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Life-course exposure to early socioeconomic environment, education in relation to late life cognitive function among older Mexicans and Mexican Americans

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Abstract

Objectives—To examine the associations between life-course education and late-life cognitive function along with the modifying role of migration history.

Methods—The combined sample includes 1,789 participants from the Sacramento Area Latino Study on Aging and 5,253 participants from the Mexican Health and Aging Study. Aged 60+ at baseline, participants were classified as Mexican residents, Mexicans-return migrants, Mexicans-immigrants to the US, and Mexicans-US-born. Cognitive function was measured using standardized z-scores of a short-term verbal recall test. Multivariate linear regression analysis was conducted.

Results—Participants' z-scores were higher among those whose mother had more than elementary education (β=0.28, $p<0.05$). Participant's education mediated this association. For 5-year difference in education, the cognitive z-score increased by 0.3 points for a US-born. Results were similar with father's education.

Discussion—Adult educational attainment mediates the effect of childhood socioeconomic status on late-life cognition. Migration plays a role in shaping cognitive aging.

Keywords

cognition; health; education; life course; old age; Mexican Americans

INTRODUCTION

There is a wealth of data that shows an association between adulthood socioeconomic status (SES), education in particular, and cognitive function in middle to late-life (Cagney & Lauderdale, 2002; Elias, Elias, D'Agostino, Silbershatz, & Wolf, 1997; Farmer, Kittner, Rae, Bartko, & Regier, 1995; Masel & Peek, 2009; Singh-Manoux, Richards, & Marmot, 2005). Such associations have been increasingly traced to early-life socioeconomic conditions (Kaplan et al., 2001; Wilson et al., 2005) whose effects on health status continue

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into adulthood. Previous evidence demonstrates the importance of childhood SES in predicting developmental outcomes. For example, children born to low SES backgrounds are more likely to have lower educational opportunities, and be less exposed to learning and stimulating environments (Ben-Shlomo & Kuh, 2002; Bradley, Corwyn, McAdoo, & Coll, 2001; Fernald et al., 2006). The clustering of risks associated with early-life stressors affects cognitive development in children and cognitive achievement across the life course (N. Clarke, Grantham-McGregor, & Powell, 1991; Cravioto, Delicardie, & Birch, 1966; Duncan, Brooks-Gunn, & Klebanov, 1994; Hackman & Farah, 2009; Paine, Dorea, Pasquali, & Monteiro, 1992). Accordingly, the study of socioeconomic status using a life-course approach is important for understanding its influence on cognitive function (Harper et al., 2002; Kaplan, et al., 2001; Karlamangla et al., 2009; Kok et al., 2006; Turrell et al., 2002).

Recently, there has been increasing evidence that documents racial and ethnic disparities in cognitive function (Schwartz et al., 2004; Zsembik & Peek, 2001) as well as disparities in the life-course trajectories of important risk factors for health and cognitive decline in old age (P. Clarke, O'Malley, Johnston, & Schulenberg, 2009; Haas & Rohlfsen, 2010). Importantly, such health trajectories may be affected by life experiences such as migration which is often associated with dramatic changes in the social, economic, cultural and physical environments. Indeed, changes associated with migration have been shown to impact SES trajectories of US Hispanics (Colon-Lopez, Haan, Aiello, & Ghosh, 2009; Haan, Zeki Al Hazzouri, & Aiello, In Press) which in turn influence cognitive function later in life (Haan, Zeki Al-Hazzouri, & Aiello, 2011). US Hispanics have also shown a greater prevalence of important health-risk factors such as type-2 diabetes compared to Mexicans residing in Mexico (Burke, Williams, Haffner, Villalpando, & Stern, 2001; M. P. Stern et al., 1992). Consequently, the complex experience of US Hispanics provides us with a great opportunity to investigate the interplay of migration and life-course socioeconomic circumstances in shaping bio-behavioral pathways.

Most, if not all, studies of migration and health are often complicated by selection on health such that migrants tend to be healthier, at least initially, than those who remained in the home country as well as healthier than their native counterparts in the receiving country. Such biases might be clarified by comparisons of non-migrants in the home country to migrants from the home country and to those born in the 'receiving' country whose ancestors migrated from the home country. This work extended previous research and filled the gap by combining samples from the sending country (Mexico) and the receiving country (US). We evaluated the hypotheses that (1) higher parental education predicted better cognitive function later in life, (2) participants' educational attainment mediated the associations between parental education and cognitive function, and (3) migration status modified the associations between participant's education and cognitive function.

METHODS

Study population

This study was based on cross-sectional analysis of baseline data from the Sacramento Area Latino Study on Aging (SALSA) and the Mexican Health and Aging Study (MHAS). SALSA is a longitudinal cohort study of 1,789 community-dwelling older Mexican Americans residing in California's Sacramento Valley and aged 60-101 years at baseline in 1998-1999. The participants were re-assessed every 12-15 months through 2008. The study population and the recruitment of SALSA participants have been described elsewhere (Haan et al., 2003). SALSA was approved by the Institutional Review Board (IRB) at the University of California, San Francisco and Davis, and the University of Michigan. MHAS is a two-wave prospective panel study of Mexican residents aged 50 and above in 2001 based on the 2000 Mexican National Employment Survey. A total of 5,253 sampled participants aged 60 and above at baseline were included in the present analysis. A detailed description of MHAS study has been published elsewhere (Wong & Diaz, 2007; Wong, Pelaez, Palloni, & Markides, 2006). MHAS was approved by the IRB of the Universities of Pennsylvania, Maryland, and Wisconsin.

Measures

Cognitive function—Within SALSA, cognitive function was assessed using the Spanish and English Verbal Learning Test (SEVLT). The SEVLT is a test of short-term verbal recall that has been validated in both English and Spanish. SEVLT consists of four 15-word memory trials, an interference trial, followed by a fifth trial. Scores range from 0 to 15 for each trial. The score from the fifth trial was used as the delayed verbal recall test. Within MHAS, the test consists of three 8-word memory trials, an interference exercise, followed by a fourth trial with scores ranging from 0 to 8 for each trial. The score from the fourth trial was used as the delayed verbal recall test. The cognitive scores of each study population were separately standardized to a mean of 0 and a standard deviation of 1. The resulting cognitive z-scores from SALSA and MHAS were then combined into one variable and used in the analysis. A higher z-score is indicative of better cognitive performance. The short-term verbal recall test is the only cognitive test in common between SALSA and MHAS and henceforth will be referred to as cognitive function/ z-score throughout the paper.

Parental and participant's education—Within SALSA, participants reported the years of education that their mother and father completed. Within MHAS, participants reported the highest level of education that their mother and father completed. Those variables were coded as ordinal where 0 was coded as 'no education', 1 to 5 years of education as 'less than elementary', 6 years of education as 'completed elementary', and 7 years of education and above as 'more than elementary'. Mother and father's education were examined separately in support of previous literature suggesting that mothers and fathers contribute in different ways to the socioeconomic context-cognitive function association (Kaplan, et al., 2001). Within SALSA and MHAS, participants also reported the years of education they have completed. Participant's education was used as a continuous variable.

Participant's household income and occupation—Within SALSA and MHAS, participants reported their monthly household income and/or pension. Tertiles of income were created as low, medium, or high. Within SALSA and MHAS, participant's occupation was dichotomized into manual and non-manual. Housewives and unemployed were placed in the manual category.

Health conditions—Within SALSA and MHAS, health conditions such as type-2 diabetes, hypertension, stroke, and heart attack were self-reported by asking the participants whether a doctor or other medical personnel ever told them that they have the appropriate medical diagnoses. Having medical insurance was self-reported and was coded as yes or no.

Migration status—Within SALSA, migration status was determined by asking participants about their country of birth. Nearly 50.8% of SALSA participants were immigrants. Within MHAS, migration status was determined by asking participants about their migration history. Participants were either non-migrant permanent residents of Mexico or migrants to the US who returned back to Mexico. Approximately, 89% of MHAS participants in this analysis never migrated from Mexico.

Statistical analysis

The sample included four comparison groups based on the participant's migration status: 1) Mexican residents (Mx); 2) Mexicans-return migrants (Mx-Rm); 3) permanent Immigrants to the US (Mx-Img); and 4) Mexicans-US born (Mx-US born). Groups 1 and 2 were from MHAS and groups 3 and 4 were from SALSA. Mexican resident (Mx) was used as the reference group in regression models. Mother's and father's education were coded into indicator variables as none, some elementary, completed elementary, and more than elementary. 'None' was used as the reference category in regression models. The distribution of descriptive characteristics was examined across the comparison groups and group differences within SALSA and MHAS were tested using one-way ANOVA for continuous variables and chi-square tests for categorical variables.

Generalized linear regression models were used to evaluate the associations between parental education and the participant's cognitive z-score while adjusting for covariates. Those covariates were selected based on the literature and on their association with both parental education and the participant's cognitive z-score. Model 1 adjusted for age and gender; model 2 added adjustment for participant's education; model 3 added adjustment for migration status, household income, participant's occupation, health conditions, and medical insurance; model 4 added adjustment to model 2 for migration status and interactions between migration status and participant's education; and model 5 adjusted simultaneously for all covariates. Regression coefficients (Beta estimates) and standard errors were computed. The two datasets were combined and all models either included a study term referring to SALSA or MHAS or included the participant's migration status. All analyses were conducted using SAS v.9.2 ("SAS Institute. SAS statistical software, release 9.2. Cary, NC, 2005,").

Data imputation

In an attempt to deal with any biasing effects of missing data, a multiple imputation approach was performed for the entire SALSA dataset. This approach conditioned on all observed variables as predictors in a sequential regression multivariate imputation (SRMI) (Raghunathan, Lepkowski, Van Hoewyk, & Solenberger, 2001; Rubin, 1987). By using all available variables, the multiple imputation approach provided less biased estimates and improved efficiency, compared to other alternative analytical approaches such as the list-wise deletion analysis. Moreover, while the list-wise deletion approach assumes that data are missing completely at random, which is rarely valid in epidemiologic studies (Rubin, 1976), the SMRI approach used in this analysis imposes a less restrictive assumption on missing data. Five data sets were imputed for SALSA using the Imputation and Variance Estimation Software (Raghunathan, Solenberger, & Hoewyk). In the present analysis, we only used imputed data for mother and father's education. Five sets were run for all corresponding regression analyses and were summarized using the 'MIANALYZE' procedure in SAS v. 9.2.

RESULTS

Table 1 presents study-specific baseline characteristics by migration status within each study. Within MHAS, the majority of Mexicans-return migrants was men and more likely than non migrants to be former or current smokers and to have ever consumed alcohol. Return migrants were also more likely to have higher household income than non-migrants. Other baseline characteristics did not differ by migration status including years of educational achievement, major lifetime occupation, cognitive z-scores, medical conditions, and parental education.

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Within SALSA, Immigrants to the US were older and less educated than the US-born. Compared to immigrants, the US-born were less likely to have never smoked and more likely to have ever consumed alcohol. The US-born had significantly higher cognitive z-scores than immigrants. The US-born were more likely to suffer from diabetes, stroke, and hypertension and to have medical insurance. The US-born were more likely to have a non-manual occupation and to report a higher household income compared to immigrants. While father's education did not differ by migration status; the US-born were more likely to have mothers who achieved higher levels of education compared to immigrants.

Figure 1 illustrates the distribution of unadjusted cognitive z-scores of the participants by migration status. Overall, cognitive z-scores were higher among the U.S.-born (median= 0.22; mean ± SD=0.15±0.99) compared to US-immigrants (median=-0.10; mean ± SD=-0.14±0.99), non-migrant residents of Mexico (median=0.17; mean ± SD=0.01±1.00), and return migrants (median=0.17; mean ± SD=-0.04±0.98).

Table 2 presents study-specific results from linear regression models for the bivariate associations between parental education and the participant's cognitive function, by study and migration status. Within MHAS, higher father's education was associated with better cognitive function among non-migrants. Return migrants whose fathers completed more than elementary showed better cognitive function than those whose fathers had no education. Higher mother's education was associated with better cognitive function among non-migrants but not for return migrants whose mothers completed elementary education.

Within SALSA, no significant associations were observed between father's education and cognitive function. Immigrants to the US whose mothers completed elementary showed better cognitive function than those whose mothers had no education. The US-born whose mothers completed more than elementary education showed significantly better cognitive function compared to those whose mothers had no education.

Table 3 presents the results of a series of linear regression models for the associations between mother's education and participant's cognitive function. In model 1, participants whose mothers had any education were likely to show better cognitive function than those whose mothers had no education. For example, the cognitive z-score of participants whose mothers had more than elementary was 0.28 of a z-score compared to participants whose mothers had no education. Adjusting for participant's education in model 2 reduced the associations between mother's education and participant's cognitive function. For participants whose mother had more than elementary, adjustment for participant's education reduced the coefficient by 75%. Associations between mother's education and participant's cognitive z-scores remained unchanged after adding adjustment for migration status, health conditions, and household income in model 3. In models 2 and 3 the adjusted associations between mother's education and participant's cognitive function were non-significant. Model 4 added interaction terms between participant's education and migration status (ref=non-migrating resident of Mexico). The association between participant's education and cognitive function was significantly different by migration status for the US-born (p-value <0.05). For every 5 year difference in education, the cognitive z-score of a US-born increased by 0.3 points of a z-score (or 6.3% on the raw cognitive score). The latter interaction remained significant in the fully adjusted model 5.

Table 4 presents the results of a series of linear regression models for the association between father's education and participant's cognitive function. In model 1, participants whose father had higher educational levels were likely to show better cognitive function than those whose father had no education. For example, the cognitive z-score of participants whose father had more than elementary was 0.23 of a z-score compared to participants whose father had no education. Adjusting for participant's education in model 2 reduced the associations to non-significance between father's education and cognitive function. For participants whose fathers had more than elementary education, adjustment for participant's education reduced the coefficient by 86.9%. Associations between father's education and participant's cognitive z-scores remained unchanged after adding adjustment for migration status, health conditions, and household income in model 3. Model 4 added interaction terms between participant's education and migration status (ref=non-migrating resident of Mexico). The association between participant's education and cognitive function was significantly different for the US-born (p-value <0.05). For every 5 year difference in education, the cognitive z-score of a US-born increased by 0.3 points of a z-score. The latter interaction remained significant in the fully adjusted model 5.

Further results from mediation analysis (data not shown) showed that participant's educational achievement mediated 71.4% of the total effect between mother's education and participant's cognitive function. Participant's education also mediated 81% of the total effect between father's education and participant's cognitive function. Both partially mediated effects were statistically significant based on the computed Sobel test (Baron & Kenny, 1986).

DISCUSSION

Using data from MHAS and SALSA, we evaluated the three hypotheses on the associations between life-course exposure to education and cognitive function later in life among a cohort of older Mexicans and Mexican Americans. Findings from this study showed significant associations between childhood SES, indicated by mother and father's education, and participant's cognitive function later in life. The latter associations were mediated by participant's educational achievement. The association between participant's education and cognitive function was significantly different for the US-born compared to permanent residents of Mexico.

This study suggests that mother and father's education do not exert direct effects on cognitive function later in life. Our results are different from earlier work showing independent effects of childhood SES on late middle-age cognitive function (Everson-Rose, Mendes de Leon, Bienias, Wilson, & Evans, 2003; Kaplan, et al., 2001; Luo & Waite, 2005; Turrell, et al., 2002). In a population-based study of eastern Finnish men, lower childhood SES measured as parental education and occupation was associated with poorer late middle-age cognitive function. A residual effect of childhood SES was still observed after adjustment for educational attainment (Kaplan, et al., 2001; Turrell, et al., 2002). Results from the 1998 Health and Retirement Study (HRS) showed attenuation in the effect of childhood SES, measured as parental education and occupation and financial well-being, on cognitive functioning after adjustment for adulthood SES, education and household income in particular (Luo & Waite, 2005). Moreover, results from the Chicago Health and Aging Project found a positive association between childhood SEP and childhood cognitive milieu and cognitive function in old age, independent of one's educational attainment (Everson-Rose, et al., 2003). Our results however are consistent with other published work reporting the absence of a direct effect between childhood SES and late-life cognitive function. A longitudinal cohort study of British civil servants suggested that the influence of childhood SES on cognitive function was mediated through adult measures of SES including occupation and income (Singh-Manoux, et al., 2005). Results from the British 1946 birth cohort reported that the effect of father's occupation on midlife cognitive function was mediated by educational attainment (Richards & Sacker, 2003).

Although our study did not find independent effects for parental education on cognitive function after accounting for their offspring's own educational achievement, this does not undermine the importance of childhood circumstances in shaping cognitive function. Childhood SES is suggested to contribute to children's cognitive development through the quality and quantity of parent-child interactions and verbalization. For example, a positive environment with a stimulating learning exposure results in better brain development due to increased neuronal branching, synaptic density and networking (Albert, 1995; Jacobs, Schall, & Scheibel, 1993). Similarly, the literature emphasizes the importance of intrauterine and early childhood nutritional status on cognitive development especially in developing countries where such deprivations are common (N. Clarke, et al., 1991; Fernald, et al., 2006; Paine, et al., 1992). Our results further suggest that the influence of childhood SES on cognitive function later in life is largely mediated by educational attainment, a marker for adolescence and early adulthood SES. While this supports a growing body of literature describing the unique and protective effect of education on cognition (Anstey & Christensen, 2000; Cagney & Lauderdale, 2002; Christensen et al., 2001; Hackman & Farah, 2009; Y. Stern et al., 1994); this does not mean that parental education does not have an effect on cognitive function but rather suggests that it shares the same pathway by which one's educational achievement affects cognition. These findings support a life-course explanation for the association between education and cognitive function in which it is possible that a better childhood SES environment triggers higher educational achievement and a motivation to more successful and stimulating opportunities throughout the life. These findings may also suggest that higher education may contribute in old age to 'brain reserve' or capacity through compensating strategies that help to maintain cognitive function later in life.

In the present study, higher participant's education was associated with better cognitive function. However, our findings showed that the association between participant's education and cognitive function was significantly different for the US-born compared to permanent residents of Mexico. In other word, with increased education, the cognitive benefit was more pronounced (steeper positive slope) among the US-born compared to permanent residents of Mexico (the significant participant's education-migration status interactions). For the remaining migration groups (US immigrants and return migrants), the cognitive benefit associated with increased education was less pronounced and showed similar slopes as the permanent residents of Mexico. Several interpretations present themselves. First, in addition to the differences in educational achievement between SALSA and MHAS participants, some of the cognitive differences observed between the four groups may possibly be attributed to the better quality of education in the US compared to Mexico. When it comes to health outcomes such as cognitive aging, researchers in the field argue that years of education and quality of education are both important but different predictors, especially in cross-cultural research (Glymour & Manly, 2008). Second, while immigrants to the US are usually a select group compared to their US-born counterparts in terms of health-related and psychosocial characteristics which are translated into better cognitive function later in life (Glymour & Manly, 2008); in SALSA, the average time since migration was 40 years. We assume that this passage of several decades is likely to have reduced the effect of migration selection. Third, while migration has been linked to better cognitive aging--partly because of the intellectual and cognitive demands associated with adjustment to a new environment-- it is possible that such benefits may have been buffered by migration-associated stressors (Glymour & Manly, 2008). Despite the predicted importance of education, migration history appears to be a more important predictor of cognition and the differences observed between the four groups were not fully explained by differences in education (parental or offspring). Existing literature exploring the association between education and cognitive function among Hispanics is very scarce. Results from the Asset and Health Dynamic among the oldest Old (AHEAD) study showed a ceiling effect of education on cognitive function after few years of schooling among Latinos (Cagney & Lauderdale, 2002). While the Latino participants of the AHEAD study were either US-born or foreign-born, the study did not have enough power to compare the two groups. More research is needed to confirm our results and attempt to understand the mechanisms underlying migration and cognitive aging.

Our findings from the present study showed that Mexican Americans have a greater prevalence of type-2 diabetes and stroke compared to Mexicans living in Mexico. Such health conditions were also found to be associated with worse cognitive functioning. It is possible that migration to the US results in a new cultural context that shapes risk factors for cognitive functioning through various pathways including behavioral or nutritional. Furthermore, while such risk factors may act in part as mediators on the pathway linking education and cognitive function, adjusting for them in the multivariate analyses only decreased the coefficient of participant's education by 25%. Thus, there remains a significant direct effect of education on cognitive function that is unexplained by these highly prevalent health conditions.

There are a few limitations to the conclusions of this study. First, the measures of parental education were reported by their offspring retrospectively possibly resulting in some recall bias. Second, SALSA and MHAS differ in their eligibility criteria and in their various assessments. In an attempt to address this concern, we included in all regression models a study term referring to the dataset or the migration status of the participant and cognitive test scores were standardized. Third, we were limited to using the delayed verbal recall test which is the only test in common between SALSA and MHAS and which consequently limited our ability to examine other cognitive domains. However, the delayed verbal recall test correlates highly with other tests of global cognitive function such as the Modified Mini Mental State Exam (3MSE) (Gonzalez, Mungas, Reed, Marshall, & Haan, 2001). In spite of these limitations, this is the first population-based study to examine the influence of migration on the association between life-course exposure to education and late-life cognitive function among older Mexicans and Mexican Americans. This study has also a major strength added by the large sample size offered by the two datasets, MHAS and SALSA.

Our results from this study showed an association between parental education and participant's cognitive function later in life and which was largely mediated by participant's educational achievement. Participant's migration history was found to have a modifying role on the association between participant's education and their cognitive function. With the growing Hispanic composition of the immigrant population to the U.S.("U.S. Department of Health and Human Services. The Office of Minority Health. Website Data Statistics: Hispanic/Latino Profile,"), further work exploring the interplay between lifetime exposure to education and migration on late-life cognitive function is warranted. Building on this work is important for understanding the underlying mechanisms of health disparities and for planning interventions targeted at reducing the associated health effects.

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REFERENCES

Albert MS. How does education affect cognitive function? Annals of Epidemiology. 1995; 5(1):76–78. [PubMed: 7728289]

Anstey K, Christensen H. Education, activity, health, blood pressure and apolipoprotein E as predictors of cognitive change in old age: a review. Gerontology. 2000; 46(3):163–177. [PubMed: 10754375]

Baron, RM.; Kenny, DA. The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations. [Research Support, U.S. Gov't, Non-P.H.S. 1986.

Journal of Personality and Social Psychology. 51(6):1173–1182. Research Support, U.S. Gov't, P.H.S.]. [PubMed: 3806354]

Ben-Shlomo Y, Kuh D. A life course approach to chronic disease epidemiology: conceptual models, empirical challenges and interdisciplinary perspectives. International Journal of Epidemiology. 2002; 31(2):285–293. [PubMed: 11980781]

Bradley RH, Corwyn RF, McAdoo HP, Coll CG. The home environments of children in the United States part I: variations by age, ethnicity, and poverty status. Child Development. 2001; 72(6): 1844–1867. [PubMed: 11768149]

Burke JP, Williams K, Haffner SM, Villalpando CG, Stern MP. Elevated incidence of type 2 diabetes in San Antonio, Texas, compared with that of Mexico City, Mexico. Diabetes Care. 2001; 24(9): 1573–1578. [PubMed: 11522701]

Cagney KA, Lauderdale DS. Education, wealth, and cognitive function in later life. The journals of Gerontology. Series B, Psychological Sciences and Social Sciences. 2002; 57(2):P163–172.

Christensen H, Hofer SM, Mackinnon AJ, Korten AE, Jorm AF, Henderson AS. Age is no kinder to the better educated: absence of an association investigated using latent growth techniques in a community sample. Psychological Medicine. 2001; 31(1):15–28. [PubMed: 11200953]

Clarke N, Grantham-McGregor SM, Powell C. Nutrition and health predictors of school failure in Jamaican children. Ecology of Food and Nutrition. 1991; 26:1–11.

Clarke P, O'Malley PM, Johnston LD, Schulenberg JE. Social disparities in BMI trajectories across adulthood by gender, race/ethnicity and lifetime socio-economic position: 1986-2004. International Journal of Epidemiology. 2009; 38(2):499–509. [PubMed: 18835869]

Colon-Lopez V, Haan MN, Aiello AE, Ghosh D. The effect of age at migration on cardiovascular mortality among elderly Mexican immigrants. Annals of Epidemiology. 2009; 19(1):8–14. [PubMed: 18922703]

Cravioto J, Delicardie ER, Birch HG. Nutrition, growth, and neuro-integrative development: an experimental and ecologic study. Pediatrics. 1966; 38(2):319–372.

Duncan GJ, Brooks-Gunn J, Klebanov PK. Economic deprivation and early childhood development. Child Development. 1994; 65(2 Spec No):296–318. [PubMed: 7516849]

Elias MF, Elias PK, D'Agostino RB, Silbershatz H, Wolf PA. Role of age, education, and gender on cognitive performance in the Framingham Heart Study: community-based norms. Experimental Aging Research. 1997; 23(3):201–235. [PubMed: 9248817]

Everson-Rose SA, Mendes de Leon CF, Bienias JL, Wilson RS, Evans DA. Early life conditions and cognitive functioning in later life. American Journal of Epidemiology. 2003; 158(11):1083–1089. [PubMed: 14630604]

Farmer ME, Kittner SJ, Rae DS, Bartko JJ, Regier DA. Education and change in cognitive function. The Epidemiologic Catchment Area Study. Annals of Epidemiology. 1995; 5(1):1–7.

Fernald LC, Neufeld LM, Barton LR, Schnaas L, Rivera J, Gertler PJ. Parallel deficits in linear growth and mental development in low-income Mexican infants in the second year of life. Public Health Nutrition. 2006; 9(2):178–186. [PubMed: 16571171]

Glymour MM, Manly JJ. Lifecourse social conditions and racial and ethnic patterns of cognitive aging. Neuropsychology Review. 2008; 18(3):223–254. [PubMed: 18815889]

Gonzalez HM, Mungas D, Reed BR, Marshall S, Haan MN. A new verbal learning and memory test for English-and Spanish-speaking older people. Journal of the International Neuropsychological Society. 2001; 7(5):544–555. [PubMed: 11459106]

Haan MN, Mungas DM, Gonzalez HM, Ortiz TA, Acharya A, Jagust WJ. Prevalence of dementia in older latinos: the influence of type 2 diabetes mellitus, stroke and genetic factors. [Research Support, U.S. Gov't, P.H.S.]. Journal of the American Geriatrics Society. 2003; 51(2):169–177. [PubMed: 12558712]

Haan MN, Zeki Al-Hazzouri A, Aiello AE. Life-span Socioeconomic Trajectory, Nativity, and Cognitive Aging in Mexican Americans: The Sacramento Area Latino Study on Aging. The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences. 2011; 66(Suppl 1):i102–i110.

Haan MN, Zeki Al Hazzouri A, Aiello AE. Life course socioeconomic trajectory, nativity and cognitive aging in Mexican Americans: the Sacramento Area Latino Study on Aging. The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences. (In Press).

Haas S, Rohlfsen L. Life course determinants of racial and ethnic disparities in functional health trajectories. Social Science & Medicine. 2010; 70(2):240–250. [PubMed: 19857917]

Hackman DA, Farah MJ. Socioeconomic status and the developing brain. Trends in Cognitive Sciences. 2009; 13(2):65–73. [PubMed: 19135405]

Harper S, Lynch J, Hsu WL, Everson SA, Hillemeier MM, Raghunathan TE, et al. Life course socioeconomic conditions and adult psychosocial functioning. International Journal of Epidemiology. 2002; 31(2):395–403. [PubMed: 11980802]

Jacobs B, Schall M, Scheibel AB. A quantitative dendritic analysis of Wernicke's area in humans. II. Gender, hemispheric, and environmental factors. The Journal of comparative neurology. 1993; 327(1):97–111.

Kaplan GA, Turrell G, Lynch JW, Everson SA, Helkala EL, Salonen JT. Childhood socioeconomic position and cognitive function in adulthood. International Journal of Epidemiology. 2001; 30(2): 256–263. [PubMed: 11369724]

Karlamangla AS, Miller-Martinez D, Aneshensel CS, Seeman TE, Wight RG, Chodosh J. Trajectories of cognitive function in late life in the United States: demographic and socioeconomic predictors. American Journal of Epidemiology. 2009; 170(3):331–342. [PubMed: 19605514]

Kok HS, Kuh D, Cooper R, van der Schouw YT, Grobbee DE, Wadsworth ME, et al. Cognitive function across the life course and the menopausal transition in a British birth cohort. Menopause. 2006; 13(1):19–27. [PubMed: 16607095]

Luo Y, Waite LJ. The impact of childhood and adult SES on physical, mental, and cognitive well-being in later life. The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences. 2005; 60(2):S93–S101.

Masel MC, Peek MK. Ethnic differences in cognitive function over time. Ann Epidemiol. 2009; 19(11):778–783. [PubMed: 19656690]

Paine P, Dorea JG, Pasquali L, Monteiro AM. Growth and cognition in Brazilian schoolchildren: a spontaneously occurring intervention study. International Journal of Behavioral Development. 1992; 15(2):169–183.

Raghunathan TE, Lepkowski JM, Van Hoewyk J, Solenberger P. A multivariate technique for multiply imputing missing values using a sequence of regression models. Survey Methodology. 2001; 27(1):83–95.

Raghunathan, TE.; Solenberger, PW.; Hoewyk, JV. IVEware: Imputation and Variance Estimation Software.

Richards M, Sacker A. Lifetime antecedents of cognitive reserve. Journal of Clinical and Experimental Neuropsychology. 2003; 25(5):614–624. [PubMed: 12815499]

Rubin DB. Inference and missing data. Biometrika. 1976; 63:581–590.

Rubin, DB. Multiple Imputation for Nonresponse in Surveys. John Wiley & Sons; New York: 1987.

SAS Institute. SAS statistical software, release 9.2. Cary, NC: 2005.

Schwartz BS, Glass TA, Bolla KI, Stewart WF, Glass G, Rasmussen M, et al. Disparities in cognitive functioning by race/ethnicity in the Baltimore Memory Study. Environmental Health Perspectives. 2004; 112(3):314–320. [PubMed: 14998746]

Singh-Manoux A, Richards M, Marmot M. Socioeconomic position across the lifecourse: how does it relate to cognitive function in mid-life? Annals of Epidemiology. 2005; 15(8):572–578. [PubMed: 16118001]

Stern MP, Gonzalez C, Mitchell BD, Villalpando E, Haffner SM, Hazuda HP. Genetic and environmental determinants of type II diabetes in Mexico City and San Antonio. Diabetes. 1992; 41(4):484–492. [PubMed: 1607073]

Stern Y, Gurland B, Tatemichi TK, Tang MX, Wilder D, Mayeux R. Influence of education and occupation on the incidence of Alzheimer's disease. Journal of the American Medical Association. 1994; 271(13):1004–1010. [PubMed: 8139057]

Turrell G, Lynch JW, Kaplan GA, Everson SA, Helkala EL, Kauhanen J, et al. Socioeconomic position across the lifecourse and cognitive function in late middle age. The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences. 2002; 57(1):S43–51.

U.S. Department of Health and Human Services. [Retrieved January 12, 2010] The Office of Minority Health. Website Data Statistics: Hispanic/Latino Profile. from http://www.omhrc.gov/templates/browse.aspx?lvl=1&lvlID=7

Wilson RS, Scherr PA, Hoganson G, Bienias JL, Evans DA, Bennett DA. Early life socioeconomic status and late life risk of Alzheimer's disease. Neuroepidemiology. 2005; 25(1):8–14. [PubMed: 15855799]

Wong R, Diaz JJ. Health care utilization among older Mexicans: health and socioeconomic inequalities. Salud Publica de Mexico. 2007; 49(Suppl 4):S505–514. [PubMed: 17724524]

Wong R, Pelaez M, Palloni A, Markides K. Survey data for the study of aging in Latin America and the Caribbean: selected studies. Journal of Aging and Health. 2006; 18(2):157–179. [PubMed: 16614339]

Zsembik BA, Peek MK. Race differences in cognitive functioning among older adults. The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences. 2001; 56(5):S266–274.

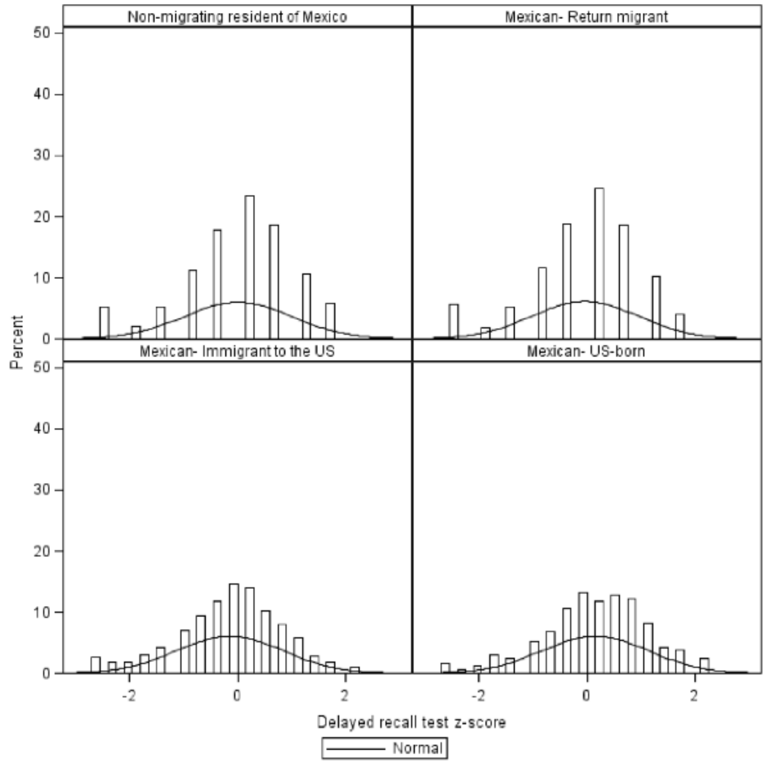

Figure 1.
Distribution of cognitive z-scores by migration status

Table 1

Baseline characteristics of the study population, by study and migration status

			MHAS			SALSA		
		Overall	**Mexican**	**Mexican-Return Migrant**	**P value[a]**	**Mexican-Immigrant to the US**	**Mexican-US-born**	**p-value[b]**
	N	**N=7042**	**n=4687**	**n=562**		**n=908**	**n=871**	
Participant's characteristics								
Gender (%men)	2966	42.1	37.8	79.9	<0.0001	39.7	43.4	0.11
Age in years	7042	70.6±7.7	70.5±8.0	71.3±7.7	0.04	71.2±7.7	70.1±6.4	<0.01
Education in years	7021	4.4±4.6	3.5±3.9	3.5±4.0	0.73	5.0±4.7	9.6±4.9	<0.0001
Smoking (%)					<0.0001			0.03
Never	3744	53.3	58.7	31.4		48.9	43.2	
Former	2289	32.6	27.5	43.7		39.6	45.5	
Current	990	14.1	13.8	25.0		11.5	11.4	
Alcohol (%ever)	3981	56.8	55.9	75.7	<0.0001	48.8	57.8	<0.01
Cognitive z-score	6257	0.0±1.0	0.01±1.00	−0.04±0.98	0.32	−0.14±0.99	0.15±0.99	<0.0001
Diabetes (%yes)	1393	20.2	17.6	15.2	0.17	24.6	32.7	<0.01
Stroke (%yes)	351	5.1	3.4	4.9	0.09	7.2	11.8	<0.01
Heart attack (%yes)	374	5.4	4.2	4.9	0.44	7.5	9.9	0.08
Hypertension (%yes)	3007	43.8	43.3	39.1	0.06	44.2	49.0	0.04
Medical insurance (%yes)	4815	68.6	61.8	55.2	<0.01	84.2	97.5	<0.0001
Occupation (%Manual)	5479	78.3	77.9	79.7	0.36	88.3	68.9	<0.0001
Household income (%)					0.02			<0.0001
Low	3418	48.9	50.8	46.3		59.3	29.9	
Medium	1723	24.7	19.3	18.0		35.6	46.8	
High	1843	26.4	29.9	35.8		5.1	23.3	
Parents' characteristics								
Father's education					0.60			0.52
None	3159	53.3	55.5	57.4		49.4	50.4	
Some elementary	1604	27.1	30.0	27.0		27.6	25.2	

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			MHAS			SALSA		
		Overall	**Mexican**	**Mexican-Return Migrant**	**P value[a]**	**Mexican-Immigrant to the US**	**Mexican-US-born**	**p-value[b]**
	N	**N=7042**	**n=4687**	**n=562**		**n=908**	**n=871**	
Completed elementary	504	8.5	8.4	9.3		8.8	8.2	
More than elementary	662	11.2	6.1	6.3		14.3	16.2	
Mother's education					0.07			<0.0001
None	3625	60.2	63.1	63.2		55.9	49.0	
Some elementary	1504	25.0	26.1	24.7		26.0	25.6	
Completed elementary	496	8.2	8.1	7.2		10.1	9.9	
More than elementary	399	6.6	2.7	4.9		8.0	15.5	

[a] *p*-value comparing within MHAS;

[b] *P*-value comparing within salsa;

Data are presented as mean ± SD

Table 2

Results from linear regression models for the Bivariate associations between parental education and the offspring's cognitive z-scores, by study and migration status

	MHAS		SALSA	
	Mexican	**Mexican-Return Migrant**	**Mexican-Immigrant to the US**	**Mexican-US born**
	n=4687	**n=562**	**n=908**	**n=871**
	B (SE)	**B (SE)**	**B (SE)**	**B (SE)**
Father's education (REF=none)				
Some elementary	0.24 (0.04) *	0.002 (0.11)	0.10 (0.10)	0.13 (0.11)
Completed elementary	0.32 (0.06) *	0.19 (0.17)	0.21 (0.13)	0.17 (0.17)
More than elementary	0.43 (0.07) *	0.41 (0.20) *	0.05 (0.11)	0.14 (0.15)
Mother's education (REF=none)				
Some elementary	0.22 (0.04) *	0.27 (0.11) *	0.21 (0.11)	0.18 (0.13)
Completed elementary	0.34 (0.06) *	0.17 (0.18)	0.26 (0.11) *	0.32 (0.15)
More than elementary	0.41 (0.10) *	0.85 (0.22) *	0.02 (0.12)	0.34 (0.11) *

* p-value<0.05

Table 3

Multivariate Linear regression models for the association between mother's education and the offspring's cognitive z-scores

	Model 1	Model 2	Model 3	Model 4	Model 5
Independent variable	**B (SE)**	**B (SE)**	**B (SE)**	**B (SE)**	**B (SE)**
Intercept	2.52 (0.12) *	2.14 (0.12) *	2.15 (0.13) *	2.14 (0.12) *	2.17 (0.13) *
Mother's education					
None (REF)					
Some elementary	0.15 (0.03) *	0.05 (0.04)	0.05 (0.04)	0.06 (0.04)	0.06 (0.04)
Completed elementary	0.26 (0.05) *	0.07 (0.05)	0.07 (0.05)	0.09 (0.05)	0.08 (0.05)
Study (SALSA vs. MHAS)	0.01 (0.03)	−0.13 (0.03) *			
Age (in years)	−0.04 (0.002) *	−0.04 (0.002) *	−0.03 (0.002) *	−0.04 (0.002) *	−0.03 (0.002) *
Gender (females vs. males)	0.26 (0.03) *	0.29 (0.02) *	0.32 (0.03) *	0.30 (0.03) *	0.32 (0.03) *
Participant's education (in years)		0.04 (0.003) *	0.03 (0.004) *	0.04 (0.004) *	0.03 (0.005) *
Migration status					
Non-migrating resident of Mexico (REF)					
Mexican-Return migrant			0.13 (0.05) *	0.13 (0.07) *	0.13 (0.07) *
Mexican-Immigrant to the US			−0.09 (0.04) *	−0.16 (0.05) *	−0.13 (0.05) *
Mexican-US born			−0.01 (0.04)	−0.23 (0.07) *	−0.15 (0.08) *
Interaction terms					
Participant's education x Mx-RM				−0.003 (0.01)	0.0003 (0.01)
Participant's education x Mx-Img				0.01 (0.01)	0.01 (0.01)
Participant's education x Mx-US born				0.02 (0.01) *	0.02 (0.01) *
Health variables					
Diabetes (yes vs. no)			−0.12 (0.03) *		−0.12 (0.03) *
Stroke (yes vs. no)			−0.30 (0.06) *		−0.29 (0.06) *
Heart attack (yes vs. no)			0.06 (0.06)		0.06 (0.06)
Hypertension (yes vs. no)			−0.04 (0.03)		−0.04 (0.03)

	Model 1	Model 2	Model 3	Model 4	Model 5
Independent variable	**B (SE)**	**B (SE)**	**B (SE)**	**B (SE)**	**B (SE)**
Medical insurance (yes vs. no)			0.06 (0.03)		0.07 (0.03) *
Occupation					
Manual			−0.05 (0.03)		−0.06 (0.03)
Non-manual (REF)					
Household income					
Low			−0.09 (0.03) *		−0.09 (0.03) *
Medium			−0.04 (0.04)		−0.05 (0.04)
High (REF)					

* p-value <0.05

Table 4

Multivariate Linear Regression models for the association between father's education and the offspring's cognitive z-scores

	Model 1	Model 2	Model 3	Model 4	Model 5
Independent variable	**B (SE)**	**B (SE)**	**B (SE)**	**B (SE)**	**B (SE)**
Intercept	2.61 (0.12) *	2.20 (0.12) *	2.22 (0.13) *	2.20 (0.13) *	2.23 (0.13) *
Father's education					
None (REF)					
Some elementary	0.13 (0.03) *	0.04 (0.03)	0.04 (0.03)	0.05 (0.03)	0.05 (0.03)
Completed elementary	0.21 (0.05) *	0.04 (0.05)	0.02 (0.05)	0.06 (0.05)	0.04 (0.05)
More than elementary	0.23 (0.05) *	0.03 (0.06)	0.04 (0.06)	0.05 (0.06)	0.05 (0.06)
Study (SALSA vs. MHAS)	0.02 (0.03)	−0.12 (0.03) *			
Age (in years)	−0.04 (0.002) *	−0.04 (0.002) *	−0.04 (0.002) *	−0.04 (0.002) *	−0.04 (0.002) *
Gender (females vs. males)	0.26 (0.03) *	0.29 (0.02) *	0.33 (0.03) *	0.30 (0.03) *	0.33 (0.03) *
Participant's education (in years)		0.04 (0.003) *	0.03 (0.004) *	0.04 (0.004) *	0.03 (0.005) *
Migration status					
Non-migrating resident of Mexico (REF)					
Mexican-Return migrant			0.13 (0.05) *	0.14 (0.07) *	0.14 (0.07) *
Mexican-Immigrant to the US			−0.08 (0.04) *	−0.16 (0.05) *	−0.13 (0.05) *
Mexican-US born			0.0004 (0.04)	−0.22 (0.07) *	−0.14 (0.08)
Interaction terms					
Participant's education x Mx-RM				−0.01 (0.01)	−0.003 (0.01)
Participant's education x Mx-Img				0.01 (0.01)	0.01 (0.01)
Participant's education x Mx-US born				0.02 (0.01) *	0.02 (0.01) *
Health variables					
Diabetes (yes vs. no)			−0.13 (0.03) *		−0.13 (0.03) *
Stroke (yes vs. no)			−0.29 (0.06) *		−0.29 (0.06) *
Heart attack (yes vs. no)			0.06 (0.06)		0.06 (0.06)

	Model 1	Model 2	Model 3	Model 4	Model 5
Independent variable	**B (SE)**	**B (SE)**	**B (SE)**	**B (SE)**	**B (SE)**
Hypertension (yes vs. no)			−0.03 (0.03)		−0.03 (0.03)
Medical insurance (yes vs. no)			0.05 (0.03)		0.06 (0.03)
Occupation					
Manual			−0.06 (0.03)		−0.06 (0.03)
Non-manual (REF)					
Household income					
Low			−0.09 (0.04)*		−0.09 (0.04)*
Medium			−0.05 (0.04)		−0.05 (0.04)
High (REF)					

* p-value <0.05