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Older Rural- and Urban-Dwelling Appalachian Adults With Mild Cognitive Impairment

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Abstract

Purpose—Mild cognitive impairment (MCI) is a well-recognized risk state for Alzheimer's disease and other dementias. MCI is rapidly increasing among older adults in general and has not yet been examined in older adults within the Appalachian region. Our objective was to compare MCI symptom severity among older rural and urban Appalachian adults with MCI at an initial neuropsychological testing visit.

Methods—A cross-sectional, descriptive study of older Appalachian adults with MCI was conducted using data from the National Alzheimer's Coordinating Center Uniform Data Set. Symptom severity was conceptualized as neuropsychological composite scores across 4 cognitive domains and Clinical Dementia Rating-Sum of Boxes (CDR-SOB) score. For group comparisons, MANCOVA was used for cognitive domains and ANCOVA for CDR-SOB.

Results—The sample (N=289) was about half male (54.3%), predominantly white (91.7%), and living with others (83.5%), with a mean($\pm$ SD) 74.6 $\pm$ 6.2 years of age and 15.4 $\pm$ 3.0 years of education. Rural and urban groups differed significantly in years since onset of cognitive

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symptoms (2.98 ± 1.91 in rural and 3.89 ± 2.70 in urban adults, $t[260] = -2.23$, $P = .03$), but they did not differ across sociodemographic features or comorbid conditions. Rural and urban participants were similar across the 4 cognitive domains and CDR-SOB ($P = .05$).

Discussion—No differences were found between rural and urban Appalachian residents on MCI symptom severity. However, urban residents reported a longer time lapse from symptom identification to diagnosis than their rural counterparts. Future studies using more representative population samples of Appalachian/non-Appalachian adults will provide an important next step to identifying disparate cognitive health outcomes in this traditionally underserved region.

Keywords

dementia; geriatrics; health disparities; mild cognitive impairment; older adults

The Appalachian region of the United States, which spans from southern New York to northern Alabama, Mississippi, and Georgia, has a total population of almost 23 million inhabitants in over 400 counties and 13 states.¹ The Appalachian region suffers from inequalities in socioeconomic conditions,² behavioral risk factors for poor health outcomes, and higher mortality rates compared to the nation as a whole.² With over double the national percent of rural-dwelling adults within the Appalachian region^{3,4} and a greater proportion of older adults,³ older rural Appalachian adults are an important, understudied population. Appalachian rural adults have worse overall health and health outcomes when compared with the rest of the nation.^{2,5-8} Additionally, behavioral risk factors such as smoking and a sedentary lifestyle^{7,9} place rural Appalachian adults at greater risk for cardiovascular (CVD) and cerebrovascular disease. Poorer health outcomes in rural Appalachia continue to be addressed in the literature.^{2,3,7,8} However, one condition that is rapidly increasing among older adults in general¹⁰ and has not yet been examined in this population is the clinical syndrome, mild cognitive impairment (MCI), which is a well-recognized risk state for Alzheimer's disease (AD) and other dementias.

Rural-dwelling Appalachian adults are especially vulnerable to late-life cognitive impairment based on known health disparities and higher rates of risk factors among those living in rural Appalachia. Established risk factors for cognitive impairment include older age,¹¹⁻¹⁴ less education,^{12,13} and female gender,^{12,13} as well as hypertension,^{11,15,16} heart disease,^{11,15,16} diabetes,^{17,18} depression,^{11,19,20} and genetic factors.^{11,12} Among these known risk factors for cognitive impairment, rural Appalachian residents have demonstrated lower levels of education^{21,22} and higher rates of hypertension,⁶ heart disease,²³ and diabetes.²³ Moreover, delayed detection of cognitive changes, possibly attributed to fewer rural-dwelling health care providers^{7,24} and limited health services,⁷ make rural Appalachian adults an especially vulnerable group. Since MCI is a recognized target for the secondary prevention of dementia, the time of MCI diagnosis may present a critical opportunity for interventions that help reduce health disparities.

The prevalence of MCI is estimated to be as high as 19% among older US adults.²⁵ An MCI diagnosis 1) involves decline in at least one cognitive domain (eg, memory), 2) requires maintenance of near normal functional activities, and 3) requires that the degree of cognitive impairment is not sufficient to warrant a diagnosis of AD or related dementia.^{25,26} Subtle

changes in cognition may not initially appear to directly affect daily living, but they often significantly worsen over time and can impact day-to-day activities. Based on known rural health disparities, especially later diagnosis of chronic diseases, it is reasonable to hypothesize that MCI may present later in its course in rural adults; however, studies describing older, rural-dwelling adults with MCI have not been documented. The purpose of this study was to compare MCI symptom severity among older rural and urban Appalachian adults with MCI at an initial neuropsychological testing visit. It was hypothesized that older, rural-dwelling Appalachian adults with MCI would present with worse symptom severity, as evidenced by neuropsychological test scores, compared to their urban counterparts.

Methods

Design

A quantitative, cross-sectional, descriptive study of symptom severity data collected from older Appalachian adults with MCI was performed. De-identified data were obtained from the National Alzheimer's Coordinating Center (NACC) Uniform Data Set (UDS), a publicly available national database drawing on over 30 federally funded Alzheimer Disease Centers (ADCs).

Sample

The ADCs, which contribute to the NACC UDS repository, conduct clinical and biomedical research on AD and related cognitive disorders. Individuals who participate in ADCs are enrolled through a variety of methods that include referrals from clinicians, family, or self-referral, and targeted recruiting through community organizations. In addition to enrolling individuals with AD and related cognitive disorders, most centers also enroll healthy control participants. There are 2 cohorts that are targeted by the ADCs: cognitively normal controls and individuals with symptoms associated with dementia.

Data are collected at an initial visit and each annual follow-up visit by clinicians, neuropsychologists, and other ADC research personnel, using up to 18 standardized data collection forms at each visit. The parent study (NACC UDS) sample, from which the present study sample was selected, includes adults who completed a memory evaluation at one of the ADC sites that may serve the Appalachia region from September 2005 through September 2014 data freeze. ADC sites located within or close to the Appalachian region that contribute data to the larger UDS include the University of Pittsburgh Alzheimer Disease Research Center, the University of Kentucky Alzheimer's Disease Center, and Emory University's Alzheimer's Disease Research Center, as well as ADC ancillary sites affiliated with these centers.

Inclusion criteria for the present study were 65 years of age; any MCI diagnosis; Appalachian residence, based on county of residence; and having a designated informant/care partner. There were no additional exclusion criteria. For the current study, individual ADCs were contacted and additional data were requested, including 5-digit ZIP codes for the purpose of rural classification. ZIP code data were provided by the individual ADCs for participants meeting the inclusion/exclusion criteria determined by and provided by NACC.

ZIP codes reflect the most recent ZIP code data provided by the participant and/or care partner. The University of Pittsburgh Institutional Review Board approval was obtained prior to data acquisition.

After merging NACC UDS and ADC data, there were a total of 3,086 ADC visits for 936 participants with an MCI diagnosis across the 3 Centers. Applying the study's inclusion and exclusion criteria, only initial visit data were used, 135 participants were younger than 65 years of age, 446 were not living within Appalachia, and 66 were excluded for other reasons such as no ZIP code available for classification. Ultimately, 289 participants were available for analysis (urban n=231, rural n=58). Participants reported residence across 9 states within Appalachia including Georgia (n=32, 15.6% rural), Kentucky (n=18, 100% rural), Maryland (n=2, 100% rural), North Carolina (n=2, 100% rural), Ohio (n=3, 33.3% rural), Pennsylvania (n=228, 12.7% rural), and West Virginia (n=4, 25.0% rural). Overall, 50.0% of the rural, Appalachian sample resided in Pennsylvania, and the University of Pittsburgh ADRC provided 86.1% of the urban sample.

Measures

Appalachia Classification—Appalachian residence was determined using the Appalachian Regional Commission classification of US counties located within the Appalachian region.³ Five-digit ZIP codes were converted to counties using the US Census Bureau's online resource, "Locate a county by place name" to classify residents as living within the Appalachia region.²⁷

Rural Classification—Once participants were determined to be of Appalachian residence, they were further classified according to United States Department of Agriculture Rural-Urban Commuting Areas Codes (RUCAs) using codes from 1-10. This classification scheme was developed by the US Department of Agriculture's Economic Research Service and the US Department of Health and Human Services, where urban ("metropolitan") includes primary RUCA codes 1-3 and rural ("micropolitan," "small town," and "rural areas") includes codes 4-10.²⁸

MCI Classification—We used the MCI criteria implemented by NACC: 1) cognition is determined to be not normal and 2) clinical dementia is not present.²⁹ We included all MCI sub-types, including a) predominant focal amnesic disorder, b) amnesic disorder plus changes in other cognitive domains, c) focal non-amnesic disorder, and d) non-amnesic disorder plus changes in other non-memory cognitive domains.²⁹

Descriptive, Comorbid Conditions, and Medication Measures—

Sociodemographic variables included age (measured in years) and education (measured in years) as continuous variables and sex (male/female), race (white/non-white), living situation (living with someone/not living with someone), and marital status (married/not married) as binary variables. Comorbid conditions and family of a first degree relative with dementia were coded as binary variables (recent/active and remote/inactive or absent/present), except for body mass index (BMI, kg/m²) and Geriatric Depression Score (GDS)³⁰ that were measured as continuous variables and collected by clinician. Age of onset of

cognitive decline was also measured as a continuous variable, as determined by the participant and family/informant self-report. Time since onset of symptoms was calculated by subtracting the age of onset of cognitive decline from the current participant age (in years). Total number of self-reported medications was reported as the sum of all prescription, non-prescription, and vitamins/supplements reported.

Distance to ADC—ArcMap (Esri, Redlands, California) was used for geocoding ZIP codes and ADCs into separate layers. The ArcGIS Network Analyst Origin-Destination (OD) function was used to compute driving distance between resident ZIP code and ADC address. The new OD cost matrix extension calculated distance between the 2 locations with a gravity model for access, assigning the same weight for each participant.

Outcome Variables: Neuropsychological Measures

To examine MCI symptom severity, we clustered neuropsychological measures conceptually across 4 cognitive domains: Memory (Wechsler Memory Scale-R Logical Memory IA – Immediate and Delayed), Language (Boston Naming Test and Category Fluency – animals or vegetables), Attention/Psychomotor Speed (Trailmaking Test A, Wechsler Adult Intelligence Scale-Revised [WAIS-R] Digit Symbol Substitution Task [DSST], and Digit Span Forward), and Executive Functioning (Trailmaking Test B and Digit Span Backwards). Neuropsychological measures are described below.

Memory—Wechsler Memory Scale-R Logical Memory IA – Immediate is a measure of memory in which a brief story is read to the participant, who is asked to recall it immediately. Logical Memory IIA is a measure of delayed recall, where the participant recalls the same story after 30 minutes. The primary performance measure is number of story units recalled,³¹ scored 0-25, with a higher score indicating better performance.³²

Language—The Boston Naming Test³¹ measures ability to name line drawings of objects, for a total possible score of 60. For the NACC UDS, only the score of the odd-numbered items are presented (scored 0-30). Category Fluency is a measure of semantic memory (verbal fluency, language) where the participant is asked to name different exemplars of a given semantic category. For the NACC UDS, the total number of animals or vegetables named in 60 seconds are scored from 0-77.³³

Attention/Psychomotor Speed—Attention and psychomotor speed is measured by 3 assessments: Trailmaking A,³⁴ Wechsler Adult Intelligence Scale-Revised (WAIS-R) Digit Symbol Substitution Task (DSST),³⁵ and Digit Span Forward.³⁶ The Trailmaking Test A requires the participant to connect randomly placed encircled numbers that are strewn across a sheet of normal-sized paper. The participant is asked to connect all numbers with a pen/pencil, in order beginning with 1, as fast as possible, for a maximum of 150 seconds.³⁴ Scores include seconds to complete (0-150), number of errors (0-48), and number of correct lines drawn (0-24). WAIS-R DSST asks participants to take digit-symbol pairs and write the corresponding symbol for a list of digits in 90 seconds with a maximum of 93 items (0-93, total number of items correctly completed). Digit Span Forward is when the participant is read number sequences of increasing length and asked to repeat them. Measures of

performance include: the number of digit sequences recalled correctly, up to 2 consecutive errors (0-12), and the length of the highest digit sequences the participant is able to repeat correctly (0-8).

Executive Functioning—Trailmaking Test B requires the participant to connect both numbers and letters in order in an alternating pattern (eg, 1-A-2-B) in a maximum of 300 seconds.³⁷ Scores include seconds to complete (0-300), number of errors (0-48), and number of correct lines drawn (0-24). Digit Spans Backward is used to measure working memory. The participant is read number sequences of increasing length and then asked to repeat each sequence backward.³⁶ The primary measure of performance is the number of digit sequences correctly reversed with up to 2 consecutive errors at the same digit length (0-12). The digit span backward length is the length of the highest digit sequences the participant is able to reverse (0-7).

The Clinical Dementia Rating-Sum of Boxes (CDR-SOB) score was also considered as an independent outcome. CDR-SOB is calculated by summing 6 domain box scores (memory, orientation, judgment and problem solving, community affairs, home and hobbies, and personal care) obtained from the Clinical Dementia Rating (range: 0-18).^{38,39} This is included as a measure of symptom severity based on clinician judgment and participant account of his/her ability to perform activities of daily living, rated independently of neuropsychological test performance.

MCI symptom severity was measured using these 9 objective neuropsychological tests spanning 4 cognitive domains and individually for CDR-SOB. Composite scores were derived based on this mapping of individual neuropsychological tests to conceptual domains to provide averaged adjusted z-scores for each cognitive domain composite. For all neuropsychological measurements, age-, sex-, and education-adjusted z-scores were used, as adjusted using the normative calculator for the UDS neuropsychological test battery⁴⁰ and provided by the NACC UDS. The initial visit neuropsychological assessment measurements were used for analysis, and the time since onset of symptoms was considered as a covariate in the analysis of each outcome domain.

Analysis

Data were analyzed using IBM® SPSS® Statistics (v.23, IBM Corp., Armonk, New York). Initially data were screened for anomalies (eg, outliers, missing data, violations of statistical assumptions) using descriptive and exploratory data analysis methods to characterize the sample overall and by rural/urban classification. Group comparisons were conducted for all sociodemographic variables by rural/urban classification using 2-sample t-tests for continuous-type descriptors and chi-square or Fisher's exact tests for categorical characteristics prior to proceeding with analysis of the neuropsychological outcome variables. All sociodemographic variables were examined as covariates for each outcome variable.

Mean adjusted z-scores for each cognitive domain composite were analyzed using multivariate analysis of covariance (MANCOVA) by examining the set of 4 cognitive domain composites simultaneously to compare MCI symptom severity between rural and

urban groups using the multivariate F-test. Effect sizes were reported as partial eta-squared. Sociodemographic variables (eg, sex, education, age) were also examined for possible associations with cognitive outcome variables and, if significant associations were found, were controlled for in the analysis. Analysis of covariance (ANCOVA) was used to compare CDR-SOB scores between rural and urban samples while controlling for sociodemographics. For all analyses, the level of statistical significance was set at .05 for 2-sided hypothesis testing.

Results

Our final sample (N=289; 231 urban, 58 rural) included participants who were, on average ($\pm$ standard deviation [SD]), 74.6 ± 6.2 years of age, predominantly white (91.7%), male (54.3%), and with a reported mean 15.4 ± 3.0 years of education. Most reported living with at least one person (83.5%) and being married (77.5%). Of those participants living with someone, 93.7% were married; of those participants who were not married, 75.8% lived alone. Rural and urban groups did not differ significantly across any sociodemographic features. See Table 1 for more detailed sociodemographic information.

Gender and education had statistically significant associations across outcome variables. Male gender was associated with lower adjusted z-scores for memory, language, and attention/psychomotor speed domains as well as higher CDR-SOB scores. Fewer years of education was associated with lower language and attention/psychomotor speed domain scores as well as higher CDR-SOB scores. Age had no statistically significant associations across outcome variables. Race was also considered; however, the small number of non-white participants in both rural and urban groups did not provide sufficient variability to warrant inclusion as a confounder. The identified significant associations for each outcome variable were adjusted for, and similar results were obtained for each outcome variable.

Overall there were no statistically significant differences in most comorbid conditions between rural and urban participants ($P = .05$). However, there was a difference in the time since onset of cognitive symptoms between groups (2.98 ± 1.91 years in rural adults and 3.89 ± 2.70 in urban adults, $t[260] = -2.23$, $P = .03$). Table 2 presents prevalence of comorbid conditions and distance traveled for the total sample as well as rural and urban samples. Rural- and urban-dwelling participants did, however, have significant differences in distance traveled to ADC. Rural participants traveled, on average, 65.03 ± 36.06 miles (Range: 23.13-181.50) to ADC, compared to urban participants who traveled on average 17.20 ± 16.49 miles (Range: 0.59-138.55) ($t[287] = 14.926$, $P < .001$).

There were no significant differences between rural and urban participants across the 4 objective cognitive domains or CDR-SOB: Memory ($F[1,287] = 1.35$, $P = .25$, partial $\eta^2 < .01$); Language ($F[1,287] = 0.12$, $P = .73$, partial $\eta^2 < .01$); Attention/Psychomotor Speed ($F[1,287] = 0.07$, $P = .79$, partial $\eta^2 < .01$); Executive Function ($F[1,287] = 0.90$, $P = .34$, partial $\eta^2 < .01$); and CDR-SOB ($t[287] = -0.15$, $P = .88$). When looking at individual neuropsychological tests, there were also no differences between rural- and urban-dwelling adults, except for 2 tests within the Attention/Psychomotor Speed domain, Trailmaking A and Digit Span Forward. Older, rural adults with MCI scored significantly worse in the

Trailmaking A test compared to urban adults ($t[286] = -3.16$, $P < .01$), while older, urban adults with MCI scored significantly worse in Digit Span Forward compared to rural adults ($t[287] = 2.27$, $P = .02$). Table 3 presents results for individual neuropsychological tests.

Discussion

We hypothesized that older, rural-dwelling Appalachian adults would have worse cognitive symptom severity than their urban counterparts at an initial neuropsychological testing visit. This hypothesis was not supported by our analyses. Across 4 cognitive domains and CDR-SOB, we found significant differences within the attention/psychomotor speed domain for 2 of the individual tests, Trailmaking A and Digit Span Forward tests. However, the differences for the 2 tests were in different directions, and thus we believe that these are isolated findings likely due to chance and should not be over-interpreted regarding their clinical significance. There was no evidence of rural/urban differences at the domain level.

Of note, our analysis revealed a significant difference in the length of time from onset of symptoms to MCI diagnosis between older rural and urban adults, where rural adults were presenting for diagnosis earlier than their urban counterparts. This was unexpected as breast, prostate, and colorectal cancers, as well as cardiovascular disease (CVD) have been found to be diagnosed at later stages for rural adults than their urban counterparts.^{2,7,8,41} A recent systematic review examining barriers to cognitive screening in rural America found that lack of knowledge about cognitive changes, lack of knowledgeable providers to offer cognitive screening, and geographic distance are barriers to cognitive screening.⁴² One reason for the shorter length of time from onset of symptoms to diagnosis for rural-dwelling adults compared to urban-dwelling adults may be that rural-dwelling adults are more likely to take the time to seek out and use specialty health care services if they have a first degree relative with dementia. Although over 50% of both rural and urban adults with MCI reported having at least one first degree relative with dementia, those living in rural areas may be more likely to be proactive in seeking out care and treatment at ADCs to try and prevent dementia symptoms or outcomes seen in their relatives. This may be explained by the significant difference in distance traveled by rural participants to ADC site compared to urban participants, with consideration for the fact that most specialty health care services are located within urban centers. Additionally, symptom identification by family members familiar with cognitive symptoms or knowledge of specialty health care centers may also play a role in bringing older, rural-dwelling adults to specialty centers earlier.

Historically, recruitment for research in rural America can be challenging,^{43,44} and recruitment for cognitive changes may be compounded because cognitive symptoms may be dismissed as normal aging.⁴² However, once involved in memory research, Hunsaker et al⁴⁵ found that both rural and urban research participants believed memory research benefited the participant, family, and society. For example, participation in memory research allowed them to understand age-related memory changes and provided family members with “an enhanced understanding of the disease process.”⁴⁵

Interpretation of results is limited as the older adults living in rural areas who attended the ADCs may not be typical of most older, rural-dwelling adults in Appalachia, as seen in the

sociodemographic characteristics presented. For example, only 20.1% of the total sample lived in rural areas compared to 42% of the Appalachian population living in rural areas.³ Within the Appalachian region, 55% are married, compared to 77.5% married in our total sample; 26% live alone in Appalachia compared to 16.5% of our total sample.⁴⁶ Our study participants also had a greater number of years of formal education (almost 3 years of college) compared to only 20.7% of adults over 25 years of age attaining a Bachelor's degree or more residing in the Appalachian region.⁴⁷

ADCs also employ various recruitment strategies and patient populations were not randomly selected. However, each center continuously monitors cohorts to try and match overall characteristics and recruit to include rural county inhabitants and minorities. This is apparent in the similarities between the rural and urban samples. Both participant characteristics and recruitment strategies support selection bias,^{48,49} and generalizations to all older adults in Appalachia are not presumed. We also acknowledge that there are regions within Appalachia that are not well represented in this analysis, which could be attributed to location or recruitment strategies of ADCs within the region. However, we have included all participants living within Appalachia as it provides important new information about an underserved population receiving cognitive evaluations at a specialty research center. With consideration for the limitations of this study, NACC UDS provided the unique opportunity to use national multi-center data with detailed standardized neuropsychological testing to describe a region underrepresented in research settings.

Conclusion

This study can serve as an initial description of MCI in the underserved Appalachian region. Findings did not show differences in MCI symptom severity between older rural and urban residents within this region; this may be due to the lack of variability in the sample, as all participants lived within the Appalachian region, or because rural and urban Appalachian residents are more similar to each other than other rural/urban comparisons. Future studies of cognitive impairment using more representative population samples of Appalachian and non-Appalachian older adults will provide an important next step to identifying disparate cognitive health outcomes among residents in this traditionally underserved region.

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Socio-demographic Features of Older, Appalachian-Dwelling Adults with MCI, Rural and Urban, N=289

Table 1

Variable	Total sample (N=289)	Rural (n=58)	Urban (n=231)	Test statistic	p-value
Age, mean years $\pm$ standard deviation (SD)	74.64 $\pm$ 6.17	74.10 $\pm$ 6.15	74.78 $\pm$ 6.18	t(287)= -1.41	.16
Education, mean years $\pm$ SD	15.39 $\pm$ 3.03	14.90 $\pm$ 3.18	15.52 $\pm$ 2.98	t(287)= -0.75	.46
Sex, % male	54.3	46.6	56.3	X ² (1)= 1.77	.18
Race, % white	91.7	96.6	90.5	<i>a</i>	.18
Marital Status, % married	77.5	81.0	76.6	X ² (1)= 0.52	.47
Living Situation, % live with someone (n=285)	83.5	87.9	82.4	X ² (1)= 1.03	.31

^a Fisher's Exact test was used due to cells with expected count less than 5

Comorbid Conditions of Older, Appalachian-Dwelling Adults with MCI, Rural and Urban, N=289

Table 2

Comorbid Condition ^a	Total sample (N=289)	Rural (n=58)	Urban (n=231)	Test statistic	p-value
Heart attack/arrest, % yes	11.4	17.2	10.0	$\chi^2(1)=2.43$	.12
Atrial Fibrillation, % yes	11.1	13.8	10.4	$\chi^2(1)=0.55$	.46
Angioplasty / Endarterectomy, % yes	12.1	19.0	10.4	$\chi^2(1)=3.20$	.07
Cardiac bypass procedure, % yes	10.7	15.5	9.5	$\chi^2(1)=1.74$	.19
Pacemaker, % yes	6.6	3.4	7.4	<i>b</i>	.38
Congestive HF, % yes	2.1	5.2	1.3	<i>b</i>	.10
Stroke, % yes	8.3	3.4	9.6	<i>b</i>	.18
Hypertension, % yes	55.4	48.3	57.1	$\chi^2(1)=1.48$	.23
Hypercholesterolemia, % yes	61.6	65.5	60.6	$\chi^2(1)=0.47$	.49
Diabetes, % yes	17.0	19.0	16.5	$\chi^2(1)=0.21$	.65
Active depression, % yes	34.0	29.3	35.2	$\chi^2(1)=0.72$	.40
Alcohol abuse, % yes	3.1	5.2	2.6	<i>b</i>	.39
Cigarette smoking, past 30 days, % yes	2.8	1.8	3.1	<i>b</i>	1.00
Cigarette smoking, > 100 in lifetime, % yes	48.6	50.9	48.0	$\chi^2(1)=0.15$	.70
Other psychiatric disorders, % yes	6.6	5.2	6.9	<i>b</i>	.77
First degree relative with dementia, % yes	52.8	52.4	54.4	$\chi^2(1)=0.07$	.79
Body Mass Index(kg/m ²), mean $\pm$ standard deviation (SD)	27.75 $\pm$ 5.05 (n=273)	27.33 $\pm$ 5.51	27.85 $\pm$ 4.94	<i>t</i> (271)= -0.67	.50
Geriatric Depression Score, total score, mean $\pm$ SD	2.32 $\pm$ 2.57 (n=282)	2.35 $\pm$ 2.40 (n=57)	2.32 $\pm$ 2.61 (n=225)	<i>t</i> (280)= 0.09	.93
Number of total medications, mean $\pm$ SD	6.56 $\pm$ 3.57 (n=288)	6.47 $\pm$ 4.01 (n=57)	6.58 $\pm$ 3.46 (n=231)	<i>t</i> (286)= -0.19	.85
Time since onset of symptoms (years), mean $\pm$ SD	3.72 $\pm$ 2.59 (n= 262)	2.98 $\pm$ 1.91 (n=49)	3.89 $\pm$ 2.70 (n=213)	<i>t</i> (260)= -2.23	.03
Distance from Alzheimer's Disease Center (miles), mean $\pm$ SD	26.80 $\pm$ 29.03	65.03 $\pm$ 36.06	17.20 $\pm$ 16.49	<i>t</i> (287)= 14.93	<.001

^a All comorbid conditions present a "history of" the condition (past and present)^b Fisher's Exact test was used due to cells with expected count less than 5

Table 3

Neuropsychological Measures for Older, Appalachian-Dwelling Adults with MCI, Rural and Urban, N=289

Neuropsychological measures *	Total sample (N=289)	Rural (n=58)	Urban (n=231)	Test statistic	p-value
Clinical Dementia Rating- Sum of Boxes (CDR-SOB, range 0-17)	1.59 ± 1.27	1.57 ± 1.27	1.60 ± 1.27	t(287)= -0.15	.88
Memory					
Logical Memory 1A- Immediate	-0.76 ± 1.07	-0.89 ± 1.15	-0.72 ± 1.05	t(287)= -1.07	.29
Logical Memory 1A- Delayed	-0.95 ± 1.00	-1.09 ± 1.09	-0.92 ± 0.98	t(287)= -1.18	.24
Language					
Boston Naming Test Score	-0.55 ± 1.00	-0.69 ± 1.12	-0.52 ± 0.97	t(287)= -1.16	.25
Category Fluency, Animals	-0.56 ± 0.88	-0.52 ± 0.87	-0.57 ± 0.88	t(287)= 0.34	.73
Category Fluency, Vegetables	0.10 ± 1.19 (n=288)	0.29 ± 1.05 (n=58)	0.06 ± 1.22 (n=230)	t(286)= 1.35	.18
Attention/Psychomotor Speed					
Trailmaking A Score	-0.17 ± 1.13 (n=288)	-0.58 ± 1.75 (n=58)	-0.06 ± 0.89 (n=230)	t(286)= -3.16	<.01
WAIS-R Digit Symbol Substitution	-0.22 ± 0.91 (n=288)	-0.35 ± 0.93 (n=58)	-0.19 ± 0.91 (n=230)	t(286)= -1.23	.22
Digit Span Forward	-0.29 ± 0.97	-0.03 ± 0.86	-0.35 ± 0.98	t(287)= 2.27	.02
Digit Span Forward Length	-0.25 ± 0.95	-0.05 ± 0.87	-0.30 ± 0.97	t(287)= 1.83	.07
Executive Functioning					
Trailmaking B Score	-0.55 ± 1.27 (n=287)	-0.75 ± 1.36 (n=58)	-0.51 ± 1.24 (n=229)	t(285)= -1.31	.19
Digit Span Backward	-0.22 ± 0.91	-0.27 ± 0.96	-0.21 ± 0.90	t(287)= -0.46	.64
Digit Span Backward Length	-0.25 ± 0.86	-0.27 ± 0.90	-0.25 ± 0.86	t(287)= -0.19	.85

* All reported values are age, sex, and education-adjusted z scores except for CDR-SOB