International Journal of Gerontology 15 (2021) 49–52
https://doi.org/10.6890/IJGE.202101_15(1).0010

International Journal of Gerontology

journal homepage: http://www.sgecm.org.tw/ijge/

Original Article

Does Living in Rural Areas Impact the Diagnostic Prevalence of Alzheimer's Disease and Related Disorders? The Cases of Arkansas and Louisiana

Badr Alnasser

Department of Health Management, College of Public Health and Health Informatics, University of Ha'il, Ha'il, Saudi Arabia

ARTICLE INFO

Accepted 21 September 2020

Keywords:
public health
Alzheimer disease
healthcare disparities
rural health

SUMMARY

Background: Alzheimer's disease is a known form of dementia that causes a person to experience the inabilities to perform daily tasks. One determinant of this disease is geographical location where variations in terms of diagnosis and prevalence of Alzheimer's disease and related disorders (ADRD) may exist. This study aims to investigate the likelihood that patients residing in rural areas are less likely to be diagnosed with ADRD compared to those living in urban communities.
Methods: An ecologic study design is utilized to investigate the association between the outcome, ADRD prevalence among Medicare beneficiaries, and the exposure of living in rural counties. The Centers for Medicare & Medicaid Services Public Use Files data is used to examine the prevalence of county-level ADRD among all Medicare beneficiaries in Arkansas and Louisiana in the year 2013. A special coding system called the Rural-Urban Continuum Codes is employed for counties classification. The performed analysis employed Poisson regression to investigate and adjust prevalence ratios.
Results: Medicare beneficiaries living in rural counties showed a very slight increase, yet insignificant, in the diagnostic prevalence of ADRD by 0.003 (95% CI: -0.06–0.06), after adjusting for state, average age, race, percent of female beneficiaries, percent of Medicaid eligibility, percent of county population aged 65+ & < 64 who were enrolled in Medicare, other comorbidities, and chronic diseases.
Conclusion: There is no significant evidence to suggest that Medicare beneficiaries living in rural counties in Arkansas and Louisiana have a lower diagnostic prevalence of ADRD compared to their urban counterparts.

1. Introduction

Alzheimer's disease (AD) is a known form of dementia that causes a person to experience the inabilities to perform daily tasks and/or carry on a conversation due to a decline in memory and mental ability.[1] Symptoms are usually first shown after the age of 60, although brain changes could occur earlier in life.[2] Many risk factors have been linked to AD such as age, genetics, and other socio-demographic determinants.[2] The Centers for Disease Control and Prevention (CDC) considers Alzheimer's disease to be one of the top ten leading causes of death in the U.S. and ranks it as the fifth primary reason for mortality among those aged 65 to 85 years old.[2] Furthermore, in 2013, the prevalence of AD reached five million in America, and the number is projected to increase to almost 14 million by 2050.[2] In terms of healthcare costs, it is predicted that by 2040, the cost related to AD will more than double, reaching between $379 and more than $500 billion each year.[2]

AD dementia is found to be underreported on death certificates[2] and this is likely to be more in rural areas where death rates of people with dementia are higher than the national average.[3] Thus, some studies have focused on the variation between rural and urban regions in terms of AD diagnosis, and the barriers that rural older people face to access adequate medical care.[4] For instance, Thorpe et al.[4] looked at the rural-urban differences in terms of access to outpatient care in community-dwelling veterans with dementia and found that those who live in the most rural counties were more likely to face difficulties accessing ambulatory care (the chosen indicator for access to outpatient care) that is adequate and on time. Moreover, another study found that the diagnosis of a certain disease in rural dementia patients is low; a likely indication of accessibility challenges.[3]

However, the focus of several studies[5–7] was primarily on the prevalence of Alzheimer's disease and related disorders (ADRD) in rural communities due to risk factors like age, gender, race, and education. Few have looked at accessibility barriers and the diagnosis of ADRD as the outcome of interest,[4] although the focus was sometimes aimed at a particular rural population (i.e. Veterans). Thus, this study aims to investigate the likelihood that patients residing in rural areas are less likely to be diagnosed with ADRD compared to those living in urban communities.

Although there isn't one known test that can determine ADRD, patients usually undergo a range of diagnostic procedures that enable doctors to decide, with high certainty, that they have AD and/or related disorders.[1] These procedures range from physical examination and laboratory tests to behavioral and psychiatric evaluation.

* Corresponding author. Department of Health Management, College of Public Health and Health Informatics, University of Ha'il, Ha'il 81451, Kingdom of Saudi Arabia.
E-mail address: b.alnasser@uoh.edu.sa (B. Alnasser)

Likewise, complete treatment for ADRD, especially in advanced cases, does not yet exist, and current treatments vary depending on individual cases but there are some medications and designed interventions that may slow or terminate the progression in some cases.[1]

This study revisits, and to some extent replicates, the study of Abner et al.: "*Rural-Urban Differences in Alzheimer's Disease and Related Disorders Diagnostic Prevalence in Kentucky and West Virginia*", but with using Arkansas and Louisiana as the study sample and setting.[9] To conduct this study, we hypothesize that the diagnosis of ADRD is less in rural counties compared to their urban counterparts in Arkansas and Louisiana. Data from the Centers for Medicare & Medicaid Services (CMS) Public Use Files for Medicare beneficiaries was used to compare rural-urban differences in terms of diagnosed ADRD prevalence in the two States.[8] The analysis was conducted using an ecologic study design, which utilized aggregated data at the county level. Although ecologic studies are known to suffer from imprecision in capturing exposure at the individual level, the fact that this study chooses rural residency as the exposure of interest is likely to limit this imprecision.

2. Methods

2.1. Sample

The data comes from the public use files of the CMS, in which data are documented on the prevalence of ADRD at the state and county levels.[8] In this study, we used data for Medicare fee-for-service and Medicare advantage beneficiaries (including beneficiaries under the age of 65) at the county level for Arkansas and Louisiana only, in the year 2013. Both of these states are geographically close to each other and believed to be appropriate for investigating rural-urban county variations in the prevalence of ADRD among beneficiaries. The coding of rural counties was derived from the Rural-Urban Continuum Codes (RUCCs) based on the 2013 Economic Research Service.[9] Rural counties were categorized as urban population less than 20,000, and took the form RUCC codes 6–9, while RUCC codes 1–5 represent urban counties where the population is 20,000 or more. The CMS website provides detailed information on their data use policy and management, and since all data in this study is publically available data from CMS, there was no need for any ethical approval.[8]

2.2. Study design

The analysis was conducted using an ecologic study design, which utilized the aggregated 2013 county-level data. We employed this design in an attempt to find the ecologic inference of an association between the outcome, ADRD prevalence among Medicare beneficiaries, and the exposure of living in rural counties. In the CMS data, the prevalence of ADRD refers to those with ADRD diagnosis and not the true prevalence of ADRD that include those undiagnosed.

2.3. Analysis

Poisson regression was used to provide the adjusted prevalence ratios (including the 95% confidence interval) to compare the prevalence of diagnosed ADRD in rural and urban counties. We considered the number of beneficiaries with ADRD for each county as the dependent variable, and the offset as the natural log of the total number of beneficiaries per county. The reason Poisson regression was chosen is due to the nature of the outcome (count data) and the absence of excess dispersion. In order to conduct the adjusted prevalence ratios of diagnosed ADRD, we used two models; both of which were to adjust for confounding. However, Model 2, a negative binomial regression, was used as it appears to be a good fit due to the insignificance p-value that resulted after the model was tested (p-value 1.26 > 0.05) and was also justified by the greater-than-zero estimate of the dispersion (95% CI 0.005–0.01). Further, there appeared to be a prevalence of many other comorbidities among beneficiaries, which may increase the possibility of seeking care and, thus, increase the chances of a diagnosis of ADRD. Model 1 included the following variables: average age, percent female, percent eligible for Medicaid, and percent of the county population who were aged 65+ and < 64 and were enrolled in Medicare. In addition to the previous variants, Model 2 included the percent of non-Hispanic White, percent of African Americans, and the following percentages of chronic diseases: chronic obstructive pulmonary disease, stroke, hypertension, high cholesterol, arthritis, depression, and diabetes.

Due to the high prevalence of the number of comorbidities shown in Table 1, Model 2 can be used, as the threat of suppressed figures were reduced (Table 2), allowing for an adequate sample for Model 2, although this could increase bias in the ecologic analysis as the number of controlled variables is high. The analysis was performed using SAS 9.4 PROC GENMOD (SAS Institute Inc., Cary, North Carolina).[10] Also, Moran's I correlation coefficient was computed by using PROC VARIOGRAM to calculate spatial autocorrelation and pairwise distance weights.

3. Results

In 2013, Medicare beneficiaries in Arkansas and Louisiana amounted to 1,297,271, out of which 947,776 beneficiaries live in urban areas while 349,495 beneficiaries constituted rural population. Table 1 shows percentages of ADRD of 10.5% across all counties, with the average age of around 70 of all Medicare beneficiaries (with the same percentage in both rural and urban counties), and with females making around 54% (slightly higher in urban than rural). Also, about 76% of beneficiaries were non-Hispanic Whites and 20% were African Americans. Of the chronic diseases, hypertension (59%), high cholesterol (40%), and arthritis (30%) were higher among all beneficiaries compared to other diseases (the same in rural and urban, except for high cholesterol, which was higher in urban counties), then followed by diabetes (28% for urban and 27% for rural). Overall, there are no significant differences in characteristics between urban and rural counties.

Table 2 above shows the prevalence ratios (reported as estimates) for patients diagnosed with ADRD in the two states. Both models suggest similar, yet non-significant results after adjustment in terms of living in rural counties, which slightly increases the diagnostic prevalence of ADRD by 0.003 (95% CI: -0.06–0.06), consistent with the results shown in Table 1. However, the insignificance of those results makes us less confident to suggest a lower diagnostic ADRD prevalence in rural counties. Further, the similarity of results in both models was supported by the absence of spatial dependence among the residuals in both of them (Moran's I for Model 1 = -0.0116, p = 0.3; Model 2 = -0.0116, p = 0.4). Model 1 shows that older average age (0.02 (95% CI: -0.004–0.04)) and female beneficiaries (0.05 (95% CI: 0.03–0.06)) were more likely to be associated with ADRD diagnostic prevalence, although this was more significant regarding female beneficiaries. The influence of race shows no significance as both non-Hispanic Whites and African Americans have the same insignificant association with ADRD diagnostic prevalence.

Table 1
Arkansas and Louisiana Medicare beneficiary characteristics by residence, rural, versus urban counties, 2013.

Beneficiaries characteristics	All (N = 1,297,271)	Urban (N = 947,776)	Rural (N = 349,495)
Alzheimer's disease and related disorders (%)	10.5	10.4	10.5
Average age	69.7	69.3	70.1
Female (%)	53.9	54.2	53.8
Eligible for Medicaid (%)	28.2	27.1	29.1
Non-Hispanic white (%)	76.5	75.6	77.9
African American (%)	20.7	21	20.2
Other chronic conditions (%)			
Chronic obstructive pulmonary disease	12.8	11.9	13.5
Stroke	4.3	4.4	4.1
Hypertension	58.9	59.5	58.6
High cholesterol	39.8	42.3	37.7
Arthritis	30.2	29.4	30.8
Depression	15	15.8	14.4
Diabetes	27.3	27.9	26.8

Table 2
Prevalence ratios with 95% Confidence intervals for patient diagnosis of Alzheimer disease and related disorders among Arkansas and Louisiana Medicare beneficiaries, 2013.

County-level characteristic	Model 1[a]	Model 2[a]
Rural vs. urban	-0.006 (-0.06–0.05)	-0.003 (-0.06–0.06)
Arkansas vs. Louisiana	-0.002 (-0.06–0.06)	0.019 (-0.08–0.12)
Average beneficiary age	0.02 (-0.004–0.04)	0.02 (-0.007–0.05)
Percent female beneficiaries	0.05 (0.03–0.06)	0.04 (0.02–0.06)
Percent Medicaid eligible	0.005 (0.0007–0.009)	0.006 (-0.0007–0.01)
Percent county pop. age 65+ enrolled in Medicare	0.007 (-0.002–0.02)	0.007 (-0.003–0.02)
Percent county pop. age < 64 enrolled in Medicare	0.02 (0.001–0.03)	-0.005 (-0.03–0.02)
Percent non-Hispanic Whites		0.012 (-0.002–0.03)
Percent African Americans		0.013 (-0.001–0.03)
Percent COPD		0.004 (-0.01–0.02)
Percent stroke		-0.03 (-0.07–0.01)
Percent hypertension		-0.003 (-0.01–0.01)
Percent high cholesterol		-0.003 (-0.01–0.004)
Percent arthritis		-0.005 (-0.012–0.003)
Percent depression		0.02 (0.003–0.03)
Percent diabetes		0.07 (0.005–0.01)

[a] Estimates derived from Poisson regression with an offset equal to the log of the number of Medicare beneficiaries in each county. Estimates for percent increases are 1 unit unless otherwise specified.
Data source: Centers for Medicaid and Medicare Services Public Use File: State/County Table, All Beneficiaries.

Regarding the diagnosis of chronic diseases, rural beneficiaries were less likely to be diagnosed with depression (0.02 (95% CI: 0.003–0.03)), and more likely, although non-significant CI, to be diagnosed with stroke (-0.03 (95% CI: -0.07–0.01)). Diabetes diagnosis was also less in rural counties (0.007 (95% CI: 0.005–0.01)).

4. Discussion

The study shows no significant evidence to support that there is a lower diagnostic prevalence among Medicare beneficiaries who live in rural counties compared to their urban counterparts in Arkansas and Louisiana. This might be explained by the almost equal distribution of beneficiaries' characteristics across rural and urban counties in those states. First, the prevalence of ADRD is relatively small and showed almost the same percentages in rural compared to urban counties (around 10.5%). Second, the distribution of females, the only variable with significant association to ADRD, among both types of residence was also the same (about 54%). Furthermore, average age and race, although insignificantly associated with ADRD, were similar in rural and urban counties. Finally, no comorbidities were significantly associated with ADRD except for depression and, to some extent, diabetes, both of which showed similar prevalence among rural beneficiaries compared to their urban counterparts.

Other possible explanations of the absence of evidence suggesting variations in terms of diagnostic prevalence between rural and urban counties might come from a comparison of the two states, Arkansas and Louisiana, to the national averages in terms of ADRD predictors found in the literature.[5–7] For instance, life expectancy in both states falls under the national average of about 79 years (76 for Arkansas and 75.7 for Louisiana),[11] allowing for the assumption that beneficiaries in both states have lower life expectancies and, thus, lower the possibility of developing dementia and AD. Another predictor can be the level of education, which is also below the national average (less than college degree: 86.3%) in both states.[12,13]

However, a significant aspect of the present study is that it seems to confirm the uncertainty discussed by Abner et al. regarding their study results.[9] Although that study yield a lower diagnostic prevalence of ADRD in Kentucky and West Virginia rural areas, they suggested that it was most likely due to the underdiagnoses of ADRD among rural population. This reason seems clearly valid when comparing the percentages of Alzheimer disease and related disorders found in both studies. Our present study shows both a higher percentage of ADRD in rural areas (10.5%) compared to the percentage of ADRD in Kentucky and West Virginia rural areas (6.4%), and an almost nondifference of ADRD percentages between rural and urban areas when compared to Abner et al. study. Accessibility to healthcare and life expectancy might be some possible explanations for such variations where both indicators found to be higher in Arkansas/Louisiana versus Kentucky/West Virginia.[11–14]

However, due to the limitation of the ecologic design of the study, where the findings might be a product of ecologic fallacy, and the consequent inability to examine variables at the individual level, we must be cautious in dealing with the findings. For instance, the findings from the inclusion of all Medicare beneficiaries in the analysis might be underestimated by the possibility that some beneficiaries were younger than expected. In other words, the failure to examine beneficiaries' data in terms of age eligibility could bias the finding that there is no difference in ADRD diagnostic prevalence. However, since the outcome of interest is the prevalence of diagnosed ADRD and since the average age distribution among the counties (rural and urban) were similar, the threat of such limitation might be reduced. Having said that, future studies with different designs that can detect data at the individual level is necessary and would be the best approach to confirm the current results.

The findings of this study show no evidence that there is a lower diagnostic prevalence of ADRD among rural Medicare beneficiaries compared to their urban counterparts in Arkansas and Louisiana. Those findings seem sensible when examined by the similar distribution of socio-demographic characteristics across both types of counties in the two states, such as average age, life expectancies, and education levels. However, a more robust investigation that would be able to incorporate data on age-eligible enrollees in the analysis is necessary. Future research can look at this issue more deeply using more effective methodology and analysis.

Funding

Not applicable. This study did not receive any sort of grants or funding.

Conflict of interests/competing interests

The author declares that there is no conflict of interests to disclose.

Availability of data and material

The study uses a publicly accessible dataset.

Code availability

Available upon request.

References

1. Alzheimer's Association. *What is Alzheimer's Disease?* Chicago, US: Alzheimer's Association. Available at https://www.alz.org/alzheimers-dementia/what-is-alzheimers. Accessed November 12, 2020.
2. Centers for Disease Control and Prevention. *Alzheimer's Disease*. Atlanta, USA: Centers for Disease Control and Prevention; 2015. Available at http://www.cdc.gov/aging/aginginfo/alzheimers.htm. Accessed March 2, 2019.
3. Naumova EN, Parisi SM, Castronovo D, et al. Pneumonia and influenza hospitalizations in elderly people with dementia. *J Am Geriatr Soc*. 2009; 57(12):2192–2199.
4. Thorpe JM, Van Houtven CH, Sleath BL, et al. Rural-urban differences in preventable hospitalizations among community-dwelling veterans with dementia. *J Rural Health*. 2010;26(2):146–155.
5. Ganguli M, Dodge HH, Chen P, et al. Ten-year incidence of dementia in a rural elderly US community population: the MoVIES Project. *Neurology*. 2000;54(5):1109–1116.
6. Hall KS, Gao S, Unverzagt FW, et al. Low education and childhood rural residence: risk for Alzheimer's disease in African Americans. *Neurology*. 2000;54(1):95–99.
7. Prencipe M, Casini AR, Ferretti C, et al. Prevalence of dementia in an elderly rural population: effects of age, sex, and education. *J Neurol Neurosurg Psychiatry*. 1996;60(6):628–633.
8. Centers for Medicare & Medicaid Services (CMS). *CMS Contractor Data Communications Support Policy*. Baltimore, US: Centers for Medicare & Medicaid Services; 2013. Available at https://www.cms.gov/Research-Statistics-Data-and-Systems/CMS-Information-Technology/AccesstoDataApplication/index. Accessed November 12, 2020.
9. Abner EL, Jicha GA, Christian WJ, et al. Rural-urban differences in Alzheimer's disease and related disorders diagnostic prevalence in Kentucky and West Virginia. *J Rural Health*. 2016;32(3):314–320.
10. SAS Institute Inc. *The GENMOD Procedure*. Version 9.4. North Carolina, US: SAS Institute Inc; 2013.
11. Kaiser Family Foundation (KFF). Life Expectancy at Birth (in years). San Francisco, USA: Kaiser Family Foundation. Available at http://kff.org/other/state-indicator/life-expectancy/. Accessed March 7, 2019.
12. Census Bureau. *Quick Facts: Arkansas*. Suitland, MD: Census Bureau. Available at http://www.census.gov/quickfacts/table/PST045215/05,00. Accessed March 7, 2019.
13. Census Bureau. *Quick Facts: Louisiana*. Suitland, MD: Census Bureau. Available at http://www.census.gov/quickfacts/table/EDU635214/22,00. Accessed March 7, 2019.
14. Black LI, Schiller JS. *State Variation in Health Care Service Utilization: United States, 2014*. Atlanta, USA: Centers for Disease Control and Prevention; 2016. Available at https://www.cdc.gov/nchs/products/databriefs/db245.htm. Accessed March 7, 2019.