<td>0.134 (0.051)**</td>
<td>0.134 (0.050)**</td>
</tr>
<tr>
<td>Education ≤ 12 × Race</td>
<td>0.013 (0.055)</td>
<td>0.013 (0.054)</td>
</tr>
<tr>
<td>Education &gt;12</td>
<td>0.061 (0.023)**</td>
<td>0.048 (0.022)*</td>
</tr>
<tr>
<td>Education &gt; 12 × Race</td>
<td>0.140 (0.034)**</td>
<td>0.141 (0.034)**</td>
</tr>
</tbody>
</table>

*Note: Model 1 is the base model. Model 2 adds a term for chronic disease.

*p < .05; **p < .01; ***p < .001.

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**Figure 1** Predicted physical function scores by level of education derived from a linear regression model for typical Blacks (solid line) and Whites (dotted line), adjusted for age, age-squared, sex, and the age by sex interaction term.
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...such that Blacks have lower predicted cognitive scores after controlling for age and sex. Years of education ≤12 has a significant positive effect on cognitive function scores among Whites (estimate = 0.114, p < .001), and the effect among Blacks does not significantly differ (Estimate for education ≤12 × Race interaction = −0.008, p = .457) from the estimated effect among Whites. Among Whites, years of education has a continued positive effect on cognitive function for years of education >12 (estimate for education >12 years = 0.019, p < .001). Furthermore, the effect of years of education in this range differed significantly by race (estimate = 0.039, p < .001), such that Blacks continued to experience a gain in late-life cognitive function for each additional year of education beyond high school, for a total effect of 0.058 (0.019 + 0.039) predicted improvement per year of education. Figure 2 shows a graph of the predicted scores of cognitive function by each level of education for Blacks and Whites derived from a linear regression model. In additional models, the results were unchanged after adjustment for chronic health conditions (see Table 2, Model 2).

To see how these results may have been affected by participants with poor cognition, we repeated the analysis for both outcomes after dropping the subset of participants with the lowest 10% of cognitive function scores. The overall pattern of results was not substantially changed, except for the estimate for high education (education >12 years), which was reduced by about 70% in size but remained statistically significant (Table 3). Given that part of cognitive health derives from aspects of physical well-being, we also conducted a series of models in which we controlled for physical function in the models with cognitive function as the outcome. Again, the results were essentially the same as the original model (Table 3). Finally, we explored the possibility that racial differences in the association of education with late-life health may have been subject to cohort effects. We repeated the analyses in persons born between 1884 and 1926 and compared the results to those born between 1926 and 1944. We found a slight suggestion of a cohort effect with a stronger association of education and functional health in younger persons (data not shown).

DISCUSSION

In this population-based study of more than 9,500 older Blacks and Whites, we found racial differences in the association of education and health, but the pattern was an interesting hybrid of what we expected. We found that the association of education with markers of physical and...
cognitive health was similar in older Blacks and Whites with low levels of education. At higher levels of education, however, there was a significantly more positive association between years of education and these health outcomes among Blacks than among Whites. The net result of these findings was that there was a constant disadvantage in health for Blacks at lower levels of education, which began to attenuate with each additional year of education beyond approximately 12 years of education. When we adjusted for differences in chronic disease between Blacks and Whites, the results were unchanged, suggesting that disease-related pathways do not account for racial differences in the relationship between years of education and late-life functional health outcomes. Together, these findings suggest that the pattern of association between education and health differs between Blacks and Whites, such that Blacks may enjoy greater returns in functional health for additional education beyond high school (>12 years).

Although there were no racial differences in the association of education and health for those with less than a high school education, consistent with previous reports, there were large level differences with Blacks performing at a significantly lower level on both physical function and cognitive performance tests compared with similarly educated Whites (Manly et al., 1998; Mehta et al., 2004; Mendes de Leon et al., 2005). One potential explanation for the level difference is the influence of social and environmental factors associated with being both of minority race and lower social class. That is, the less favorable social conditions due to poverty, compounded with the effects of racial discrimination due to minority status, may have combined to produce a chronic state of social disadvantage, which translated into more adverse health or poorer performance for Blacks. Another possible explanation is differences in the early educational experiences of Blacks and Whites. It has been well documented that educational facilities, resources, and opportunities were more limited for Blacks compared with Whites during the time that the present cohort would have received their primary education (e.g., Hall, Gao, Unverzagt, & Hendrie, 2000; Williams, 1999). For example, many Blacks would have been educated in segregated schools in southern US states where there were not only racial differences in public expenditures per pupil, but differences in other school-level variables such as length of school term, quality and experience of teachers, and access to quality books and other resources (Williams, 1999). These disparate factors could have influenced the development and maintenance of cognitive skills that is reflected in lower test performance in old age. However, we also found significant level differences for physical function, suggesting that differences in educational quality and related factors associated with educational disparities may have had broader influences that permeated beyond cognitive health or that some other marker of social disadvantage is responsible for the differences in health.

Although we found that the association between education and health differed between Blacks and Whites, the pattern was not entirely consistent with the double jeopardy account. The effect of race seems constant across education from 4 through 12 years, but decreases with more education beyond 12 years. That is, the lines were parallel at lower levels of education and began to converge with additional education (i.e., beyond 12 years). One possibility for the flattening of the education–health relationship among Whites is a ceiling effect in this population. In contrast, a possible explanation for the positive slope observed in Blacks is that perhaps Blacks with higher education may have had different educational experiences when younger that placed them on a trajectory in later life that allowed them to engage in more cognitively stimulating occupations or have other life-time experiences that translated into better overall health. Another possibility is that many Blacks may complete their education later in life after entering the workforce and therefore experience more benefits of education perhaps due to increased life experience compared with Whites who may be more likely to complete their education while young and without interruption. In fact, there is recent evidence that a higher percentage of Black high school dropouts return to school in later life compared with other races (2000 US Census report). Although only recently documented in the past decade or so, this would be a particularly viable explanation for our older cohort as educational opportunities have broadened since the Civil Rights era, allowing more Blacks to achieve more than they could in the past. Related to this, it is possible that there may be racial differences in the types of educational experiences at higher levels that we did not measure. That is, for respondents who reported more than 12 years of education, we do not know whether the additional years were for years in college or graduate school, community college, or vocational training.

Finally, it is possible that these data reflect a selection effect for Blacks at the higher levels of education. The Blacks in this cohort would have been college-aged during the pre-Civil Rights era (between 1946 and 1958). Given the lack of structural opportunities and overt racism that created barriers to achieving a higher education at that time, those who were able to complete high school and pursue a college education may have had to be particularly resilient and overcome greater challenges to achieve the same result. The positive slope for Blacks for physical and cognitive function may represent a hardier group of Blacks who survived the negative adverse experiences of being shut out of higher educational opportunities (Gibson & Jackson, 1995). Related to this point, it is possible that we are seeing a selection effect due to differential mortality between Blacks and Whites prior to old age (Hayward et al., 2000), again resulting in a harder more resilient cohort of Blacks who were able to achieve more than their counterparts who did not make it to old age. Whatever the mechanism, the leveling off between education and health for Whites, but positive association for
Blacks resulted in smaller overall level differences in health (and at least for physical function, better health) between Blacks and Whites at the highest levels of education.

Although relatively few studies have systematically examined the interaction of race and education on health outcomes across the full spectrum of education, our finding of a greater benefit for health indicators among Blacks with more education is consistent with others (e.g., Bandiera, Pereira, Arif, Dodge, & Asal, 2008; Cagney & Lauderdale, 2002; Freedman, Strogatz, Williamson, & Aubert, 1992; Luo & Waite, 2005; Shadlen et al., 2001; Shadlen et al., 2006). For example, Shadlen and colleagues found a reduced magnitude of ethnic differences on a global cognitive measure for more highly educated Whites and African Americans compared with less educated, and in a later study, (Shadlen et al., 2006) an attenuated risk of dementia in African Americans with more than 10 years of education. Similarly, both Cagney and Lauderdale and Luo and Waite reported that educational attainment had larger effects on cognitive function scores for African Americans than Whites. Finally, Freedman and colleagues found smaller racial differences in the association of education and lipoprotein cholesterol in those with more education, and Bandiera and colleagues, reported smaller differences in chronic asthma for those with greater economic resources.

Confidence in these findings is strengthened by several factors. First, our data are from a population-based sample of older adults with a wide spectrum of physical and cognitive function. It can be challenging to examine the intersection of race and SES in explaining and understanding health disparities in populations where there is little to no variation within group. Our sample included a higher proportion of Blacks than found in most studies and a broad range of education within Blacks from 4 to 24 years. In addition, the fact that Blacks and Whites were sampled from the same population enhanced our ability to make meaningful comparisons across race, and the large size of the population increased our power to do so. Second, we used performance-based measures of physical and cognitive function, that were both psychometrically sound and found to be valid and reliable from previous studies in this cohort (Mendes de Leon et al., 2005; Wilson et al., 1999, 2003). In addition, results generalized across both health measures, strengthening the potential impact of the findings.

These findings also have several important limitations. There are many factors during life that may affect health in late life, such as early life factors (Bowen, 2009; Cohen, Doyle, Turner, Alper, & Skoner, 2004; Everson-Rose, Mendes de Leon, Bie nias, Wilson, & Evans, 2003; Guralnik, Butterworth, Wadsworth, & Kuh, 2006), behavioral factors in adulthood (Barnes, Mendes de Leon, Wilson, Bienias, & Evans, 2004; Boyle, Buchman, Wilson, Bienias, & Bennett, 2007), or health care utilization factors (Bowen & Gonzalez, 2008). The current results pertain to racial differences in health in late life, and it is unclear if they have any relation to racial differences observed in health in early life. Second, because we included everyone with valid physical or cognitive function scores at baseline, we may have included individuals with mild forms of disease, which could bias our estimates of the association of education and health. However, in secondary models with cognitive function as the outcome, we excluded those persons with low cognitive function and the results were unchanged. Third, we used only one marker of SES. Although educational attainment is a principle measure of SES and is strongly associated with other SES indicators, other indicators, such as wealth may have yielded a different pattern of racial differences in the association of SES and health. Fourth, our population is from an urban setting in the Midwest, and so the findings may not be generalizable to aging populations in other types of settings in the United States. Fifth, as is true of any research study, particularly in older adults, it is possible that persons agreeing to enroll in our study may have had higher levels of education, which may have decreased our power to see racial differences at the low ends of education. Finally, our results could be due to various selection effects among the Blacks that we were not able to fully capture in this dataset. Although educated Blacks during the pre-Civil Rights era were predominantly from higher achieving or wealthier families, the passage of several federal mandates in the United States that allowed access to higher education for Blacks and the creation of several Historically Black Colleges and Universities made it possible for a broader spectrum of Blacks to attend college. It is possible that a significant proportion of Blacks from our sample could have benefited from such opportunities.

The current research adds to the growing body of evidence of interactive effects of SES and health as a function of race. Contrary to what we hypothesized, we found that although the association of education and health was similar among Blacks and Whites at low levels of education, the association was significantly more positive among Blacks than Whites at higher levels of education. The results suggest that Blacks with more than 12 years of education experience greater gains in two specific measures of physical and cognitive health compared with Whites with the net result being that racial differences in the association of education and functional health are smaller at higher levels of education than at lower levels. The results have important policy implications and suggest that continuing education or programs that promote higher education in minority populations may be helpful in reducing health disparities in old age. This could also have implications for late-life dementia risk as far as potential targeted educational interventions. Whether these patterns exist for other health outcomes or mortality risks and whether they influence trajectories of health over time need to be considered in future work.
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Correspondence

Correspondence should be addressed to Lisa L. Barnes, PhD, Rush Alzheimer’s Disease Center, Rush University Medical Center, 600 South Paulina, Suite 1038, Chicago, IL 60612. E-mail: lbarnes1@rush.edu.

References


