Published in final edited form as:
J Aging Health. 2019 October ; 31(9): 1589–1615. doi:10.1177/0898264318783489.

Childhood Socioeconomic Status and Later Life Cognition: Evidence From the Wisconsin Longitudinal Study

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Abstract

Objectives—This study examined childhood socioeconomic status (SES) as a predictor of later life cognition and the extent to which midlife SES accounts for associations.

Methods—Data came from 5,074 participants in the Wisconsin Longitudinal Study. Measures from adolescence included parents' educational attainment, father's occupational status, and household income. Memory and language/executive function were assessed at ages 65 and 72 years.

Results—Global childhood SES was a stronger predictor of baseline levels of language/executive function than baseline memory. Associations involving parents' education were reduced in size and by statistical significance when accounting for participants' midlife SES, whereas associations involving parental income and occupational status became statistically nonsignificant. We found no associations between childhood SES and change in cognition.

Discussion—Findings contribute to growing evidence that socioeconomic differences in childhood have potential consequences for later life cognition, particularly in terms of the disparate levels of cognition with which people enter later life.

Keywords

life course; childhood; socioeconomic status; cognition; health disparities

A large body of research on child development indicates that children from families with higher socioeconomic status (SES) demonstrate better cognitive outcomes than their lower SES counterparts (Bradley & Corwyn, 2002; Lipina, 2017). Socioeconomic differences in cognitive functioning emerge among children as young as infants (Tomalski et al., 2013), extend into adolescence (Piccolo et al., 2016), and have been documented both by measures of cognitive performance and neurological imaging (Hackman, Farah, & Meaney, 2010). There have been fewer research studies, however, on the extent to which linkages between childhood SES and cognition persist into adulthood, especially into later life when age-

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Declaration of Conflicting Interests
The authors DECLARED no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

related processes heighten risk for declining cognitive health. Better understanding childhood SES as a risk/protective factor for later life cognition is essential for specifying the complex etiological pathways from early-life conditions to adult cognitive health. It also is important for advancing early detection, prevention, and treatment strategies on later life cognitive impairment as increasing numbers of individuals and families are confronted with health conditions related to cognition (Barnes & Yaffe, 2011; Reitz, Brayne, & Mayeux, 2011; Shatenstein, Barberger-Gateau, & Mecocci, 2015).

We used data from the Wisconsin Longitudinal Study (WLS)—one of the largest, longest, and most comprehensive cohort studies in the U.S. (U.S.)—to extend population health research in this area. More specifically, we aimed to advance understanding of childhood SES as a risk/protective factor for later life cognition by examining whether particular components of childhood SES (parental education, occupational status, and income) are associated with distinct aspects of later life cognition (memory versus language/ executive functioning; baseline levels at age 65 years versus change over a 7-year period). We also investigated the extent to which midlife SES accounts for associations between childhood SES and later life cognition.

A Life Course Epidemiological Perspective

A growing body of health research is drawing on insights from life course epidemiology—a field of study that addresses how early-life conditions have potential health ramifications long thereafter (Ben-Shlomo, Cooper, & Kuh, 2016). Such research has found evidence of linkages between childhood SES and adult morbidity (e.g., Zimmer, Hanson, & Smith, 2016) and mortality (e.g., Cohen, Janicki-Deverts, Chen, & Matthews, 2010). Scholars have called for the greater inclusion of this perspective within the field of cognitive aging, given that neurological functioning is especially responsive to environmental conditions in childhood (e.g., nutrition and interpersonal relationship processes), which could have long-lasting implications throughout adulthood (Richards & Hatch, 2011). Moreover, it is now well accepted that human brain maturation is ongoing through at least age 25 years (Romer, Reyna, & Satterthwaite, 2017) and that adolescence is a sensitive period for cognitive development, during which time the brain is especially malleable (Fuhrmann, Knoll, & Blakemore, 2015).

Regarding how childhood SES might influence later life cognition, scholars have posited two broad categories of mechanisms (Fors, Lennartsson, & Lundberg, 2009). The first category focuses on direct mechanisms in childhood, whereby SES is linked with other childhood advantages and disadvantages that directly affect individuals' neurophysiological development, which then influences later life cognition. Examples of childhood disadvantages include environmental toxins, illness, and greater overall stress, and examples of childhood advantages include cognitive stimulation, higher quality schools, and better nutrition (Hackman & Farah, 2009; Wilson et al., 2005). The second category focuses on mechanisms in adulthood, whereby childhood SES has an indirect effect on later life cognition by leading to more proximal risk and protective factors throughout adulthood. Examples include adult cardiometabolic health, quality personal relationships in adulthood, and degree of cognitively stimulating environments in adulthood (Luo & Waite, 2005;

Scazufca et al., 2008). While risk/protective mechanisms in childhood versus adulthood are oftentimes conceptualized as two distinct pathways, it is plausible that both operate simultaneously, with some childhood conditions affecting cognition directly and others acting indirectly through mechanisms in adulthood (Zhang, Hayward, & Yu, 2016).

Researchers have posited SES in adulthood as a primary mechanism of risk through which childhood SES influences later life cognition, theorizing that children of high SES are likely to become adults of high SES, and greater resources in adulthood allow people to maintain their cognitive health. Scholars have emphasized the mediating role of one's own educational attainment, in particular, given consistent evidence from prospective, population-based cohort studies that greater educational attainment is associated with better adult cognition (see Borenstein, Copenhaver, & Mortimer, 2006, for a review). Some scholars interpret this association as causal, theorizing that education enhances individuals' cognitive reserve, or ability to withstand age-related changes in the brain without developing functional symptoms of disease (Meng & D'Arcy, 2013). Others have emphasized ways in which educational attainment is part of a causal chain, wherein education leads to other socioeconomic resources and health-promoting conditions such as higher income, more cognitively challenging activities, access to health care, and residence in healthier neighborhoods (Zahodne, Stern, & Manly, 2015).

Prior Studies on Childhood SES and Later Life Cognition

Most studies of childhood SES and later life cognition have drawn on samples outside of the U.S., such as in China (e.g., Wen & Gu, 2011; Zhang et al., 2016; Zhang, Liu, Li, & Xu, 2017), Finland (e.g., Kaplan et al., 2001; Turrell et al., 2002), Eastern Europe (e.g., Horvat et al., 2014), the United Kingdom (e.g., Richards & Wadsworth, 2004), Sweden (e.g., Wang, MacDonald, Dekhtyar, & Fratiglioni, 2017), and France (e.g., Glymour, Tzourio, & Dufouil, 2012). To our knowledge, only a handful of studies have been conducted in the U.S. Advancing population health research on childhood SES and later life cognition in the U.S. is important given that associations between social inequalities and health might be especially strong in a country with limited "safety net" policies for those with lower SES (Avendano, Glymour, Banks, & Mackenbach, 2009).

Several U.S. studies have included measures of respondents' own SES in adulthood as control variables when testing associations between childhood SES and later life cognition. Rogers and colleagues (2009) used data from a subset of participants in the Health and Retirement Study (HRS) who completed in-person clinical assessments for dementia. They found consistent evidence that participants whose mothers had 8 years or less of education had increased risk for cognitive impairment. Moreover, Melrose and colleagues (2015) used data from the UC Davis Aging Diversity Cohort, which included White, African, American, and Latina/o individuals from northern California who were at least 60 years old at baseline. Childhood SES was associated with baseline scores on semantic memory, but not episodic memory or executive function, nor with changes in global cognition. Persons in the lowest quintiles of childhood SES consistently demonstrated greater decline in global cognition than persons in the highest quintile. Finally, Lee, Kawachi, Berkman, and Grodstein (2003) used data from a sample of U.S. women who were assessed every 2 years between ages 70 and 79 years. Results indicated that women whose fathers were farmers were at slightly elevated risk for cognitive decline on global cognition—but not on individual test scores—compared with women whose fathers were upper white-collar. No other associations were found.

Other studies in the U.S. have more explicitly examined respondents' SES in adulthood as a potential mediator of associations between childhood SES and later life SES. Everson-Rose, Mendes de Leon, Bienias, Wilson, and Evans (2003) used data from Chicago Health and Aging Project, a population-based sample of community-dwelling adults aged 65 years or older from Chicago, Illinois, from 1993 to 1997. They found that childhood socioeconomic position was associated with global baseline cognition in later life, but not with change in cognition, and that adult SES accounted for some, but not all, of the association. These findings are consistent with the majority of research conducted in other national contexts, which has found that SES in adulthood partially accounts for associations between childhood SES and later life cognition (Fors et al., 2009; Horvat et al., 2014; Kaplan et al., 2001; Richards & Wadsworth, 2004; Zhang, Gu, & Hayward, 2008; Zhang et al., 2017).

Other U.S. studies have found that SES accounts for all of the association between childhood SES and later life cognition. Using HRS data from participants ages 65 years and older in the 1998-2010 sample, González, Tarraf, Bowen, Johnson-Jennings, and Fisher (2013) found linkages between better subjective childhood financial status, mother's education, and father's education with higher baseline levels of cognition at age 65 years or older, but not with change in cognition over the 12-year period. Many of these associations became statistically nonsignificant when respondents' education and income in adulthood were included in the models. Zhang and colleagues (2016) used data from the same analytic sample and confirmed that higher scores on a four-item cumulative childhood SES measure were associated with greater incidence of later life cognitive impairment; this association was explained by respondents' own educational attainment in adulthood. Furthermore, a study using data from men in the Vietnam Era Twin Study of Aging (Beck et al., 2018) reported associations between retrospective reports of parental education and scores across seven domains of cognition at age 62 years. Results further indicated that with the exception of abstract reasoning, which was partially accounted for, participants' SES in adulthood fully accounted for associations. These findings are consistent with a study of older adults in China, which found that education in adulthood fully accounted for the associations between retrospective reports of father's occupational status and cognitive impairment in later life (Wen & Gu, 2011).

Focus of the Current Study

Our study aimed to extend U.S. population-based research on childhood SES as a predictor of later life cognition by using data from the WLS—a cohort sample that has not been utilized widely for the study of later life cognition. Whereas most prior studies of childhood SES and later life cognition in the U.S. have relied solely on retrospective measures, the WLS includes prospective measures of parental occupation and income based on tax records collected when participants were in adolescence. This is an important methodological advantage given that retrospective reports introduce the possibility of recall bias and other systematic sources of error in measures of childhood SES (Hardt & Rutter, 2004). Moreover, studies using retrospective reports are unable to assess the potential impact of selective attrition in earlier periods of the life course—that is, that individuals with the greatest disadvantage in childhood are less likely to be in survey panels of adults. This methodological issue might further bias estimates (Dupre, 2007).

Our study further aimed to contribute by examining both SES and cognitive functioning as multidimensional constructs. SES, by definition, is a composite of various indicators of people's social standing, such as educational attainment, occupational status, and income (Centers for Disease Control and Prevention, 2014). As Duncan and Magnuson (2012) contend, distinct socioeconomic resources might benefit children's cognitive development in different ways. For example, greater economic resources vis-à-vis higher household income can allow families to purchase more developmental resources (e.g., nutritious meals and materials for cognitive stimulation). Prior studies have found that such resources are associated with better neurocognitive development in early childhood and perhaps in adolescence alone (Galler, Koethe, & Yolken, 2017), which could have long-lasting effects throughout adulthood. Higher education can lead to parents interacting with their children in more cognitively enhancing ways, such as use of a greater range of vocabulary and complex sentence structures (Duncan & Magnuson, 2012), as well as greater expectations for their children's success (Dubow, Boxer, & Huesmann, 2009). This can potentially contribute to lifelong cognitive advantages. Finally, parents' occupational status might influence parenting behaviors that also contribute to cognitive outcomes, such as parents in low-skilled jobs being more likely to use disciplinary strategies that emphasize conforming to authority (Duncan & Magnuson, 2012). Although few empirical studies have examined parents' occupational status specifically and children's cognition, classic sociological theorizing suggests differences in how parents of various social classes facilitate home and school environments that could affect children's cognitive development (Kohn, 1963; Lareau, 1987). Prior research also indicates the importance of examining global measures of SES. This is because different aspects of childhood SES might influence cognitive development through shared mechanisms (e.g., higher education and income both being associated with aspects of the child-rearing environments). Therefore, examining one component net of others could underestimate the components' shared influence (Erola, Jalonen, & Lehti, 2016).

Similar to SES, cognitive functioning is a multifaceted construct. Biomedical and social science researchers recognize that there are related-yet-distinct domains of cognitive functioning—such as attention, learning, memory, language, and visuospatial skills—underpinned by various neurophysiological systems and that social-behavioral factors, as well as age-and disease-related changes, can affect these systems differently (Hackman & Farah, 2009). Research on child development has drawn on these perspectives to examine how environmental conditions might influence some aspects of children's cognition more strongly than others (Peyre et al., 2016). For example, research studies focusing specifically on childhood SES and cognition among young children have found that SES is a more powerful predictor of language and executive functioning than of visual and spatial cognition (Noble, McCandliss, & Farah, 2007; Noble, Norman, & Farah, 2005). This may be because the neurophysiological systems underlying language and executive functioning have more prolonged postnatal development, making these domains especially sensitive to environmental influences, such as childhood SES. Many studies on childhood SES and later life cognition have used global measures of cognition (e.g., Everson-Rose et al., 2003; Rogers et al., 2009), and studies examining multiple domains of cognition largely have not employed techniques that account for shared variance among dependent variables (e.g., Kaplan et al., 2001; Lee et al., 2003; Melrose et al., 2015).

Cognitive functioning also is a dynamic health outcome, with researchers increasingly recognizing that predictors of baseline levels of cognition at a given point in time do not necessarily predict decline in cognition. For example, some studies have found that measures of cognitive reserve are only associated with baseline levels of cognition and not with rates of cognitive change, whereas other studies have found evidence for greater, as well as lesser, cognitive decline among individuals with initially higher cognitive reserve scores (see Soldan et al., 2017, for a review). Overall, this research implicates the importance of examining multiple domains of later life cognition, as well as considering both baseline levels of, and change in, cognition over time.

In summary, we broadly hypothesized that greater childhood SES would be associated with better cognition in later life, and that SES in midlife would at least partially account for the associations. Conceptualizing SES and cognitive functioning as multidimensional constructs, we also explored the extent to which (a) particular aspects of later life cognition are especially sensitive to childhood SES (Research Question [RQ] 1), (b) particular aspects of childhood SES are more strongly and independently associated with later life cognition than others (RQ2), and (c) particular aspects of adulthood SES account for associations between childhood SES and later life cognition (RQ3).

Method

Data

The WLS follows a random sample of individuals who graduated from Wisconsin high schools in 1957 (N = 10,317). One third of all Wisconsin high school graduates were included in the original sample. Data from 1957, when most participants turned 18 years, included a self-report questionnaire as well as data on parents' income and occupation from their tax filings. Participants were followed with a combination of in-person, telephone, and mail surveys at ages 36 (1975), 54 (1993; 87% response rate), 65 (2004; 86% response rate), and 72 years (2011). At age 72 years, 74.4% of the surviving respondents continued to participate (i.e., 6,152 of the 8,268 individuals who were still alive). Of the original 10,317 participants, 2,831 had dropped out of the study by 2004, and therefore, we omitted these participants from the analytic sample. We also omitted 2,412 participants who were still active WLS participants in 2004, but who did not have valid measures of cognition at that time. In 2004, five of the six cognitive tests were administered to random subsamples of participants, rather than to the complete sample, to reduce participants' response burden. Approximately 65% of the 2,412 omitted participants were in the random sample not selected to receive any of the five cognitive tests. The remainder comprised participants who completed three or fewer of the six tests. Thus, our final analytic sample was 5,074 participants. Because insufficient numbers of African American, Asian, Latina/o, and Native

American graduates were included in the original WLS sample for statistical analysis, these participants comprise a White sample, with most participants of German, English, Irish, Scandinavian, Polish, or Czech descent.

Measures of Adult Cognitive Function

At age 65 years, participants completed a battery of six cognitive tests, which were repeated when they were age 72 years. These tests included a subscale of the Wechsler Adult Intelligence Scale–Revised (WAIS-R; Wechsler, 1981), which asked participants to name the similarities of things presented in six sets (e.g., an orange and a banana); a letter fluency task (Tombaugh, Kozak, & Rees, 1999), which asked participants to name all the words they could beginning with the letter “L” or “F” in 1 minute; a category fluency task (Tombaugh et al., 1999), which asked participants to name all the words they could belonging to the categories “animals” or “foods” in 1 minute; immediate and delayed word recall tests (Brandt, Spencer, & Folstein, 1988); and a digit ordering test, which involved their reordering a series of single digits from smallest to largest, following a modified protocol of the WAIS-III digit backward subtest (Wechsler, 1997).

We conducted factor analyses on scores across the six cognitive tests, which demonstrated a two-factor solution. (Results are available from the authors upon request.) Memory included scores on the tests of immediate recall, delayed recall, and digit ordering. Language/executive function included scores on the WAIS similarities scale, as well as the letter fluency and category fluency tests. Following recommendations by Moeller (2015) for repeated measures on scores with different metrics, we calculated the percent of maximum possible scores for each test and averaged the scores within each domain (Cohen, Cohen, Aiken, & West, 1999). The correlation between memory and language/executive function was 0.28 in 2004 ($p < .001$) and 0.43 in 2011 ($p < .001$).

Measures of Childhood SES

This study included three measures of childhood SES—all of which we standardized for ease of interpretability. Parents’ educational attainment was obtained through participants’ reports on their mother’s and father’s educational attainment in the original survey in 1957. Scores ranged from 7 (*no high school*) to 18 (*has graduate degree*) years, and we selected the higher of the two levels. There was a high degree of homogamy in the sample between mother’s father’s educational attainment: 43% of mothers and fathers had the same level of educational attainment. Fathers’ occupational status was based on information from tax filings from 1957 to 1960. Because only one third of mothers worked for pay, we excluded mothers’ occupational status. The data were coded on the 1950 Duncan Socioeconomic Index (SEI), which is a weighted average of occupational education and income (Hauser & Warren, 1997). Scores ranged from 1 to 100. We averaged SEI across the 4-year period. Household income was also taken from tax filings and averaged over the 4-year period. Because values were skewed, we recoded them into quartiles to create an ordinal measure. Finally, we took the standardized measures of highest parental education, father’s occupational prestige, and household income and averaged them together to create a measure of global childhood SES. A large majority (79.66%) of the analytic sample had data for all components of childhood SES, and 98.15% of the analytic sample had data for at least two components. Only 40 (i.e., 0.80%) had no information on any component of childhood SES. As omitting these participants had no effect on results, we retained them in the analytic sample by imputing components.

Measures of Adult SES

We used three measures of adult SES collected in 1993 when participants were approximately age 53 years. We selected this time point because it preceded age 65 years, at which time the battery of cognitive tests was first administered, and at which time many participants already had retired from the full-time labor force. The selection of this time point also is consistent with prior studies using data from the WLS to examine adult SES as a mediator of earlier-life conditions and later life health (Warren, 2015). A continuous measure of educational attainment was created based on detailed information from each wave of data collection about degrees attained and years spent as a student. All participants graduated high school, such that the lowest educational attainment was 12 years. The highest end of the range was 21 years, corresponding to multiple graduate degrees. Following Hauser and Warren (1997), we used a measure of occupational education to indicate occupational status. WLS researchers coded participants' reports of their occupation based on the percentage of 1970 U.S. Census participants in each occupation (e.g., insurance underwriters) who completed at least 1 year of college (Hauser & Warren, 1997). The measure was normally distributed and ranged from 20 (2% of employees had a year or more of college) to 960 (96% of employees had a year or more of college). The measure of household income included all sources of income, businesses, annuities, retirement accounts, and government programs (e.g., disability benefits). Because this measure was significantly skewed, we divided it into quartiles to create an ordinal measure.

Covariates

Prior research has identified childhood conditions that are likely to be associated with both childhood SES and later life cognition, such as geographic setting (Borenstein et al., 2006), family structure (Yi, Gu, & Land, 2007), and family size (Moceri, Kukull, Emanuel, Belle, & van Larson, 2000). We included measures of several such variables that potentially could render associations between childhood SES and later life cognition to be spurious. Three dichotomous variables were created, including gender, family structure (whether participants reported living with both parents most of the time up until 1957), and any self-reported hearing problems at age 65 and/or 72 years, as assessed by the Health Utilities Index Mark 3 (Horsman, Furlong, Feeny, & Torrance, 2003). We also included a continuous measure for number of living siblings, as assessed in 1975, as well as a multicategorical measure of adolescent geographic setting. WLS researchers recorded the population size of the locality in which the participant attended high school. We coded populations of 9,999 or fewer residents as *rural*, 10,000 to 49,999 as *suburban*, and 50,000 or more residents as *urban*.

Analytic Strategy

Statistical approach—After examining the means and standard deviations for all study variables, we estimated multilevel regression models, where up to two observations of cognitive function were nested within 5,074 participants. This sample included 1,088 persons who participated in 2004 but dropped out of the study before 2011, as an advantage of multilevel modeling is that even participants who responded only once contribute meaningful information (Hox, Moerbeek, & van de Schoot, 2010). To account for the fact that memory and language/executive function were not independent outcomes, but rather two related domains of overall cognition, all models for these dependent variables controlled for the other domain. We modeled cognition at baseline (i.e., age 65 years) and change in cognition scores between ages 65 and 72 years. Cognition at baseline was allowed to vary across participants (i.e., a random intercept), but all slopes were fixed because random slopes cannot be estimated without a third wave of data on cognition.

For each of the outcomes, we estimated a series of four models. Model 1 tested the association between global childhood SES and cognition at baseline and change over 7 years. Model 2 did the same, except using the component measures of childhood SES (i.e., mother's education, father's education, father's occupational status, and household income). Model 3 added the components of adult SES (i.e., educational attainment, occupational status, and income) to Model 1, and Model 4 added the components of adult SES to Model 2. (We estimated additional models examining a global measure of adult SES, but we do not display them because results are consistent with the models shown.) To assess the extent to which adult SES accounts for associations between childhood SES and later life cognition, we used Krull and MacKinnon's (2001) product of coefficients test of mediation in multilevel models. This test provides an estimate of the indirect association, its significance, and its proportion of the total association.

Missing data and study attrition—Within the analytic sample of 5,074 participants, 68% had complete data on all measures used in the present analyses, from 1957 through 2011. The measures with the most missing data were father's occupation and household income, both drawn from tax records, which were unavailable for 12% of participants. We searched for patterns in the missing data and found none; therefore, we conducted multiple imputation by chained equations. The regression results combine the estimates from the five datasets using Rubin's (1987) rules. Results from analyses that used listwise deletion are available upon request. The results were substantively similar regardless of the treatment of missing data.

There were 2,831 people who dropped out of the study before 2004 and 2,412 additional participants who were excluded from analyses because their cognitive scores were absent or incomplete. We examined these data for evidence of selective attrition. Of those who dropped out, 17% had died. Compared with our analytic sample, dropouts were significantly lower on each of the dimensions of childhood SES and each of the three dimensions of midlife SES. Those who did not have complete cognitive scores showed lower educational attainment and income in midlife; however, they did not differ from the analytic sample on occupational education or on any dimension of childhood SES. Among the people in this group who had some, albeit incomplete, cognitive scores, those recorded cognitive scores were significantly lower than the scores of participants in the analytic sample. In the Results section, we report on tests indicating how attrition might affect the findings.

Results

Descriptive Statistics

As Table 1 displays, participants, on average, came from households in which both mothers and fathers had completed fewer than 12 years of education. The average father's occupational prestige was in the bottom third of possible scores. The median household income in childhood was US$5,500 per year, which is relative to the median family income nationwide in 1960 at US$5,620 (Bureau of Labor Statistics, 2006). In midlife, participants themselves averaged 13.72 years of education. Their average occupational status was at about the midpoint of possible scores. Median household income in midlife was US$55,000. Correlations among these measures were highly significant ($p < .001$) and moderate to large in size. Descriptive statistics for cognitive function indicated that scores on all six tests were normally distributed at both time points. Average scores declined significantly ($p < .001$) over the 7-year period for all six tests. (Results available upon request.)

Multilevel Model Results

Table 2 shows the results of multilevel models for memory and language/executive function. RQ1 concerned patterns of associations between the two domain-specific cognitive outcomes, as well as effects at age 65 years compared with effects on change over the 7-year study period. Model 1 demonstrates that for both outcomes, childhood SES was associated with cognitive scores at age 65 years, but not with change between ages 65 and 72 years. This association was strongest for language/executive function, where participants from a family that was one standard deviation above average in childhood SES had scores on language/executive function that were 2.43 percentage points ($p < .001$) higher at age 65 years. The corresponding association was 1.34 percentage points ($p < .001$) for memory.

RQ2 concerned disparate effects of the components of childhood SES. As Model 2 indicates, for language/executive function, parental education, father's occupational status, and household income all were independently positively associated with baseline cognition. For memory, parental education and household income had independent associations, but no associations were found for father's occupational status.

RQ3 addressed the extent to which adult SES accounts for associations between childhood SES and later life cognition. Models 3 demonstrate that for language/executive function, the significant association with global childhood SES persisted but was attenuated with the addition of adult SES to the models, while for memory, adult SES made the association statistically nonsignificant. The formal test of mediation (not shown, available upon request) demonstrated that together, the three components of adult SES accounted for 58% of the relationship between childhood SES and language/executive function, and for 67% of the relationship between childhood SES and memory. Models 4 demonstrate that the associations of the components of childhood SES with cognition were attenuated with the addition of adult SES. Midlife educational attainment was the strongest, alone accounting for 53% of the association with language/executive function and 39% of the association with memory.

Table 2, includes a comparative fit statistic for *deviance* with a chi-square distribution (Rabe-Hesketh & Skrondal, 2012). That is, for each additional degree of freedom in a model, the deviance should drop by at least 3.84 to indicate a good fit. Thus, for memory, both models with global childhood SES (i.e., Models 1 and 3) fit better than their counterparts that include individual SES components (i.e., Models 2 and 4), and the model with global childhood SES and measures of adult SES (i.e., Model 3) has the overall best fit. For language/executive function, individual SES components fit better than global SES (i.e., Model 2 is preferred to Model 1), but again, Model 3 has the overall best fit.

Selective Attrition

Following Rubin (1987), we examined the robustness of findings against the possibility that original WLS participants who died or otherwise left the study might have had poorer cognition than those who remained, for example, because their childhood SES was systematically lower. First, we multiply imputed all missing reports. Then we subtracted a standard deviation from the imputations of memory and language/executive function to test the possibility that nonreporters had even poorer cognition than multiple imputation would predict. We reestimated the models using this complete dataset ($N = 10,317$). For memory, parental income did not have a significant effect on baseline in Model 2. For language/executive function, the global measure of childhood SES had a significant negative effect on change in Model 1. Otherwise, the direction and significance of the coefficients was consistent with the results shown here. We conclude that our results are unlikely to have been significantly biased by selective attrition.

Discussion

This study used data from one of the longest-running cohort studies in the U.S. to advance understanding of childhood SES as an early-life course predictor of cognition in later life. We capitalized upon several methodological strengths of this dataset, including measures of parental income and occupational status based on prospective administrative records; assessments of participants’ own education, occupational status, and income in midlife; and measures of memory and language/executive function at two time points in later life. We also examined both SES and cognitive functioning as multidimensional constructs, probing whether linkages between childhood SES and later life cognition are component specific.

Overall, results provided consistent evidence that global childhood SES, as well as many of its specific components, is associated with levels of cognition—both in terms of memory and language/executive function—at age 65 years. However, we found no evidence that measures of childhood SES are associated with change in either domain between ages 65 and 72 years. These findings are congruent with a National Institutes of Health (2010) consensus statement on the prevention of Alzheimer’s disease that “childhood socioeconomic status or cognitive milieu does not appear to strongly influence cognitive decline later in life” (p. 10). It also is consistent with prior studies that have found more robust linkages between aspects of childhood SES and baseline cognition relative to associations with measures of change (e.g., Glymour et al., 2012; Wilson et al., 2005). It is possible that our sample was not old enough to experience sufficient variability in cognitive decline to detect associations with change. Regardless, findings contribute to a growing body of evidence that childhood SES is associated with the initial levels of cognition with which people enter into later life (e.g., Everson-Rose et al., 2003). These findings suggest that inequalities stemming from childhood contribute to within-cohort differences in later life cognition and potential disparities in cognitive health more generally. For example, the better performance on the cognitive tests among respondents with higher childhood SES might suggest their greater cognitive reserve, or ability to withstand neurophysiological changes that would otherwise compromise their cognitive health (Stern, 2003). Therefore, older adults with histories of higher childhood SES might be less vulnerable to cognitive impairment because of their initially higher levels of cognition, thereby allowing them to experience greater decline before dropping below a threshold for impairment.

In addition to examining baseline levels versus change in cognition, we also examined whether any particular domain of later life cognition was especially sensitive to childhood SES. While some prior studies in this area have incorporated measures of more than one domain of cognitive function (e.g., Glymour et al., 2012; Melrose et al., 2015; Turrell et al., 2002), we uniquely estimated cross-control models to more rigorously examine potential domain-specific effects. Although childhood SES was associated with both domains of cognition, the association for language/executive function was considerably larger than that for memory. This finding is consistent with research on children, which has found some evidence that particular environmental conditions—such as SES and cognitive stimulation in the home—are most robustly associated with aspects of cognition such as language, attention, and other executive functions (Hackman & Farah, 2009; Noble et al., 2015; Peyre et al., 2016). This suggests that the neurophysiological systems underlying these particular aspects of cognition are especially susceptible to environmental influences (Noble et al., 2007).

This study also examined childhood SES as a multidimensional construct—examining whether linkages between childhood SES and later life cognition were particularly robust for some components of childhood SES. Notably, results indicated that parental education was the largest and most robust predictor of both aspects of later life cognition. Parental education was the only aspect of childhood SES that remained associated with later life cognition after accounting for participants' SES in adulthood. This suggests that parental education might have a more direct association with later life cognition—that parent's education alone is predictive of baseline levels of cognition in later life regardless of one's own education, occupational status, and income in adulthood. Prior research has emphasized the importance of parents' education for optimal life course human development, supporting the idea that parental education reflects human and social capital that benefits children through a variety of processes, such as parenting styles, access to resources, and status attainment (Erola et al., 2016). It also supports the importance of examining where different aspects of childhood SES are associated with particular outcomes, as opposed to assuming that SES components are substitutable for each other (Wolfe, 2015).

Findings also contribute to a growing body of empirical studies that examine the extent to which SES in adulthood accounts for associations between childhood SES and later life cognition (Beck et al., 2018; Dupre, 2007; Lee et al., 2003; Moceri et al., 2000; Richards &

Wadsworth, 2004; Zhang et al.,2016). Researchers have theorized adult SES—especially educational attainment—as a causal mechanism linking childhood advantages/disadvantage to adult cognition (e.g., Guerra-Carrillo, Katovich, & Bunge, 2017). Nevertheless, it is important to note that correlational studies, such as ours, are unable to provide evidence of causation. Other variables that our analysis did not account for—such as genetic differences —might be associated with both adult SES and later life cognition and thereby explain our study's findings regarding midlife SES. Childhood SES might also lead to other circumstances in the life course—such as subsequent neurological development in early adulthood—that influence both midlife SES (e.g., occupational status and post-secondary education) and later life cognition. These noncausal explanations for associations among childhood SES, midlife SES, and later life cognition indicate issues of mediator-outcome confounding (Richiardi, Bellocco, & Zugna, 2013). They highlight the critical importance of empirical studies that focus explicitly on the complex, multidimensional, and time-varying pathways through which childhood SES is associated with later life cognition.

Study Limitations

First, the WLS precluded measurement of key childhood health variables, such as birth weight, child nutrition, and prenatal measures—all which have been found to be associated with adult cognition (e.g., Grove, Lim, Gale, & Shenkin, 2017) and which are likely associated with childhood SES. Our study also was unable to measure psychological variables in childhood—such as sense of control—which have been found to attenuate associations between childhood SES and adult health outcomes (Oi & Alwin, 2017). Second, this study's measure of SES was in adolescence. We were unable to test whether duration of SES at distinct points in childhood differentiates associations with later life cognition. Third, our sample was relatively educated (i.e., all high school graduates), exclusively White, and represented a single cohort of older adults who went to high school in Wisconsin. Therefore, results might not be generalizable to other racial/ethnic groups and cohorts (for a discussion, see Zhang et al., 2016). Moreover, the restricted variability in education among WLS participants might mute the estimations of associations between childhood SES and later life cognition; for example, participants in the sample are likely more cognitively healthy than a sample with lower educational attainment. Fourth, the WLS did not include measures that are amenable to clear diagnostic categories of cognitive health, such as dementia, which are of particular relevance to population health and clinical sciences. The WLS cognitive assessments also were limited to language/executive function and memory.

Conclusion

Despite these limitations, this study contributes robust empirical evidence to research on childhood SES as a life course antecedent to later life cognition—specifically in terms of initial levels of cognition in later life, especially for the domain of language/executive function, and with particularly large and robust associations involving parents' education. Building from this research, future studies are well positioned to better specify the likely complex life course pathways through which SES in childhood influences cognition throughout later life, including one's own SES in midlife. Findings also indicate the importance of examining whether specific life course pathways contribute to functioning within particular domains of later life cognition. Rigorously pursuing these research directions is essential for advancing promising policies and programs to optimize cognition for children and adults of diverse socioeconomic backgrounds.

Acknowledgments

Funding

The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This study was supported by a grant from the National Institutes of Health (R01 AG057491-02).

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Table 1.

Univariate and Bivariate Statistics for Independent Measures.

	M (*SD*) or %	1	2	3	4	5
Childhood socioeconomic status						
1. Highest parental education (years)	11.50 (3.02)	—				
2. Father's occupational prestige (1 = *low*; 100 = *high)*	30.63 (22.30)	0.42	—			
3. Household income (quartiles)	2.53 (1.12)	0.32	0.44	—		
Adulthood socioeconomic status						
4. Own education (years)	13.72 (2.33)	0.34	0.28	0.23	—	
5. Household income (quartiles)	2.61 (1.10)	0.14	0.13	0.14	0.32	—
6. Occupational status (2 = *low*; 1,000 = *high*)	488.60 (227.30)	0.23	0.21	0.21	0.53	0.34
Covariates						
Female	53.94					
Any self-reported hearing problems (grand mean)	5.06					
Did not live with both parents until 1957	9.56					
Number of siblings	2.97 (2.25)					
Urban geographic setting in adolescence (50,000 or more residents)	24.40					
Suburban geographic setting in adolescence (10,000-49,999 residents)	24.12					
Rural geographic setting in adolescence (9,999 or fewer residents)	51.48					

Note. All values reported on their original metrics (i.e., prior to the creation of indices, skew correction, or standardizing) and prior to multiple imputation. All correlations are significant at the level of $p < .001$.

Table 2.

Multilevel Models Indicating Associations Between Childhood and Adulthood Socioeconomic Status and Cognition (in Percent of Maximum Possible) at Age 65 Years Baseline and Change Across a 7-Year Period (*N* = 5,074).

	Memory				Language/executive function			
	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
	***B* (*SE*)**	***B* (*SE*)**	***B* (*SE*)**	***B* (*SE*)**	***B* (*SE*)**	***B* (*SE*)**	***B* (*SE*)**	***B* (*SE*)**
Childhood socioeconomic status								
Global (effect on baseline)	1.34*** (0.24)	—	0.45 (0.25)	—	2.43*** (0.19)	—	0.72*** (0.19)	—
Global (effect on change)	−0.58 (0.30)	—	−0.22 (0.31)	—	−0.09 (0.19)	—	0.01 (0.20)	—
Highest parental education (baseline)	—	1.13*** (0.24)	—	0.61* (0.24)	—	1.81*** (0.19)	—	0.72*** (0.18)
Highest parental education (change)	—	−0.48 (0.31)	—	−0.29 (0.30)	—	−0.23 (0.19)	—	−0.15 (0.20)
Father’s occupation (baseline)	—	−0.15 (0.25)	—	−0.44 (0.25)	—	0.58** (0.21)	—	0.03 (0.20)
Father’s occupation (change)	—	0.02 (0.32)	—	0.14 (0.32)	—	0.08 (0.22)	—	0.10 (0.22)
Household income (baseline)	—	0.75** (0.26)	—	0.47 (0.26)	—	0.62** (0.22)	—	0.20 (0.22)
Household income (change)	—	−0.28 (0.31)	—	−0.15 (0.31)	—	0.04 (0.23)	—	0.05 (0.23)
Adulthood socioeconomic status								
Own education (baseline)	—	—	1.36*** (0.26)	1.35*** (0.26)	—	—	3.60*** (0.19)	3.56*** (0.19)
Own education (change)	—	—	−0.54 (0.32)	−0.53 (0.32)	—	—	−0.46* (0.20)	−0.44* (0.20)
Household income (baseline)	—	—	1.30*** (0.23)	1.29*** (0.23)	—	—	0.62*** (0.17)	0.62*** (0.17)
Household income (change)	—	—	−1.00** (0.29)	−0.99** (0.29)	—	—	0.33 (0.19)	0.33 (0.19)
Occupational status (baseline)	—	—	1.36*** (0.26)	1.36*** (0.26)	—	—	1.20*** (0.19)	1.20*** (0.19)
Occupational status (change)	—	—	−0.35 (0.32)	−0.34 (0.33)	—	—	−0.02 (0.21)	−0.02 (0.21)
Covariates								
Female (baseline)	6.73*** (0.41)	6.77*** (0.41)	7.95*** (0.42)	7.97*** (0.42)	1.09*** (0.33)	1.12*** (0.33)	2.83*** (0.32)	2.84*** (0.32)
Female (change)	−2.51** (0.52)	−2.53** (0.52)	−3.16** (0.54)	−3.17** (0.54)	−0.47 (0.34)	−0.48 (0.34)	−0.56 (0.35)	−0.57 (0.35)
Did not live with both parents until 1957 (baseline)	−0.56 (0.70)	−0.55 (0.71)	−0.64 (0.69)	−0.57 (0.70)	0.88 (0.56)	0.60 (0.57)	0.74 (0.52)	0.64 (0.53)
Did not live with both parents until 1957 (change)	0.81 (0.89)	0.82 (0.90)	0.85 (0.88)	0.84 (0.89)	−0.71 (0.57)	−0.64 (0.58)	−0.69 (0.57)	−0.65 (0.58)
Hearing problems (baseline)	−3.39** (1.16)	−3.35** (1.16)	−2.98* (1.15)	−2.97* (1.15)	−0.09 (0.82)	−0.04 (0.82)	0.40 (0.78)	0.42 (0.78)
Hearing problems (change)	0.83 (1.31)	0.83 (1.31)	0.64 (1.30)	0.64 (1.31)	0.42 (0.88)	0.40 (0.88)	0.19 (0.86)	0.18 (0.86)

	Memory				Language/executive function			
	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
	B (SE)	**B (SE)**	**B (SE)**	**B (SE)**	**B (SE)**	**B (SE)**	**B (SE)**	**B (SE)**
Number of siblings (baseline)	−0.10 (0.09)	−0.09 (0.09)	−0.03 (0.09)	−0.02 (0.09)	−0.06 (0.07)	−0.06 (0.07)	0.07 (0.07)	0.07 (0.07)
Number of siblings (change)	0.01 (0.12)	0.01 (0.12)	−0.02 (0.12)	−0.02 (0.12)	−0.05 (0.08)	−0.05 (0.08)	−0.05 (0.08)	−0.06 (0.08)
Urban geographic setting in adolescence (baseline)	1.35* (0.54)	1.43* (0.55)	1.22* (0.54)	1.24* (0.55)	0.86* (0.43)	1.19* (0.44)	0.76 (0.40)	0.89* (0.41)
Urban geographic setting in adolescence (change)	−0.41 (0.69)	−0.45 (0.70)	−0.37 (0.68)	−0.40 (0.70)	−0.32 (0.44)	−0.40 (0.45)	−0.36 (0.44)	−0.42 (0.45)
Suburban geographic setting in adolescence (baseline)	0.03 (0.53)	0.06 (0.53)	−0.06 (0.52)	−0.07 (0.52)	0.56 (0.41)	0.75 (0.42)	0.56 (0.39)	0.64 (0.39)
Suburban geographic setting in adolescence (change)	1.03 (0.66)	1.01 (0.66)	1.03 (0.65)	1.02 (0.66)	−0.56 (0.42)	−0.61 (0.43)	−0.62 (0.42)	−0.65 (0.42)
Random components								
Person-level intercept	8.28 (0.22)	8.27 (0.22)	8.13 (0.22)	8.12 (0.22)	8.60 (0.14)	8.58 (0.14)	7.65 (0.13)	7.65 (0.13)
Observation-level intercept	11.96 (0.14)	11.96 (0.14)	11.87 (0.14)	11.87 (0.14)	7.60 (0.09)	7.59 (0.09)	7.55 (0.09)	7.55 (0.09)
Deviance; *df*	73,790; 17	73,778; 21	73,603; 23	73,595; 27	68,418; 17	68,396; 21	67,552; 23	67,547; 27

Note. Continuous independent measures are standardized. All models include time and the effects on baseline and change of the opposite domain of cognitive function (not shown).

* $p < .05$.

** $p < .01$.

*** $p < .001$.