Published in final edited form as:

J Alzheimers Dis. 2013 January 1; 34(3): 701–706. doi:10.3233/JAD-122071.

The Link between C-Reactive Protein and Alzheimer's Disease Among Mexican Americans

Sid E. O'Bryant, Ph.D.^{a,b}, Leigh Johnson, Ph.D.^{a,b}, Melissa Edwards, M.A.^{a,c}, Holly Soares, Ph.D.^d, Michael D. Devous Sr., Ph.D.^e, Sarah Ross, D.O.^a, Geoffrey Rohlfing, B.S.^f, and James Hall, Ph.D.^{b,g} for the Texas Alzheimer's Research & Care Consortium*

^aUniversity of North Texas Health Sciences Center, Department of Internal Medicine, Fort Worth, TX, U.S.A

^bUniversity of North Texas Health Sciences Center, Institute for Aging & Alzheimer's Disease Research, Fort Worth, TX, U.S.A

^cUniversity of North Texas, Department of Psychology, Denton, Texas, U.S.A

^dBristol-Myers Squibb, Wallingford, CT, U.S.A

^eUniversity of Texas Southwestern Medical Center, Department of Radiology, Dallas, Texas, U.S.A

^fUniversity of North Texas Health Science Center, Texas College of Osteopathic Medicine (TCOM), Fort Worth, TX, U.S.A

^gUniversity of North Texas Health Sciences Center, Department of Psychiatry, Fort Worth, TX, U.S.A

Abstract

Background—The aim of this study is to evaluate the link between CRP and Alzheimer's disease (AD) and Mild Cognitive Impairment (MCI) among Mexican Americans.

Methods—Non-fasting serum CRP levels, MMSE scores and CDR scores were analyzed from 1,066 participants (Mexican American n=471, non-Hispanic n=595) of the Texas Alzheimer's Research & Care Consortium (TARCC).

Results—Among the total cohort, CRP levels among AD cases were significantly decreased as compared to normal controls ($p < 0.001$) and MCI cases ($p = 0.002$). CRP levels among MCI cases were decreased relative to controls ($p = 0.03$). Among Mexican American and non-Hispanic AD cases, CRP levels were significantly decreased among AD cases as compared to controls. CRP levels were only associated with disease severity (CDR scores) among non-Hispanics ($p = 0.03$) AD cases.

Address correspondence to: Sid E. O'Bryant, PhD, University of North Texas Health Sciences Center, Department of Internal Medicine Division of Geriatrics, 3500 Camp Bowie Blvd, Fort Worth Texas, 76107. sid.o'bryant@unthsc.edu. Phone: 817-735-2963.

*Investigators from the Texas Alzheimer's Research and Care Consortium: Baylor College of Medicine: Rachele Doody MD, PhD, Susan Rountree MD, Valory Pavlik PhD, Wen Chan PhD, Paul Massman PhD, Eveleen Darby, Tracy Evans RN, Aisha Khaleeq; Texas Tech University Health Science Center: Gregory Schrimsher, PhD, Andrew Dentino, MD, Ronnie Orozco; University of North Texas Health Science Center: Thomas Fairchild, PhD, Janice Knebl, DO, Robert C. Barber, PhD, Douglas Mains, Lisa Alvarez, Erin Braddock, Rosemary McCallum; University of Texas Southwestern Medical Center: Perrie Adams, PhD, Roger Rosenberg, MD, Myron Weiner, MD, Mary Quiceno, MD, Benjamin Williams, MD, Joan Reisch, PhD, Ryan Huebinger, PhD, Guanghua Xiao, PhD, Doris Svetlik, Amy Werry, Janet Smith; University of Texas Health Science Center – San Antonio: Donald Royall, MD, Raymond Palmer, PhD, Marsha Polk.

Conclusions—These results show that, while CRP levels are decreased among Mexican American AD cases, CRP appears to not be related to clinical variables as it is among non-Hispanic whites.

Keywords

C-Reactive Protein; Alzheimer's disease; Mexican American; Neuropsychology

Introduction

C-Reactive protein (CRP) is an acute-phase reactant that is synthesized by the liver in response to acute injury, infection, or other inflammatory stimuli. Numerous studies have linked CRP levels to AD. Neuropathological studies have shown CRP to be associated with both neurofibrillary tangles [1] and senile plaques [2] in AD brain tissue. Longitudinally, midlife elevations in CRP have been found to increase risk for late life AD and vascular dementia (VaD) on 25-year follow up [3]. However, once AD becomes manifest, CRP levels appear to be lower among AD cases than age-matched normal controls [4, 5]. In our prior work, CRP levels were significantly decreased among AD cases as compared to controls; however, among AD cases, higher CRP levels were associated with significantly greater disease severity [4]. These findings were cross-validated by an independent research group who found CRP levels to be significantly decreased among AD cases, but that elevations in CRP among AD cases was associated with significantly poorer cognitive functioning and reduced survival time [5]. More recent work by Hu and colleagues found CRP levels to be consistently decreased across three independent cohorts of very mild dementia/Mild Cognitive Impairment (MCI)/AD [6]. Soares and colleagues [7] recently demonstrated that ApoE ϵ 4 carriers (AD cases and normal controls [NCs]) showed significantly lower CRP levels when compared to ApoE ϵ 4 non-carriers, which is consistent with prior work [8].

Though the significant decrease in CRP among AD cases has now been cross-validated across multiple cohorts, the impact of ethnicity on the CRP-AD link has not been investigated. Prior work has shown that CRP levels vary according to ethnicity and ancestry with CRP levels being higher among Hispanics when compared to non-Hispanic whites [9]. Among Mexican Americans, CRP levels have been shown to be associated with socioeconomic status [10] and level of acculturation [11]. Given the known ethnic differences regarding CRP levels, additional work is needed to determine how ethnicity impacts the link between CRP and disease outcomes [12]. Recently, Veeranna and colleagues [13] analyzed data from the Multi-Ethnic Study of Atherosclerosis (MESA) and found CRP to be a significant predictor of cardiovascular disease (CVD) event incidence among non-Hispanic Caucasians and African Americans, but CRP did not predict such events among Hispanics. Therefore, the relation of this biomarker to clinical outcomes may vary according to ethnicity and requires further investigation.

The percentage of Hispanics 65 and above will *triple* by the year 2050 [14] with rates of AD expected to grow six-fold [15]. Given that approximately 65% of the U.S. Hispanic population is Mexican American [16], this the fastest aging segment of the population. Our prior work has shown that Mexican Americans diagnosed with AD and MCI are younger, achieve fewer years of education, are less likely to have the ApoE ϵ 4 allele (the strongest genetic risk for AD among non-Hispanic whites), and suffer a disproportionate number of cardiovascular risk factors thought to be related to AD (e.g. diabetes) [17, 18]. However, we are aware of no prior work examining the CRP – AD link among Mexican Americans diagnosed with AD and MCI. The current study was undertaken to (1) evaluate the previous findings of decreased CRP levels among AD cases in Mexican Americans, (2) examine how

CRP is related to disease outcomes of global cognition and disease severity, and (3) expand the prior work to Mexican Americans and non-Hispanics diagnosed with MCI. It was hypothesized that among Mexican American and non-Hispanic AD cases, CRP levels would be significantly decreased compared to controls. It was further hypothesized that, among AD cases, higher CRP levels would be related to significantly poorer global cognition (Mini Mental State Examination scores) and elevated disease severity (Clinical Dementia Rating scale Sum of Boxes scores). Additionally it was hypothesized that CRP levels would be significantly decreased among all MCI cases as compared to controls.

Methods

Participants

Data were analyzed from 1,066 participants (Mexican American n=471, non-Hispanic n=595) of the Texas Alzheimer's Research & Care Consortium (TARCC). Each participant underwent a standardized evaluation at the respective TARCC site, which included an interview (e.g. demographics, family dementia history, NSAID, Vitamin E & anti-dementia medication history, medical history), neuropsychological testing and non-fasting blood draw. Global cognition was assessed via the Mini Mental State Examination (MMSE) [19] and disease severity rated according to the Clinical Dementia Rating scale [20] sum of boxes scores (CDR SB) [21, 22]. An informant interview was conducted for each research participant to obtain information regarding his/her activities of daily living (basic and instrumental). All information was reviewed by consensus committee who diagnosed participants as of NINCDS-ADRDA Probable Alzheimer's disease [23], Mayo Clinic criteria for MCI [24] or cognitively normal control (NC) if they performed within normal limits on psychometric assessment [25]. Demographic characteristics of the sample are presented in Table 1. Mexican American AD and MCI cases were more likely to have hyperlipidemia and hypertension ($p<0.05$) as compared to non-Hispanics, but there was no difference between controls. Mexican American AD and MCI cases as well as normal controls were more likely to be obese and have diabetes ($p<0.05$) as compared to non-Hispanics. In our prior work, we have shown in this cohort [18] that Mexican American AD and MCI cases as well as normal controls are significantly younger and achieved significantly fewer years of formal education.

Assays

Non-fasting samples were collected with 10mL serum-separating (tiger-top) vacutainers tubes at the time of interview. Samples were allowed to clot at room temperature for 30 minutes in a vertical position before being centrifuged at 1300 x g for 10 minutes. Next, 1mL aliquots were pipetted into cryovial tubes and placed in -20°C (non-frost free) or -80°C freezers until shipment to TARCC Biobank. Samples were shipped in batches to Myriad Rules Based Medicine (Myriad RBM) for assay on the luminex-based HumanMAP 1.0 platform, which included high sensitivity CRP (hsCRP).

Statistical Analyses

CRP levels were log-transformed due to non-normality. CRP levels were analyzed across three batches, and the impact of batch on CRP levels was evaluated with ANOVA. Analyses of demographic characteristics between diagnostic and ethnic groups were conducted via t-tests (continuous) or χ^2 (categorical) analyses. Unadjusted mean group differences between diagnostic groups by ethnicity were examined by t-test. Follow-up mean group differences adjusting for significant demographic and cardiovascular risk factors related to CRP levels were conducted via ANCOVA. Linear regression models were utilized to examine the link between CRP levels and MMSE scores as well as CDR SB scores; age, gender, and education were entered as covariates.

Results

Batch did not impact CRP levels ($F=1.11$, $p=0.33$) and therefore batches were combined. Among the total sample, CRP levels were significantly elevated amongst the Mexican American group as compared to the non-Hispanic group ($t=-2.56$, $p=0.01$); however, when split by diagnostic group, no significant differences remained for any group (NC, MCI or AD). Among the total sample, CRP levels were significantly lower among AD cases as compared to NCs ($t=-6.29$, $p<0.001$) and MCI cases ($t=-3.16$, $p=0.002$). CRP levels among MCI cases were significantly lower than NCs ($t=2.23$, $p=0.03$).

When split by ethnicity, CRP levels were significantly decreased among AD cases as compared NCs in both Mexican Americans ($t=-2.42$, $p=0.02$) and non-Hispanics ($t=-4.03$, $p<0.001$); however, the significant difference between AD cases and MCI cases no longer remained for either ethnicity. CRP levels were significantly decreased among MCI cases as compared to controls among non-Hispanics ($t=-2.79$, $p=0.005$) whereas there was no statistically significant difference between Mexican American MCI cases and controls (see Table 1 & Fig 1).

Next we examined the above findings after controlling for significant covariates ($p<0.05$). Age ($p=0.01$) and education ($p=0.04$) were significantly correlated with CRP levels among Mexican Americans, but were not related to CRP among non-Hispanics. Gender was significantly related to CRP levels amongst both ethnic groups with women having higher CRP levels ($p<0.01$). Duration of illness was not related to CRP levels. CRP levels were higher among non-Hispanics with hypertension ($p<0.01$) though no such relation held for Mexican Americans. CRP levels were significantly higher among obese Mexican Americans ($p<0.001$) whereas no such relation held for non-Hispanics. CRP levels were significantly higher among non-Hispanic individuals who were ApoEε4 negative ($p<0.01$), but no such relation was found for Mexican Americans; however, ApoEε4 genotyping was not available for 50% of the Mexican American sample, which excluded this as a potential covariate in further models. The initial adjusted ANCOVA included age, gender, education, obesity and hypertension as covariates. The overall model was significant for non-Hispanics ($F[2,578]=10.22$, $p<0.001$), but was not significant among Mexican Americans. Among non-Hispanics, post-hoc analyses showed that CRP levels were significantly lower among AD cases as compared to normal controls ($p<0.001$) and MCI cases ($p=0.006$). MCI and normal control CRP levels were not significantly different from one another. Given the marginal relation between age and education and CRP levels (only among Mexican Americans), the ANCOVA was re-run excluding those variables. In that model, the results for non-Hispanics were unchanged though the overall significance was reduced. The overall model showed a trend for significance for Mexican Americans ($F[2,465]=2.86$, $p=0.06$) with the only significant post-hoc comparison being that CRP levels were significantly lower among Mexican American AD cases as compared to normal controls ($p=0.04$). As can be seen from the analyses above, there was a cardiovascular risk factor x ethnicity interaction and follow-up analyses demonstrated that there was a risk factor x diagnostic group x ethnicity interaction. Specifically, the significant difference in CRP levels based on cardiovascular risk factors fluctuated by both diagnostic group (AD, MCI, NC) and ethnicity (data not shown). This is the topic of further inquiry within the group currently.

Next, the link between CRP levels and global cognition as well as disease severity was examined. Among AD cases, higher CRP levels were associated with significantly increased CDR SB scores ($B=0.94$, $SE=0.46$, $t=2.03$, $p=0.04$). CRP levels were not significantly related to CDR SB scores among MCI cases or NCs. There was a trend towards higher CRP levels being associated with lower MMSE scores ($B=-1.26$, $SE=0.66$, $p=0.06$) among AD cases; however, CRP levels were not associated with MMSE scores among other diagnostic

groups. When split by ethnicity, higher CRP levels were associated with significantly higher CDR SB scores only among non-Hispanic AD cases ($B=1.17$, $SE=0.52$, $p=0.03$) without being significantly related to CDR SB scores among Mexican American AD cases. A similar trend was found with the link between CRP levels and MMSE scores, which only held for non-Hispanics ($B=-1.53$, $SE=0.76$, $p=0.05$).

Discussion

The current findings cross-validate and extend prior work. Consistent with previous findings, CRP levels were significantly decreased among AD cases as compared to normal controls, which held for both Mexican Americans and non-Hispanics. The current work finds this decrease in CRP in MCI cases, but only for non-Hispanics. These findings can be seen as support for the hypothesis that the link between CRP and AD risk varies according to time and disease progression. It has been shown that elevations in mid-life increase risk for late-life AD; however, as this study and our previous work suggest, CRP levels appear to decline prior to disease manifestation (MCI) to a level below that of normal controls [4]. Therefore, the utility of CRP in predicting AD/MCI risk varies according to disease level and time to disease onset.

The current findings also demonstrate, for the first time, that the link between CRP and clinical outcomes among AD cases varies according to ethnicity. Specifically, CRP levels were not significantly related to global cognition or disease severity among Mexican Americans. Our findings fail to demonstrate a significant relationship between higher levels of CRP and poorer clinical outcome measures of global cognition and disease severity among Mexican-Americans. This differential relationship between CRP and disease outcomes by ethnicity is similar to what was found in a recent study examining CRP in a multi-ethnic sample. Veeranna and colleagues [13] conducted archival analysis of data from 6,067 participants (2362 Caucasian, 1601 African Americans, 1353 Hispanics, 751 Chinese) from the Multi-Ethnic Study of Atherosclerosis (MESA) to examine the link between baseline blood-based biomarkers, including CRP and incidence of CVD. CRP levels were higher among Hispanics as compared to Caucasians; however, CRP level was a significant predictor of incident CVD among Caucasians, but not among Hispanics. One could have expected CRP to be a more powerful predictor of disease outcomes among those with higher levels (i.e. Mexican Americans), but this was not the case. It is possible that differential disease prevalence rates of conditions related to CRP levels (e.g. diabetes) underlies the significant ethnic group differences, but CRP may not be a useful predictor of clinical outcomes among Mexican Americans and requires further study. If CRP is not a biomarker of clinical outcomes and risk, other markers need to be identified and validated.

Interestingly, the link between CRP levels and both demographic factors and cardiovascular risk factors varied by ethnicity. Specifically, there was a marginal significant correlation between CRP levels and age and education among Mexican Americans though gender was consistently related to CRP levels. Additionally, hypertension was related to CRP levels among non-Hispanics whereas obesity was significantly related to CRP levels among Mexican Americans. In pilot analyses, the picture became more complicated as the above-mentioned differences varied by diagnostic category. For example, hypertension was significantly related to CRP levels among non-Hispanic AD ($p<0.05$) and MCI ($p<0.01$) cases but not normal controls whereas hypertension was only significantly related to CRP levels among Mexican American MCI cases ($p<0.01$). Obesity was significantly related to CRP levels among non-Hispanic MCI cases ($p<0.01$) but no other diagnostic group whereas obesity was only significantly related to CRP levels among Mexican American normal controls ($p<0.001$). These findings are of significance as they suggest that the inflammation – cognition link may vary according to disease stage, specific cardiovascular risk factor and

ethnicity. Further analyses on this are being conducted by the by the investigative team currently.

There are limitations to the current study. The cross-sectional nature of the analyses precludes any causative conclusions (longitudinal analyses are currently under way). The sample size of Mexican Americans diagnosed with AD is relatively small and follow-on analyses will be conducted once additional cases are recruited. Additionally, these findings may not generalize to other Hispanic groups or other ethnic minority populations and should be evaluated.

Recent years have seen the development of exceptional large-scale, longitudinal studies of biomarkers related to MCI/AD nationally and internationally. However, the samples in these studies are largely composed of non-Hispanic whites. For example, the Alzheimer's Disease Neuroimaging Initiative (ADNI), the largest, and perhaps most impactful study of biomarkers of AD and MCI to date, included a total of 21 Hispanics. The findings of the current study support the importance of examining biomarkers of cognitive aging, MCI and AD in larger and more representative samples of Mexican Americans.

Acknowledgments

This study was made possible by the Texas Alzheimer's Research and Care Consortium (TARCC) funded by the state of Texas through the Texas Council on Alzheimer's Disease and Related Disorders. Research reported in this publication was supported by the National Institute on Aging (NIA) and National Institute on Minority Health and Health Disparities (NIMHD) of the National Institutes of Health under Award Numbers R01AG039389, P30AG12300, and L60MD001849. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

References

1. Duong T, Nikolaeva M, Acton PJ. C-reactive protein-like immunoreactivity in the neurofibrillary tangles of Alzheimer's disease. *Brain Res.* 1997; 749:152–156. [PubMed: 9070642]
2. Iwamoto N, Nishiyama E, Ohwada J, Arai H. Demonstration of CRP immunoreactivity in brains of Alzheimer's disease: immunohistochemical study using formic acid pretreatment of tissue sections. *Neurosci Lett.* 1994; 177:23–26. [PubMed: 7824175]
3. Schmidt R, Schmidt H, Curb JD, Masaki K, White LR, Launer LJ. Early inflammation and dementia: a 25-year follow-up of the Honolulu-Asia Aging Study. *Ann Neurol.* 2002; 52:168–174. [PubMed: 12210786]
4. O'Bryant SE, Waring SC, Hobson V, Hall JR, Moore CB, Bottiglieri T, Massman P, Diaz-Arrastia R. Decreased C-reactive protein levels in Alzheimer disease. *J Geriatr Psychiatry Neurol.* 2010; 23:49–53. [PubMed: 19933496]
5. Nilsson K, Gustafson L, Hultberg B. C-reactive protein level is decreased in patients with Alzheimer's disease and related to cognitive function and survival time. *Clin Biochem.* 2011; 44:1205–1208. [PubMed: 21819975]
6. Hu WT, Holtzman DM, Fagan AM, Shaw LM, Perrin R, Arnold SE, Grossman M, Xiong C, Craig-Schapiro R, Clark CM, Pickering E, Kuhn M, Chen Y, Van Deerlin VM, McCluskey L, Elman L, Karlawish J, Chen-Plotkin A, Hurtig HI, Siderowf A, Swenson F, Lee VM, Morris JC, Trojanowski JQ, Soares H. For the Alzheimer's Disease Neuroimaging Initiative . Plasma multi-analyte profiling in mild cognitive impairment and Alzheimer's disease. *Neurology.* 2012; 79:897–905. [PubMed: 22855860]
7. Soares H, Potter WZ, Pickering E, Kuhn M, Immermann FW, Shera DM, Ferm M, Dean RA, Simon AJ, Swenson F, Siuciak JA, Kaplow J, Thambisetty M, Zaqouras P, Koroshetz WJ, Wan HI, Trojanowski JQ, Shaw LM. for the Biomarkers Consortium Alzheimer's Disease Plasma Proteomic Project. Plasma biomarkers associated with ApoE genotype and Alzheimer's disease. *Arch Neurol.* 2012; 16:1–8.

8. Haan MN, Aiello AE, West NA, Jagust WJ. C-reactive protein and rate of dementia in carriers and non carriers of Apolipoprotein APOE4 genotype. *Neurobiol Aging*. 2008; 29:1774–1782. [PubMed: 17540481]
9. Shah T, Newcombe P, Smeeth L, Addo J, Casas JP, Whittaker J, Miller MA, Tinworth L, Jeffery S, Strazzullo P, Cappuccio FP, Hingorani AD. Ancestry as a determinant of mean population C-Reactive protein values: Implications for cardiovascular risk prediction. *Cir Cardiovasc Genet*. 2010; 3:436–444.
10. Gallo LC, Fortmann AL, de Los Monteros KE, Millis PJ, Barrett-Conner E, Roesch SC, Matthews KA. Individual and neighborhood socioeconomic status and inflammation in Mexican American women: What is the role of obesity? *Psychosom Med*. 2012; 74:535–542. [PubMed: 22582313]
11. Rodriguez F, Peralta CA, Green AR, López L. Comparison of C-reactive protein levels in less versus more acculturated Hispanic adults in the United States (from the National Health and Nutrition Examination Survey 1999–2008). *Am J Cardiol*. 2012; 109:665–669. [PubMed: 22169128]
12. Forouhi NG, Sattar N. CVD risk factors and ethnicity - A homogeneous relationship? *Atheroscler Suppl*. 2006; 7:11–19. [PubMed: 16500156]
13. Veeranna V, Zalawadiya SK, Niraj A, Kumar A, Ference B, Afonso L. Association of novel biomarkers with future cardiovascular events is influenced by ethnicity: Results from a multi-ethnic cohort. *Int J Cardiol*. 2012 in press.
14. Jacobsen L, Kent M, Lee M, Mather M. America's Aging Population. *Population Bulletin*. 2011; 66
15. Novak, K.; Riggs, JA. Hispanics/Latinos and Alzheimer's disease. *Alzheimer's Association*; Chicago: 2004.
16. US Census Bureau. American Fact Finder. 2005. <http://www.census.gov/>
17. O'Bryant SE, Humphreys JD, Schiffer RB, Sutker PB. Presentation of Mexican Americans to a memory disorder clinic. *J Psychopathol Behav Assess*. 2007; 29:137–140.
18. O'Bryant SE, Johnson L, Balldin V, Edwards M, Barber R, Williams B, Devous M, Cushings B, Knebl J, Hall J. Characterization of Mexican Americans with Mild Cognitive Impairment and Alzheimer's disease. *J Alzheimers Dis*. 2012 in press.
19. Folstein MF, Folstein SE, McHugh PR. "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. *J Psychiatr Res*. 1975; 12:189–198. [PubMed: 1202204]
20. Morris JC. The Clinical Dementia Rating (CDR): current version and scoring rules. *Neurology*. 1993; 43:2412–2414. [PubMed: 8232972]
21. O'Bryant SE, Waring SC, Cullum CM, Hall J, Lacritz L, Massman PJ, Lupo PJ, Reisch JS, Doody R. Texas Alzheimer's Research Consortium. Staging dementia using clinical dementia rating scale sum of boxes scores: A Texas Alzheimer's research consortium study. *Arch Neurol*. 2008; 65:1091–1095. [PubMed: 18695059]
22. O'Bryant SE, Lacritz LH, Hall J, Waring SC, Chan W, Khodr ZG, Massman PJ, Hobson V, Cullum CM. Validation of the new interpretive guidelines for the clinical dementia rating scale sum of boxes score in the National Alzheimer's Coordinating Center database. *Arch Neurol*. 2010; 67:746–749. [PubMed: 20558394]
23. McKhann GM, Knopman DS, Chertkow H, Hyman BT, Jack CR Jr, Kawas CH, Klunk WE, Koroshetz WJ, Manly JJ, Mayeux R, Mohs RC, Morris JC, Rossor MN, Scheltens P, Carrillo MC, Thies B, Weintraub S, Phelps CH. The diagnosis of dementia due to Alzheimer's disease: Recommendations from the National Institute on Aging-Alzheimer's Association workgroups on diagnostic guidelines for Alzheimer's disease. *Alzheimers Dement*. 2011; 7:263–269. [PubMed: 21514250]
24. Petersen, RC., editor. *Mild Cognitive Impairment: Aging to Alzheimer's Disease*. Oxford University Press; New York: 2003.
25. Ivnik R, Malec JF, Smith GE, Tangalos EG, Petersen RC, Kokmen E, Kurkland LT. Mayo's Older Americans Normative Studies: WAIS-R norms for age 56 to 97. *Clin Neuropsychol*. 1992; 6:1–30.

Figure 1.
CRP levels by ethnicity and diagnostic group

Table 1

Demographic Characteristics

	Hispanic				Non-Hispanic White			
	AD N=55	MCI N=91	NC N=325	AD N=229	MCI N=134	NC N=232		
Age (years)	76.3(7.3)	72.3(9.0)	65.0(8.0)	77.6 (8.6)	74.9 (8.7)	71.0 (8.7)		
	61–94	50–91	50–87	54–102	55–94	52–92		
Education (years)	9.5(5.5)	11.4(4.2)	11.3(4.2)	14.3(3.1)	14.5(2.4)	15.6(2.6)		
	0–20	0–20	0–20	5–22	10–20	10–23		
Duration of illness (years)	4.8(3.9)	3.2(3.1)	N/A	6.2(3.1)	3.7(3.3)	N/A		
	0–16	0–20		0–16	0–20			
Gender (%male)	39	44	37	39	46	34		
MMSE	19.0(5.0)	26.9(2.5)	28.3(2.3)	19.7(6.0)	27.3(2.5)	29.4(0.9)		
	9–28	20–30	19–30	1–30	19–30	26–30		
CDR SB	6.1(3.5)	1.0(0.6)	0.02(0.2)	7.6(4.3)	1.3(1.0)	0.01(0.1)		
	2–17	1–5	0–3	1–18	1–5	0–1		
CRP	3.28 (3.65)	3.65 (3.89)	4.35 (4.14)	2.97 (4.61)	3.58 (4.13)	3.77 (4.38)		
Hyperlipidemia (%yes)	66%	69%	55%	52%	56%	50%		
Hypertension (%yes)	79%	81%	60%	56%	60%	58%		
Diabetes (%yes)	36%	40%	33%	9%	16%	12%		
Obesity (%yes)	32%	52%	50%	13%	26%	22%		

Note:

* where appropriate mean (standard deviation) and range are presented; duration of illness based on informant report of age of onset.