Published in final edited form as:

Ann Epidemiol. 2009 November ; 19(11): 778–783. doi:10.1016/j.annepidem.2009.06.008.

Ethnic differences in cognitive function over time

Meredith C. Masel, PhD*

School of Health Professions University of Texas Medical Branch at Galveston

Department of Rehabilitation Sciences, University of Texas Medical Branch, Galveston, TX

M. Kristen Peek, PhD

Preventive Medicine & Community Health University of Texas Medical Branch at Galveston

Department of Sociomedical Sciences, University of Texas Medical Branch, Galveston, TX

Abstract

Minority group membership in old age has been implicated as a risk factor for lower scores on cognitive function tests, independent of education level. In addition, differential rates of cognitive decline by ethnic group have been identified in several epidemiologic studies. However, others have not been able to detect differences.

METHODS: In order to determine if health disparities in cognitive function scores extend to rates of decline, the current research examined rates of change in memory and mental status over the course of 9 years (1996–2004) in a nationally representative sample of late middle aged and older white, black, and Hispanic adults who were part of the nationally representative Health and Retirement Study. Change in cognitive function was measured by separate indices of memory and mental status items and analyzed with multivariable mixed modeling.

RESULTS: Results indicated that, after controlling for demographic, social, and health-related variables, ethnicity was associated with cognitive function scores across waves ($P < 0.01$), but did not greatly impact rates of decline. Furthermore, although education was associated with cognitive function scores across waves ($P < 0.01$), education level did not impact decline rates.

Keywords

Middle Aged; Aged; Ethnic Groups; Cognitive Function

Research has consistently shown that minority status is a risk factor for poorer cognitive function in older age (1–3), however, it is still unclear as to whether these disparities extend to rates of decline. Several studies have produced mixed results including no differences in rate of change by ethnicity (4) and disparities in decline rates that are inconsistent by minority group (5,6). Furthermore, most longitudinal research conducted focused only on older adults (65+ at baseline) making it difficult to draw comparisons between groups that have increasingly different health profiles with age (7). Efforts to explain any disparities found often point to educational differences as a primary source (3,8), however in longitudinal studies, there have

© 2009 Elsevier Inc. All rights reserved.

*Corresponding Author.

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Conflict of Interest:

The authors have no conflicts of interest to disclose

also been inconsistent results about whether or not education is associated with differential rates of decline (5,9). Consequently, it is still uncertain whether or not ethnic disparities exist in the slope of decline in cognitive function, or whether education, though associated strongly with cognitive function scores, impacts the slope of decline.

In order to clarify the vague findings about the associations between ethnicity and education on rates of cognitive decline, data from the longitudinal Health and Retirement Study, a nationally representative sample of late middle aged adults (1996-2004), were analyzed. Data were collected every two years on measures of cognitive function that included both memory and mental status. Both contributions of ethnic group and education to rates of cognitive decline were explored.

MATERIALS AND METHODS

The Health and Retirement Study

The data used for this research was from the Health and Retirement Study. Data collection began in 1992 with a nationally representative sample of US adults aged 51 and older that included oversamples of Florida residents and black and Hispanic participants (n=12,654) (10). To provide researchers with an overview of aging in America from late middle age and on, respondents were asked about their health status, insurance coverage, financial status, family systems, work status, and retirement plans. Respondents were surveyed every two years to record changes in their health, financial status, and social variables in order for researchers to determine predictors of a variety of health and retirement outcomes(10).

Due to measurement consistency issues (described in the next section), the current study analyzes non-proxy responses from survey years 1996-2004 (n=10,427). The sample size was further reduced to those who identified themselves as non-Hispanic white, non-Hispanic black, or Hispanic (n=10,218) and who were 51-61 at baseline in 1992 (n=7,831), and. Those who responded by proxy were excluded from the analyses because they were unable to respond to the cognitive function outcome measures.

Measurement of cognitive function

Two assessment tools utilized by trained interviewers were employed as measures of cognitive function - items from the Telephone Interview of Cognitive Status, representing “mental status,” and word recall items, representing “memory.” Memory items were asked of participants beginning in 1992, and mental status items were added in 1996. However, word recall questions were not a consistent length (10 words) until 1996 and beyond. Furthermore, in 1998 mental status questions were asked only of those over the age of 65 or new study participants. Therefore, due to consistency of measurements for memory, data from 1996 and beyond were used, and only those who were 63-66 in 1996 were evaluated longitudinally for mental status items. Consequently, the sample size for the memory analysis was (n=7944) and for the mental status analysis, the sample size was (n=1916).

The mental status questions in the Health and Retirement Study, and those used for the current project, were derived from the Telephone Interview of Cognitive Status (11) and were comprised of a backwards count of at least 10 numbers beginning at the number 20 (attention/calculation), the current day, month, year, and day of the week (orientation), naming of objects described (scissors and cactus) (language), and naming the current President and Vice President of the United States (orientation) (12). Health and Retirement Study administrators created a mental status summary score ranging from 0-10 that included orientation to time and date, counting backwards, object naming, and president and vice president naming. However, the results of a principal components analysis showed that the items did not load on a single factor.

Subsequently, the mental status score should be interpreted as a count of mental status indicators.

Immediate and delayed recall tests were used to assess memory. Each wave, respondents were read a list of 10 words (distinct from the previous wave) and asked to recall as many as possible. Five minutes later, after going through several other survey questions, they were asked to recall words from the list. The responses led to a possible total memory score of 0-20. Principal components analysis with no rotation was used to examine whether the immediate and delayed recall questions were independent measures of cognitive function. Using principal components analysis, the measures were found to be strongly associated and produced a single factor solution. Reliability analyses produced a Cronbach's coefficient alpha of 0.86. Therefore, the immediate and delayed items were converted into a factor score and standardized (range -2.53-5.33) for use in the analyses.

Measurement of demographic, socioeconomic and health related variables

At baseline, participants' age, sex (1=female, 0=male), and ethnicity were collected, and marital status in 1996 was categorized as married (1) or not married (0). Education was measured as the number of years of school a participant reported completing. This measure was used as both a continuous and categorical (<8 years, 8-11 years, 12 years, ≥ 13 years) in the models. Household income in 1996 was comprised of respondents' earnings, unemployment and Workers' Compensation, pensions and annuities, Social Security Income and welfare, capital income, disability income, other income received by the respondents, and income of other household members. Income was divided into quartiles. Missing information on participants' age, income and education were previously imputed by HRS administrators. Respondents were also asked if they worked for pay that year, and work status was accounted for as a dichotomous variable.

Health related variables included body mass index calculated from self-reported height and weight, participation in vigorous activity 3 or more times per week or not (1=yes, 0=no), and self-report (1=yes, 0=no) of doctor diagnosis of heart disease, stroke, diabetes, or hypertension.

Statistical analyses

All analyses were completed using Statistical Analysis Software (SAS) 9.1.3 analytical software (13). Baseline (1996) descriptive statistics were presented by ethnic group and differences among groups were detected with analysis of variance and chi square tests. Multivariable mixed models and logistic regressions were used to determine if the rates of change of cognitive function scores differed by ethnic group or education level. Regression diagnostics included examining the linear relationships between the outcome and predictor variables, plotting model residuals to examine normality, and monitoring of the model fit statistics during model building. Model assumptions were met.

Multivariable mixed models were carried out using the PROC MIXED procedure using SAS software. The purposes of using the MIXED procedure were two-fold. First, the MIXED procedure employs a maximum likelihood feature that accommodates the missing data due to attrition that occurs in longitudinal samples. In other words, participants with missing data, or who are lost in future waves, can still contribute to the model results. Second, the MIXED procedure allows for observation of how measures covary over time. The models allow the observation of longitudinal correlations within study participants. In addition, each model included the aforementioned dependent and independent variables as well as time interaction terms. The time interaction terms provided data points for mean cognitive function scores by ethnicity and education at each time in the presence of the model covariates. The mixed models

were protected from inflation of Type I error due to repeated measures by using the Tukey posthoc test. A p-value of 0.05 was used as the measure of statistical significance.

The following is an example of a model used to examine the longitudinal relationships between race/ethnicity, cognitive function:

$$Y_c = \text{time} + \text{race/ethnicity} + \text{physical activity} + \text{sociodemographic variables} + \text{health-related variables} + \text{race/ethnicity} * \text{time} + \text{education} * \text{time} + \text{error}.$$

In order to further confirm the findings, logistic regression analyses were performed. Odds ratios for memory and mental status decline by one standard deviation over the course of the study period were calculated.

RESULTS

Table 1 shows baseline characteristics of the sample by ethnicity. The sample consisted of 5918 (74%) white, 1324 (17%) black, and 702 (9%) Hispanic participants. The participants differed significantly by ethnicity with regard to age, gender, income, education level, working for pay, chronic illnesses, body mass index, physical activity, and measures of cognitive function. Specifically, white participants appeared to have higher scores on both cognitive function measures than both black and Hispanic participants.

Table 2 presents the results of multivariable mixed models of the relationships among ethnicity, education, and memory score. In the study sample, the memory score declined an average of 0.01 units every other year of the survey (Model 1). After adjusting for age, ethnicity, sex, income, work status, chronic illnesses, body mass index, and physical activity, education level was positively associated with memory score ($P < 0.0001$), but the interactions of time with education were not significant. A further exploration of interaction effects with time to determine if certain thresholds of education were associated with differential rates of memory decline revealed similar results. Using the education categories from previous cross-sectional analyses (<8 years, 8-11 years, 12 years, 13 or more years), the results remained unchanged. However, after comparing mean memory test scores by education level (adjusted for model covariates), mean memory scores for those with greater than 12 years of education were significantly higher than those with less than 12 years of education. Thus, the interaction term between time and less than or greater than 12 years of education was examined, but the results remained unchanged.

Also in the cross-sectional results presented in Table 2, being black or being Hispanic was associated with lower memory scores ($P < 0.0001$ and $p = 0.04$, respectively). When interacted with time, however, being Hispanic was not related to cognitive change. Being black appeared to be negatively related to cognitive change ($p = 0.0001$), indicating that the disparity in memory score between white and black participants worsened slightly over time.

Table 3 includes results of the associations of time, education, and ethnicity in mixed model analyses of mental status over the course of the study waves. Overall, there was a decrease in mental status score over the study waves. In addition, higher education was associated with higher mental status scores ($P < 0.0001$). Being black and being Hispanic was associated with lower mental status scores than being white ($P < 0.0001$). When interacted with time, however, a different picture emerged.

The slope in mental status score change over time indicated that education was negatively related to cognitive change ($P < 0.0001$). In addition, being black was not related with the slope

of mental status change over time, but being Hispanic was linked with an increasing negative disparity in scores from white participants ($P < 0.005$).

The puzzling finding that education level was associated with negative change in mental status scores was explored in greater detail. First, mean change in mental status scores by each level of education at each study wave was examined. In general, mental status scores decreased, but increased in 2004. So, although the overall trend was a decrease in score, the score improvement in the last wave skewed the results. In addition, less than 4 percent of the sample had 0-4 years of education, and those respondents' scores were some that changed the most dramatically over time. These respondents' scores coupled with an average increase in mental status score for the whole sample in 2004 skew the results considerably and will be addressed further in the discussion section.

In an effort to further investigate these areas of confusion, additional analyses were carried out. Multinomial logistic regressions examined the odds of decline in memory and mental status score by one standard deviation between 1996 and 2004. Results are shown in Tables 4 and 5. With the exception of education and memory change, ethnicity and education do not appear to be factors that are associated with greater odds of a decline in memory or mental status. According to the models, each year of education is slightly protective of decline in memory score (Odds Ratio (95% CI). 0.97 (0.937, 0.997)).

DISCUSSION

The purpose of the current analyses was to determine if there were differences in cognitive decline by ethnicity or education level. Results indicated that lower levels of education, being black, or being Hispanic was associated with lower memory and mental status scores throughout the course of the study, though no variables of interest were consistently associated with differential rates of change.

The results of these analyses are somewhat consistent with previous research. With regard to education, though consistently related to cognitive function in cross sectional studies, research about its effect on decline has produced mixed results. In the National Institute of Mental Health Epidemiologic Catchment Area Study, almost 15,000 people were assessed with the Mini Mental State Examination⁹. In those younger than 65 and older than 65, education level was protective against decline in Mini Mental State Examination score for those who started with scores higher than the Mini Mental State Examination cutoff of 239. However, the follow-up time was only one year, and for those with scores of 23 or less, decline was not affected by years of education⁹. In a follow-up study, using only the Baltimore participants from the Epidemiologic Catchment Area Study, researchers found that an educational threshold of 8 years was an important predictor of decline in Mini Mental State Examination scores¹⁴. Those who had less than 8 years of education had greater rates of decline than those with 9 or more¹⁴.

The conflicting results have presented a challenge to researchers, and most recently, researchers using the Asset and Health Dynamics of the Oldest Old (AHEAD) data attempted to determine if education affected decline⁵. Researchers divided the cognitive items into four measures: immediate recall, delayed recall, mental status items, and the serial 7 subtraction test. They found that higher education was associated with more rapid decline on the delayed recall measure, but a slower rate of decline on the mental status measure⁵. The results of this and other studies imply that education may not protect against decline in cognitive function as a whole, but that it may have differential effects of decline by cognitive domain.

In the current study, the lack of effect of education on memory change may have been due to the minimal variation in scores over time. After future waves of the Health and Retirement

Study are collected and coded, more research should be conducted to continue to explore these issues. The appearance of a negative effect of education on change in mental status score is likely due to the study limitation that average mental status score increases in 2004. The increase in scores, having been addressed elsewhere, may be due to practice effects^{1,12}. In addition, because of the 2004 presidential election, respondents may have been more cognizant of the names of the president and vice president. A greater proportion of the respondents correctly answered those questions in 2004 than in 2002.

The longitudinal results by ethnicity are not consistent with recent research from the AHEAD data that black adults had slower rates of memory decline than white adults⁵. This may be due to the different age groups studied (late middle age vs. older). It is somewhat consistent with the findings from the Women's Health and Aging Study that there were no differences in rates of decline in Mini Mental State Examination score by race/ethnicity⁴. However, inconsistencies between the Health and Retirement Study and the Women's Health and Aging Study include the study sample (all female versus coed), and the outcome measures used. Our finding, that there was a slight hastening of memory score decline in black respondents as compared to white respondents must be further validated with future waves.

In addition, the finding that there were no differences between white and Hispanic participants' rates of change in mental status was inconsistent with Alley and colleagues who found that Hispanic participants declined at a faster rate than white on the mental status measures in the AHEAD⁵. Because the age of the participants in the current analyses (63+) were almost 10 years lower than those in the AHEAD (70+), it is possible that the AHEAD data showed greater variance in change than the Health and Retirement Study, and were able to detect differences by race/ethnicity.

The lack of protective effects of education on rates of decline in memory or mental status scores may be due to several factors. First, the unexpected improvement in mental status score prevented a thorough study of decline. Secondly, the very small decline that occurred in the memory scores may have prohibited the observation of protective effects of education. Finally, it is possible that education is simply associated with differential scores over time, but that it does not impact the rates of decline.

In addition to these limitations, it is important to note that those with missing data on the mental status test were more likely to be Hispanic than other participants (OR=1.11 $p<0.0001$). This may be indicative of an underlying ethnic bias that was not controlled for by asking the questions in Spanish. In the future, researchers should always separate the memory from the mental status items. Furthermore, another study limitation is the nature of the outcome variables to be subject to a substantial ceiling effect whereby they may underestimate cognitive function. In future research, emphasis should be placed on more sensitive measures of cognitive function such as clinician diagnoses.

On the whole, the results may indicate that beginning in late middle age, disparities over time in cognitive scores are present, and change over time varies little by race/ethnicity. Future Health and Retirement Study research should continue to observe this trend and document changes over the next several waves.

ACKNOWLEDGMENTS

FUNDING

This work was supported by the National Institutes of Health/National Institute on Aging T32 AG00270

Financial Support:

Research was supported by Health of Older Minorities NIH/NIA T32 AG00270

Special Thanks:

The authors thank Drs. Frederic Wolinsky, Sue Weller, Laura Rudkin, and Mukaila Raji for their contributions to this study

Reference List

1. Rodgers W, Ofstedal M, Herzog A. Trends in Scores on Tests of Cognitive Ability in the Elderly U.S. Population, 1993–2000. *J Gerontol B Psychol Sci Soc Sci* 2003;58B(6):S338–S346. [PubMed: 14614121]
2. Schwartz B, Glass T, Bolla K, et al. Disparities in cognitive functioning by race/ethnicity in the Baltimore Memory Study. *Environ Health Persp* 2004;112(3):314–20.
3. Zsembik BA, Peek MK. Race Differences in Cognitive Functioning Among Older Adults. *J Gerontol B Psychol Sci Soc Sci* 2001;56(5):S266–S274. [PubMed: 11522808]
4. Atkinson HH, Cesari M, Kritchevsky SB, et al. Predictors of Combined Cognitive and Physical Decline. *JAGS* 2005;53(7):1197–202.
5. Alley D, Suthers K, Crimmins E. Education and Cognitive Decline in Older Americans: Results From the AHEAD Sample. *Res Aging* 2007;29(1):73–94.
6. Sloan FA, Wang J. Disparities Among Older Adults in Measures of Cognitive Function by Race or Ethnicity. *J Gerontol B Psychol Sci Soc Sci* 2005;60(5):242–50.
7. Grove, R.; Hetzel, A. Vital statistics rates in the United States, 1940–1960. US Government Printing Office; Washington, D.C.: 1968.
8. Albert M, Jones K, Savage C, et al. Predictors of Cognitive Change in Older Persons: MacArthur Studies of Successful Aging. *Psychol and Aging* 1995;10(4):578–89.
9. Farmer ME, Kittner SJ, Rae DS, Bartko JJ, Regier DA. Education and change in cognitive function : The Epidemiologic Catchment Area Study. *Ann Epidemiol* 1995;5(1):1–7. [PubMed: 7728280]
10. Juster FT, Suzman R. An Overview of the Health and Retirement Study. *J Hum Resour* 1995;30:S7–S56.
11. Brandt J, Spencer M, Folstein M. The Telephone Interview for Cognitive Status. *Neuropsychiatry Neuropsychol Behav Neurol* 1988;1:111–7.
12. Ofstedal, M.; Fisher, G.; Herzog, A. Documentation of cognitive functioning measures in the Health and Retirement Study. Survey Research Center, University of Michigan; Ann Arbor, MI: 2005. Report No.: DR-006
13. SAS Software. Version 9.1.3. SAS Institute Inc.; Cary, N.C.: 2008.
14. Lyketsos CG, Chen LS, Anthony JC. Cognitive Decline in Adulthood: An 11.5-Year Follow-Up of the Baltimore Epidemiologic Catchment Area Study. *Am J Psychiatry* 1999;156(1):58–65. [PubMed: 9892298]

TABLE 1

Baseline Descriptive Statistics by Ethnic Group for Participants in the Health and Retirement Study (1996) (n=7831)

		White	Black	Hispanic
		n=5918	n=1324	n=702
μ (SD)	Age *	60 (3.15)	60 (3.13)	59 (3.11)
%	Male *	45	38	41
%	Married *	81	56	74
%	HH Income Q1	18	41	51
%	HH Income Q2 *	25	26	27
%	HH Income Q3	28	19	13
%	HH Income Q4 *	29	14	11
Education				
	% ≤ 8 years *	6	17	50
	% 8-11 years *	14	25	15
	% 12 years *	39	31	17
	% 13+ years *	41	26	18
%	Working *	55	49	47
%	Stroke *	4	7	3
%	Heart *	17	18	12
%	Diabetes *	11	23	19
%	Hypertension *	40	64	44
BMI				
	% Underweight	1	1	1
	% Normal Weight *	37	22	26
	% Overweight	41	40	43
	% Obese *	21	37	29
%	Vigorous Activity ≥3x/week *	53	43	42
μ (SD)	Memory (0-20) *	11.5 (3.31)	9.9 (3.70)	9.7 (3.45)
μ (SD)	Mental Status (0-10) *	9.5 (0.80)	8.7 (1.48)	8.7 (1.37)

* Significantly different by race/ethnicity at p<0.05 (ANOVA for Age, Memory, and Mental Status; Chi square and Likelihood Ratio tests for other variables)

TABLE 2
Results of Mixed-Effects Models of the Relationship Between Ethnic Group and Memory Score Among Late Middle Aged and Older Adults in the Health and Retirement Study (1996-2004) (n=7831).

	Model 1				Model 2			
	Estimate	SE	t	p	Estimate	SE	t	p
Time	-0.01	0.003	-3.94	<.0001	-0.01	0.01	-0.55	0.58
Education	0.10	0.003	32.46	<.0001	0.10	0.003	28.05	<.0001
Hispanic	-0.06	0.03	-2.1	0.04	-0.04	0.04	-1.11	0.27
Black	-0.31	0.02	-13.98	<.0001	-0.26	0.026	-10	<.0001
Education × Time					0.0002	0.001	0.17	0.87
Hispanic × Time					-0.01	0.01	-1.25	0.21
Black × Time					-0.03	0.01	-3.87	0.0001

* All models adjust for age, sex, education, household income, marital status, work status, body mass index, physical activity, stroke, diabetes, heart disease, and hypertension

TABLE 3
Results of Mixed-Effects Models of the Relationship Between Ethnic Group and Mental Status Score Among Late Middle Aged and Older Adults in the Health and Retirement Study (1996-2004) (n=1916).

	Model 1				Model 2			
	Estimate	SE	t	p	Estimate	SE	t	p
Time	-0.43	0.01	-43.43	<.0001	-0.18	0.05	-3.97	<.0001
Education	0.08	0.005	16.97	<.0001	0.12	0.01	14.45	<.0001
Hispanic	-0.27	0.05	-5.27	<.0001	-0.06	0.09	-0.67	0.50
Black	-0.53	0.04	-14.12	<.0001	-0.45	0.07	-6.91	<.0001
Education × Time					-0.02	0.003	-5.57	<.0001
Hispanic × Time					-0.11	0.04	-2.83	0.005
Black × Time					-0.04	0.03	-1.52	0.13

* All models adjust for age, sex, education, household income, marital status, work status, body mass index, physical activity, stroke, diabetes, heart disease, and hypertension

Table 4
Odds Ratios for Cognitive Decline by Ethnic Group Among Late Middle Aged and Older Adults in the Health and Retirement Study (1996-2004).

Cognitive Function Score	Race/Ethnicity					
	White		Black		Hispanic	
	No.	No.	OR	95% CI	OR	95% CI
Memory						
No. decline by 1 SD	529	108			53	
Adjusted* OR (95% CI)	1.0		1.04	(0.82,1.32)	0.82	(0.59,1.11)
Mental Status						
No. decline by 1 SD	737	201			108	
Adjusted* OR (95% CI)	1.0		1.36	(0.94,1.96)	1.11	(0.67,1.86)

* All models adjust for age, sex, education, household income, marital status, work status, body mass index, physical activity, stroke, diabetes, heart disease, and hypertension

Table 5

Odds Ratios for Cognitive Decline by Education (Years of Schooling) Among Late Middle Aged and Older Adults in the Health and Retirement Study (1996-2004).

Cognitive Function Score	Education (per 1 year)		
	No.	OR	95% CI
Memory			
No. decline by 1 SD	690		
Adjusted* OR (95% CI)		0.97	(0.937,0.997)
Mental Status			
No. decline by 1 SD	1046		
Adjusted* OR (95% CI)		0.96	(0.915,1.004)

* All models adjust for age, sex, education, household income, marital status, work status, body mass index, physical activity, stroke, diabetes, heart disease, and hypertension