Published in final edited form as:
J Rural Health. 2016 June ; 32(3): 314–320. doi:10.1111/jrh.12155.

Rural-Urban differences in Alzheimer's disease and related disorders diagnostic prevalence in Kentucky and West Virginia

EL Abner, PhD[1,2], **GA Jicha, MD, PhD**[1,3], **WJ Christian, PhD**[2], and **BG Schreurs, PhD**[4]

[1]Sanders-Brown Center on Aging, Alzheimer's Disease Center, University of Kentucky, Lexington, Kentucky

[2]Department of Epidemiology, College of Public Health, University of Kentucky, Lexington, Kentucky

[3]Department of Neurology, College of Medicine, University of Kentucky, Lexington, Kentucky

[4]Department of Physiology and Pharmacology and Blanchette Rockefeller Neurosciences Institute, West Virginia University, Morgantown, West Virginia

Abstract

Purpose—Older adults living in rural areas may face barriers to obtaining a diagnosis of Alzheimer's disease and related disorders (ADRD). We sought to examine rural-urban differences in prevalence of ADRD among Medicare beneficiaries in Kentucky and West Virginia, 2 geographically similar states with large rural areas and aged populations.

Methods—Centers for Medicaid and Medicare Services Public Use Files data from 2007 to 2013 were used to assess prevalence of ADRD at the county-level among all Medicare beneficiaries in each state. Rural-Urban Continuum Codes were used to classify counties as rural or urban. We used Poisson regression to estimate unadjusted and adjusted prevalence ratios. Primary analyses focused on 2013 data and were repeated for 2007 to 2012. This study was completely ecologic.

Findings—After adjusting for state, average beneficiary age, percent of female beneficiaries, percent of beneficiaries eligible for Medicaid in each county, Central Appalachian county, percent of residents ≥ age 65 enrolled in Medicare, and percent of residents < 65 enrolled in Medicare in our adjusted models, we found that 2013 diagnostic prevalence was 11% lower in rural counties (95% CI: 9%, 13%).

Conclusions—Medicare beneficiaries in rural counties in Kentucky and West Virginia may be underdiagnosed with respect to ADRD compared to other chronic disease conditions. However, due to the ecologic design, and evidence of a younger, more heavily male beneficiary population in some rural areas, further studies using individual-level data are needed to confirm the results

Keywords

access to care; epidemiology; Medicare; health disparities

Corresponding author: Erin Abner, PhD, 800 S. Limestone St., Sanders-Brown Center on Aging, Lexington, KY 40536, ph. 859-218-3825, erin.abner@uky.edu.

Disclosures:
The authors have no conflicts of interest to report.

Introduction

By 2030, over 20% of the United States population will be at least 65 years old,[1] the age at which incidence of Alzheimer's disease and related disorders (ADRD) begins to increase. The Alzheimer's Association estimates that there are 5.3 million cases of ADRD in 2015 and predicts that there will be 8.4 million cases in 2030.[2] Currently, there are no effective disease-modifying treatments or preventive strategies for ADRD. Without breakthroughs in treatment and prevention, these numbers are expected to continue to increase dramatically over the next several decades. Importantly, by 2013, 20% of the population in non-metropolitan areas was already over the age of 65,[3] which suggests that rural populations may be disproportionately affected by diseases of old age, including ADRD. Indeed, age-adjusted mortality due to ADRD in rural areas exceeded that in metropolitan areas by 11% between 2005 and 2009.[4]

Prior studies on rural health disparities related to ADRD have focused largely on issues of access to care for patients diagnosed with dementia, and the research has shown that patients with dementia living in rural areas are more likely to receive suboptimal healthcare.[5,6] Thorpe and colleagues (2010) suggest that rural dementia patients may face barriers to effective ambulatory care and experience unnecessary hospitalizations.[5] Similarly, Naumova and colleagues (2009) examined claims data from Centers for Medicaid and Medicare Services (CMS) between 1998 and 2002 and reported that while rural beneficiaries were more likely to be diagnosed with pneumonia and influenza overall, rural dementia patients were less likely to receive an influenza diagnosis, had shorter hospital stays associated with influenza, and were 50% more likely to die from influenza.[6]

In addition to receiving suboptimal care once diagnosed, we hypothesize that rural patients may be less likely to be diagnosed with ADRD overall, that is, to remain undiagnosed when the disease is present. ADRD diagnoses are based on a complex evaluation by the clinician and should include cognitive and functional evaluations, brain imaging, and blood tests to screen for medically reversible causes of dementia at minimum.[7] Current criteria also include consideration of biomarker evidence for disease that may include amyloid-positron emission tomography (PET) and fluorodeoxyglucose (FDG)-PET imaging, as well as cerebrospinal fluid collection and analysis for β-amyloid and tau levels. Such procedures, including even basic brain imaging, may not be available in many rural areas, and more advanced diagnostic procedures such as PET are typically only available in specialized academic research centers. Moreover, higher prevalence of multi-morbidity in rural populations[8] may leave rural clinicians with limited time to assess patients for emerging cognitive dysfunction using even routine bedside assessment tools.

Despite the lack of available disease-modifying treatments to prevent, slow, or halt the disease process, missed diagnoses are a concern for several reasons. First, the underlying cause of cognitive impairment may be medical and potentially reversible (e.g., vitamin B12 deficiency, thyroid dysfunction, or depression).[9] Second, there are several symptomatic therapies that can help manage the symptoms of cognitive impairment due to ADRD, and many other treatment options that can address the behavioral and psychiatric symptoms of dementia effectively. Third, dementia patients' quality of life may be enhanced by non-pharmacologic management of comorbidities and lifestyle modifications such as increasing physical activity.[10,11] Additionally, the personality, behavioral, and functional changes that often accompany dementia may be less upsetting for caregivers if they are explained by a diagnosis. Lastly, accurate diagnoses allow for prognosis, planning, and preparation in order to lessen the socioeconomic impact of ADRD on both persons with ADRD and their caregivers, as well as on health care facilities and resources in underserved rural areas.

We hypothesized that ADRD prevalence would be lower in rural than urban counties in Kentucky and West Virginia. To test this hypothesis, we conducted a completely ecologic study of ADRD diagnostic prevalence in rural versus urban counties using data from the CMS Public Use Files for Medicare beneficiaries. The ecologic design was selected due to the unavailability of individual-level data. However, we note that the central limitation of ecologic studies, that information on the exposures of individuals is lacking, is less critical in this application because the exposure of interest, residence in a rural county, can be assumed to be true of all beneficiaries in a given rural county.

Methods

Sample

Centers for Medicaid and Medicare Services (CMS) provides public use data files with state- and county-level prevalence for a number of chronic conditions, including ADRD.[12] The prevalence figures cover 100% of Medicare fee-for-service and Medicare Advantage beneficiaries in each county, including those under age 65, and are available for the years 2007 to 2013. County-level data for only beneficiaries over age 65 are not available, and it was not possible to separate out only beneficiaries who were over age 65. We extracted county-level data for Kentucky and West Virginia, which are similar geographically and culturally, to examine differences in prevalence of ADRD among Medicare beneficiaries in rural versus urban counties. Rural counties were categorized based on the 2013 Economic Research Service Rural-Urban Continuum Codes (RUCC), where counties with an urban population size less than 20,000 were considered rural (RUCC codes 6–9: Urban population less than 20,000) and all others were considered urban (RUCC codes 1–5: Urban population of least 20,000).

Study Design

We conducted a completely ecologic analysis using the county-level aggregated data described above, focusing on the results from 2013, with the goal of making ecologic inferences about the association between rural residence and prevalence of ADRD among Medicare beneficiaries. We interpreted prevalence of ADRD in the CMS file to be indicative of patients who were adequately diagnosed with ADRD rather than the true prevalence of ADRD among beneficiaries (which would include all undiagnosed cases), and we will refer to these prevalence figures as ADRD diagnostic prevalence. This assumption is based on studies of primary care providers and general practitioners that show that diagnostic sensitivity for mild dementia may be poor (ie, <50%).[13] We hypothesized that beneficiaries living in rural counties may be underdiagnosed for ADRD at higher rates compared to beneficiaries living in urban counties.

Analysis

Unadjusted and adjusted prevalence ratios, and their associated 95% confidence intervals, comparing ADRD treatment prevalence in rural and urban counties were estimated with Poisson regression such that the number of beneficiaries with ADRD per county in 2013 was the dependent variable, and the natural log of the total number of beneficiaries per county was used as the offset. Poisson regression was selected due to the count distribution of outcome. Two adjusted models were constructed to estimate adjusted diagnostic prevalence ratios. To address potential confounding factors, county-level measures of average beneficiary age, percent of female beneficiaries, and percent of beneficiaries who were Medicaid eligible, percent of county residents age ≥ 65 years enrolled in Medicare, percent of county residents age < 65 enrolled in Medicare, and an indicator for Central Appalachian county were included in the first adjusted model (Model 1). Central Appalachian counties were defined based on the 2009 Appalachian Regional Commission classifications, and percent of country residents enrolled in Medicare was obtained from the Health Resources and Services Administration Area Health Resources File, based on 2012 data. State of residence was also included to adjust for differences in overall ADRD diagnostic prevalence between the 2 states. An interaction term between rural classified county and state of residence was also assessed to examine whether the effect, if any, of rural residence depended on state of residence; this term was not retained due to its non-significance in the model. Its inclusion and subsequent exclusion did not affect the model results.

Over 70% of Medicare beneficiaries diagnosed with ADRD in 2012 had at least three comorbid conditions.[14] To address the increased opportunity of ADRD diagnosis if beneficiaries were more likely to seek frequent medical care due to comorbid conditions, we constructed a second adjusted model that included all terms from Model 1 along with county-level diagnostic prevalence of chronic obstructive pulmonary disease (COPD), hypertension, ischemic heart disease, stroke, diabetes, depression, colorectal cancer, lung cancer, and breast cancer.

To address the question of whether our results were specific to ADRD or reflected general prevalence patterns across a number of chronic diseases, Model 1 was rerun for each chronic condition listed above. We also investigated whether the patterns we saw were specific to 2013 or had remained stable over time by running Model 1 for each data year (2007 – 2013), for ADRD only. Model 1 was used instead of Model 2 because low diagnostic prevalence of certain conditions in some counties (i.e., fewer than 11 cases), for which figures were suppressed by CMS, led to a reduced sample for Model 2. Additionally, adjustment for numerous confounders in ecologic analyses may increase bias.[15] All regression analyses were conducted using SAS 9.4® PROC GENMOD. Spatial autocorrelation among the model raw residuals was assessed by using PROC VARIOGRAM to calculate Moran's I correlation coefficient based on the latitude and longitude of each county seat.

Results

The total number of Medicare beneficiaries for Kentucky and West Virginia in 2013 was 1,209,976, with 443,726 living in counties classified as rural (n=110 of 175 total counties) (Table 1). Overall, 97.9% of Medicare-eligible adults ≥ age 65 were enrolled, and rural counties had a higher proportion of individuals under the age of 65 who were enrolled (9.3% vs. 6.8%, $P < .0001$). Average age of beneficiaries ranged from 62 to 72, with an overall mean age of 68. The gender distribution in rural counties tended to be more male than female, particularly in Central Appalachian areas of eastern Kentucky, and a significantly higher proportion of beneficiaries in rural counties were eligible for Medicaid ($P < .0001$ for both comparisons by χ^2 test).

Overall ADRD diagnostic prevalence was somewhat higher in Kentucky (6.98%) than in West Virginia (6.53%) ($P < .0001$), and prevalence in both rural (6.57% vs. 5.88%, $P < .0001$) and urban (7.25% vs. 6.82%, $P < .0001$) counties was also higher in Kentucky. Diagnostic prevalence in rural counties in both states together was lower than in urban counties (Table 1; PR = .90, 95% CI: .87, .91). It is striking that in Table 1, diagnostic prevalence for all conditions listed, except ADRD, is higher in rural than in urban counties. It is also worth noting that compared to ADRD, many of these conditions have straightforward diagnostic procedures.

ADRD diagnostic prevalence remained lower in rural than urban counties after adjustment in both Model 1 and Model 2 (Table 2). No spatial dependence among the residuals was detected in either model: Moran's I for Model 1 = −.00528, $P = .9$; Model 2 = −.00482, $P = .75$. Although inclusion of multiple chronic conditions appears to attenuate the disparity in ADRD diagnosis, missing data for lung, breast, and colorectal cancer in nine rural, but no urban, counties led to their exclusion from the model. Thus, the small attenuation may be an artifact. As in Model 1, older average age and higher proportion of female beneficiaries was significantly associated with higher ADRD diagnostic prevalence (Table 2).

In addition to ADRD, beneficiaries in rural counties were significantly less likely to be diagnosed with stroke (PR = .90, 95% CI: .87, .93). These results may indicate a lack of access to neurological care in rural counties. In addition, depression (PR = .95, 95% CI: .94, .97) and ischemic heart disease (PR = .96, 95% CI: .95, .98) were less likely to be diagnosed in rural counties. Beneficiaries in rural counties were significantly more likely to be diagnosed with diabetes ($P = .0003$) and hypertension ($P < .0001$). The disparity in ADRD diagnostic prevalence appears to have grown since 2007 (Table 3), when there was a 5% reduction in adjusted ADRD diagnostic prevalence in rural counties, to 2013, where there was an 11% reduction.

Discussion

This ecologic study of Medicare beneficiaries in Kentucky and West Virginia found evidence for reduced diagnostic prevalence of ADRD in rural versus urban counties, and this disparity increased by an estimated 6% between 2007 and 2013. There are several possible explanations for the findings: 1) ADRD may simply not be diagnosed in rural counties at the same rates as urban counties; 2) the true prevalence of ADRD among beneficiaries is in fact lower in rural counties, which could result from a population of beneficiaries who are younger and predominantly male, or from reduced life expectancy due to the higher burden of poverty and other chronic conditions; 3) the findings are a result of the ecologic fallacy (eg, if we were able to calculate age- and sex-standardized morbidity ratios, we might find no difference between rural and urban counties).

We believe our data suggest that ADRD may simply be underdiagnosed in rural counties in Kentucky and West Virginia. There are several reasons why this is the most likely explanation for the reduced prevalence of dementia in rural populations seen in the present study. These include both consideration of increased risk for dementia and decreased access to healthcare for dementia diagnosis and care in rural communities. Risk factors for dementia include many chronic health conditions and lifestyle factors[16] such as hypertension, obesity, hyperlipidemia, diabetes, head trauma, depression, alcoholism, tobacco use, and lower educational attainment, among others, that are over-represented in rural vs. urban populations. Thus, it stands to reason that one would expect a higher prevalence of dementia in rural communities, in contrast to our findings. On the other hand, access to dementia care services, as well as education and support programs, may be reduced in rural communities.[17] As such, primary care physicians and medical staff in rural areas may be both overburdened with management of medical morbidities that consume the limited interaction time with their patients, and may also be underprepared or undertrained to accurately diagnose ADRD.

Additionally, the finding that stroke was also less commonly diagnosed in rural areas lends some support to the underdiagnosis hypothesis, as does the fact that primary care providers,[18] and especially neurological specialists,[19] tend to practice in more urban areas, where there are large enough populations to support their practices. A recent study of telemedicine-based neuropsychological evaluation of patients in rural and small communities suggests over 80% of patients with neurocognitive disorders in these areas may have an inaccurate diagnosis.[20] Our experience with a rural telemedicine clinic serving these regions in Kentucky suggests that at initial referral, those from rural areas are more advanced in their dementia compared to those referred from urban or suburban areas. This suggests that lower recognition of the early stages of ADRD in these rural populations could be responsible for the overall lower prevalence estimates of ADRD seen in the present study.

Regarding the possibility of reduced rural ADRD prevalence due to a younger beneficiary population, it is the case that in 2010, total life expectancy in rural counties in Kentucky and West Virginia[21] was reduced relative to urban counties for both men (71.9±2.2 vs. 73.4±1.7 years, $P < .0001$) and women (77.5±1.5 vs. 78.4±1.2 years, $P < .0001$). This is an incomplete explanation, however, because total life expectancy reflects life expectancy from birth, whereas the beneficiaries have already survived to much higher ages, the majority over age 65, and thus residual life expectancy is the most appropriate measure. However, those data were not available at the county level.

In Kentucky in particular, rural counties had beneficiaries with the youngest average ages. Indeed, a striking finding in this study is that the beneficiary populations in Central

Appalachian areas of southeastern Kentucky and southwestern West Virginia were predominantly male and were on average among the youngest beneficiaries. The reasons for this difference in the beneficiary population are unclear and likely complex. However, it is interesting that according to 2013 Census population estimates,[22] rural counties in these 2 states have similar, even slightly higher, proportion of residents age 85 and older compared to urban counties (rural: range 1.03 – 3.63%, urban: range: .96 – 3.27%). This suggests that it is not the overall age distributions of the counties that are different but rather the beneficiaries specifically. If we restrict the analysis to counties with an average beneficiary age of 65 and above (n=101 rural counties, n=65 urban counties), ADRD diagnostic prevalence remains lower in rural counties (PR = .88, 95% CI: .87, .91). Although we controlled for county-level average age, gender distribution, Central Appalachian county, percent of residents ≥ age 65 enrolled in Medicare, and percent of residents < 65 enrolled in Medicare in our adjusted models, ecologic studies are vulnerable to residual confounding. This is a question worth pursuing with individual-level data.

Finally, it may be that at the individual level, beneficiaries in each county are optimally diagnosed. Although there are currently only symptomatic treatments available and no proven disease-modifying treatments for ADRD, diagnosis is important for patients and their families. Early diagnosis provides opportunities for symptomatic treatment, participation in clinical treatment trials, for creating long-term care plans, estate planning, and often provides the answer as to why a loved one has become forgetful, irritable, paranoid, anxious, or depressed. Further, early intervention to improve the general health of the patient through management of comorbidities and increasing physical activity, along with other lifestyle modifications, may delay the onset of more severe symptoms.[10,11]

This study demonstrated that diagnostic prevalence of ADRD among Medicare beneficiaries in rural counties in Kentucky and West Virginia is lower on average than in urban counties. Although we controlled for confounding so far as we were able, we cannot rule out that at the individual level, diagnostic prevalence is the same. However, if it truly is the case that Medicare beneficiaries, and older adults in general by extension, in rural counties are not being optimally diagnosed, that has important public health implications. Further studies are needed to confirm these findings.

Acknowledgments

We thank Dr. Richard J. Kryscio for advice on the statistical analyses.

Funding:

This study was partially supported by funding from NIA P30 AG028383.

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Table 1

Kentucky and West Virginia Medicare beneficiary characteristics by residence rural versus urban counties* (2013)**

Beneficiaries Characteristics	All Beneficiaries (N=1,209,976)	Rural (N=443,726)	Urban (N=766,250)
Average age, years	68.4±2.0	68.1±2.2	68.0±1.4
Female (%)	53.0	50.9	54.2
Eligible for Medicaid (%)	26.4	31.8	23.3
Alzheimer's Disease and related disorders (%)	6.8	6.4	7.1
Other chronic conditions (%)			
Chronic Obstructive Pulmonary Disease	12.2	14.6	10.9
Hypertension	44.2	46.4	42.9
Ischemic heart disease	22.5	24.6	21.5
Stroke	2.3	2.6	2.1
Diabetes	21.5	23.1	20.5
Depression	14.2	14.6	14.1
Colorectal cancer	.9	1.0	.8
Lung cancer	.8	.9	.7
Breast cancer	1.5	1.6	1.5

*Rural residence is defined by 2013 Economic Research Service Rural-Urban Continuum Codes 6–9. Urban includes Continuum Codes 1–5.

**Data source: Centers for Medicaid and Medicare Services Public Use File: State/County Table, All Beneficiaries. Downloaded April 11, 2015.

Table 2

Prevalence ratios with 95% confidence intervals* for patient diagnosis of Alzheimer's disease and related disorders among Kentucky and West Virginia Medicare beneficiaries (2013)**

County-level characteristics***	Unadjusted	Model 1	Model 2****
Rural vs. urban	.90 (.87, .91)	.89 (.87, .91)	.91 (.89, .93)
Average beneficiary age, 5-year	--	1.19 (1.13, 1.25)	1.24 (1.17, 1.32)
Percent female beneficiaries, 10-point	--	1.19 (1.13, 1.25)	1.12 (1.05, 1.19)
Percent Medicaid eligible, 10-point	--	1.17 (1.15, 1.19)	1.17 (1.15, 1.19)
Percent county pop. age 65+ enrolled in Medicare, 10-point		1.06 (1.02, 1.10)	1.06 (1.02, 1.10)
Percent county pop. age <64 enrolled in Medicare		1.02 (1.01, 1.02)	1.01 (1.00, 1.01)
Kentucky vs. West Virginia	--	1.11 (1.09, 1.13)	1.09 (1.07, 1.12)
Central Appalachian vs. not	--	.82 (.80, .84)	.82 (.80,.84)
Percent COPD	--	--	1.01 (1.00, 1.01)
Percent hypertension	--	--	1.01 (1.00, 1.01)
Percent ischemic heart disease	--	--	1.00 (0.99, 1.00)
Percent stroke	--	--	1.04 (1.03, 1.06)
Percent diabetes	--	--	1.00 (1.00, 1.01)
Percent depression	--	--	1.00 (1.00, 1.01)
Percent colorectal cancer	--	--	.90 (.87, .94)
Percent lung cancer	--	--	.95 (.91, .99)
Percent breast cancer	--	--	1.05 (1.02, 1.08)

* Estimates derived from Poisson regression with offset equal to the log of the number of Medicare beneficiaries in each county.

** Data source: Centers for Medicaid and Medicare Services Public Use File: State/County Table, All Beneficiaries. Downloaded April 11, 2015.

*** Estimates for percent increases are one unit unless otherwise specified.

**** Suppressed data for lung, breast, and colorectal cancer led to the exclusion of nine rural, but no urban, counties.

Table 3

Adjusted prevalence ratios with 95% confidence intervals* for diagnostic prevalence of Alzheimer's disease and related disorders in Kentucky and West Virginia, by year (2007–2013)**

Year	Adjusted PR (95% CI)
2007	.95 (.93, .97)
2008	.93 (.91, .95)
2009	.93 (.91, .95)
2010	.92 (.90, .94)
2011	.92 (.90, .94)
2012	.91 (.89, .93)
2013	.89 (.87, .91)

*Estimates derived from Poisson regression with offset equal to the log of the number of Medicare beneficiaries in each county. Estimates are adjusted for average beneficiary age, percent female beneficiaries, percent of Medicaid eligible beneficiaries, state, Central Appalachian county indicator, percent of county residents ≥ age 65 enrolled in Medicare, and percent of county residents < 65 enrolled in Medicare.

**Data source: Centers for Medicaid and Medicare Services Public Use File: State/County Table, All Beneficiaries. Downloaded April 11, 2015.