Investigating Relationships Between Hypertension, Sleep, and Cognitive Risk in an Underserved Community

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Abstract

Purpose: The aim of this descriptive correlational pilot study was to investigate the relationship between hypertension, sleep deprivation, and risk of Alzheimer's disease in a rural, older, underserved, and ethnically diverse cohort.

Sample: Residents (n = 52) from three independent subsidized housing units for retired farmer workers, located in a rural Florida area known as the Glades, volunteered for the study. **Methods:** A quantitative descriptive approach using Pearson correlations, t-tests, and scatter plot analysis was applied to surveys and Mini-CogTM results.

Findings: About a quarter (23.1%) of the participants were identified as being at risk for cognitive impairment. Hypertension risk correlated moderately with cognitive impairment risk ($r = 0.40$, $p = 0.01$). However, in this ethnically, diverse cohort, sleep quality did not significantly influence either blood pressure or cognitive status. This is contrary to other studies that have found an increased risk of Alzheimer's disease among persons with hypertension (Carnevale, Perrotta, Lembo, & Trimarco, 2015) and insufficient sleep (Brzecka et al., 2018). **Implications:** These results suggest that further investigation is needed to examine if rural living or culture moderates Alzheimer's disease risk factors of diminished sleep and hypertension. Future

findings could impact the design of interventions aimed at reducing AD risk in diverse rural settings.

Keywords: Alzheimer's disease, Sleep, Hypertension, Rural, Elders, Underserved, Diverse

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Multiple studies have shown that people living in rural, underserved populations with hypertension are at a higher risk for Alzheimer's disease and related dementias (ADRD) (Paterson, 2018). This population often experiences a lack of education, reduced health care, little income, poor nutrition, insignificant accessibility to primary and specialty providers, shortage of insurance, and low health literacy (Wiese, Williams, Hain, Galvin, & Newman, 2019; Wiese, Williams, & Tappen, 2014). These factors serve as root causes for increased risk of Alzheimer's disease and for secondary Alzheimer's-related health outcomes (Gaugler, James, Johnson, Marin, and Weuve (2019). Additionally, there is a lack of studies examining cognitive screening behaviors among ethnically diverse populations, despite the well-documented increased risks of AD in cultural minorities (Babulal et al., 2019). Within Florida, the Department of Elder Affairs Purple Ribbon Task Force (PRTF) found that 38% of people with AD had been undiagnosed, and the ethnically diverse inhabitants are facing greater disparities (Department of Elder Affairs, 2013). These findings demonstrate the need for a greater awareness of AD risk and detection by both providers and residents (Department of Elder Affairs PRTF, 2013). However, there are few studies that address increased AD risk in rural, older, ethnically diverse populations (Wiese, Williams, & Galvin, 2018). The purpose of this pilot study was to examine potent relationships between

cognitive impairment, hypertension, and sleep deprivation in a cohort of rural, ethnically diverse retired farmworkers.

Background

Dementia is a syndrome of cognitive decline that interferes with communication and performance of daily activities, most often characterized by declines in memory, language skills, and problem-solving (Gaugler et al., 2019). The most common type of dementia is Alzheimer's disease (AD), associated with disrupted nerve cell function seen in the presence of excess amyloid plaque buildup and neurofibrillary tangles in the brain (Selkoe & Hardy, 2016). A new case of AD emerges every 65 seconds, and half of adults over age 85 have AD. This illness is the only top-ten cause of death without a cure (Gaugler et al., 2019).

Blood Pressure and Risk of Alzheimer's Disease

There are recent studies that portray a pathophysiological connection between hypertension and AD. When blood pressure is normal, the brain can maintain a proper perfusion, which helps to keep steady oxygen levels and a good supply of nutrients throughout the body. Elevated blood pressure tends to impose stress on the cerebrovascular beds that may lead to vascular remodeling and dysfunction (Tarumi et al., 2015). Hypertension or high blood pressure can prevent proper perfusion, leading to stroke, which then increases dementia risk (Carnevale, Perrotta, Lembo, & Trimarco, 2015). In contrast, effective management of hypertension aids in decreasing AD risk (Ju, Lucey, & Holtzman, 2013).

Sleep Deprivation and the Risk of Alzheimer's Disease

The presence of a neurodegenerative disease may result in sleep deprivation, and conversely the lack of sleep increases the production of amyloid plaque. Deep sleep has been shown to decrease amyloid production. However, sleep and cognitive ability tend to decrease with age.

When elders suffer from sleep deprivation it has a damaging effect on most cognitive domains, such as attention, working memory, processing information, and reasoning, which can exacerbate AD risk (Dzierzewski, Dautovich, & Ravyts, 2018).

Of importance to this study is that the combination of a reduction of sleep and elevated blood pressure are linked to a greater production of amyloid plaque, thus altering cerebral blood flow regulation in participants with cognitive impairment (Ju et al., 2013). The investigation of sleep deprivation and hypertension both show that they influence the accumulation of amyloid plaque in the brain, thus increasing AD risk.

Materials and Methods

Setting and Sample

The study was initiated in January of 2018 in a rural Florida area known as the Glades, comprised of several small towns surrounding Lake Okeechobee. This region has been designated as a Health Professional Shortage Area and Medically Underserved Area as a Medically Underserved Area (MUA) and Health Professional Shortage Area (HPSA) (Rural Economic Development Initiative, n.d.). For purposes for this study, rural was defined as an area outside of a Metropolitan Statistical Area (Health Resources & Services Administration, Office of Management and Budget, n.d.).

Participants. Individuals ranging from 65 and older comprise 33.8% of this population, which are less than 25,000 residents. Over 20% of inhabitants are living below the poverty level and lack health insurance. Employment in Glades County is largely agricultural, with a high school graduation rate of 62% (U.S. Census Bureau, n.d.).

The participants for this study (n = 52) were drawn from a subsample of a larger study (N = 139) funded by the Florida Department of Health's Ed and Ethel Moore Alzheimer's Disease

Research program (Wiese, Williams, & Hain, 2017). Inclusion criteria were age 65 and older and the ability to speak English, Spanish, or Creole. Exclusion criteria included being previously diagnosed with depression or dementia, and inability to complete surveys and the clock drawing test. Visiting friends or family members or persons under 65 were excluded from the study. Permission to conduct the study was given through the principal investigator's university Institutional Review Board, #1064503-5. The research participants in this convenience study subsample were comprised of immigrant and retired farm workers, of which 81% were African American, 10% Afro-Caribbean, 2% Hispanic American, and 7% non-Hispanic White.

Data Collection and Analysis

The data collection consisted of (1) the Sociodemographic Survey which included four questions regarding sleep patterns and hypertension history, (2) blood pressure measurements conducted at three time points throughout the study (entry, mid-point, and exit), and 3) the Mini-Cog™ (Borson, Scanlan, Chen, & Gaguli, 2003; Morley et al., 2015).

Instrument: The Sociodemographic Survey. This measure consisted of 19 questions regarding age, gender, race, ethnicity, health literacy, sleep patterns, history of hypertension, and eight independent variables (sex, gender, race, ethnicity, education, health literacy, sleep patterns, and history of hypertension). Additional questions were asked in reference to the years of rural residence and caregiver status, and if the participant's care provider had previously asked about and/or examined memory during any emergency or office visits.

Instrument: Sleep Survey. This instrument measured the participants' sleep quality through self-rating with the use of questions, such as "Within the past month, how would you rate your sleep quality?" This tool has shown acceptable construct validity in addressing relations with one's mental and physical health (Hale, Hill, & Burdette, 2010). The survey contained a Likert-type

scale with answers consisting of excellent, very good, good, fair, and poor. Afterward, the study results were dichotomized into individuals who answered fair or poor sleep versus excellent, very good, and good sleep.

Instrument: Blood Pressure Screening Form. This instrument measured the participants' family history and risk factors that may increase the likelihood of developing hypertension. The questions contained in this form were influenced by information from the American Heart Association and the Centers for Disease Control and Prevention. The form consisted of a series of closed ended questions such as "Has anyone in your family been diagnosed with hypertension?" as well as sections to measure the participants' blood pressure and pulse rate.

Instrument: The Mini-CogTM. This instrument (Borson et al., 2003) helped to detect the risk of cognitive impairment in older adults. It consisted of a three-item recall test for memory and a scored clock-drawing test. The results were based on a point system in which the participants received one point for each word they remembered for the recall section. For the clock drawing section, the participants received two points for drawing a normal clock and zero points for an abnormal clock. These screenings helped to detect patients whose cognitive deficits have gone unnoticed.

Data Analysis

Descriptive statistics, T-test and Pearson correlation were used to analyze findings and exploring relationships between variables. Descriptive and frequency statistics were used to summarize sociodemographic characteristics and results of completed measures (The Mini-Cog^{TM}, Blood Pressure Screening Form, Sleep Survey, & The Sociodemographic Survey). Specifically, the results were analyzed in order to identify if the participants were at risk for hypertension based on the questionnaire, if the current blood pressure reading was within the spectrum of normal blood

pressure (120/80), and if there were relationships between the dependent variable (dementia risk) and eight independent sociodemographic variables (sex, gender, race, ethnicity, education, health literacy, sleep patterns, and history of hypertension). Analyses were conducted using SPSS v24 (IBM Corporation, n.d.). Alpha was set at .05 for all statistical tests.

Results

The sample of 52 patients was derived from three independent senior living facilities for persons aged 65 and older in the Glades, FL central rural community. The average participant in the public sample was 68 years of age (*SD* = 8.3), had lived in a rural area 37.5 years *(SD* = 24.2), and had received 9.9 years of formal education (*SD* = 3.59). They demonstrated a health literacy score of 3.54 (*SD* = 2.9), indicating a 4th-6th grade reading level as seen in Table 1.

Table 1
Continuous Sociodemographic Variables (N = 52)

Variables	M	SD
Age	68.9	8.3
Years of Education	9.9	3.6
Years Living Rural	37.5	24.2
Health Literacy Level*	3.5	2.9

Note. *score between 3 – 4 = 4th to 6th grade reading level

Most of the participants (73.1%) did not report previous cognitive screening by a healthcare provider and had not been treated for ADRD (34.6%). The majority of participants were minorities; African American (80.8%) and Afro-Caribbean (9.6%). Non-Hispanic Whites comprised 7.7% of the cohort, and over half were females (55.8%) as seen in Table 2. Approximately a third of the participants identified as being married or engaged (9.6%).

Table 2
Categorical Sociodemographics (N = 52)

Variables	*f*	%
Live Alone*		
Yes	46	88.5
No	5	9.6
Marital Status*		
Married	5	9.6
Single/Divorce/Separated/ Widow	46	88.5
Sees Provider		
Yes	13	25
No	39	75
Gender		
Male	23	44.2
Female	29	55.8
Treated for ADRD*		
Yes	1	1.9
No	18	34.6
Ethnicity		
African American	42	80.8
Afro Caribbean	5	9.6
White, non-Hispanic	4	7.7
Hispanic American	1	1.9
Cognitive Impairment*		
No Risk	38	73.1
Risk	12	23.1

Note: * indicate N < 52 because some of the participants did not want to disclose that information

Screening findings showed that the majority of participants were not at risk for hypertension (73%) or cognitive impairment (73.1%) as represented in Figure 3. Those with hypertension risk correlated significantly with risk of cognitive decline (r = .40, p = .01). The two scatter plots illustrate blood pressure as the dependent variable, and cognitive impairment and sleep deprivation as the independent variables shown in Figure 1 and 2. The t-test data in Table 3 shows that the means for each risk factor are significantly larger than 0.

Most participants have higher blood pressure, which is clear from the larger mean. Participants who exhibited sleep deprivation showed a larger mean score as well. Furthermore, most subjects did not show cognitive impairment, which is represented in the smallest mean, but it is still significant.

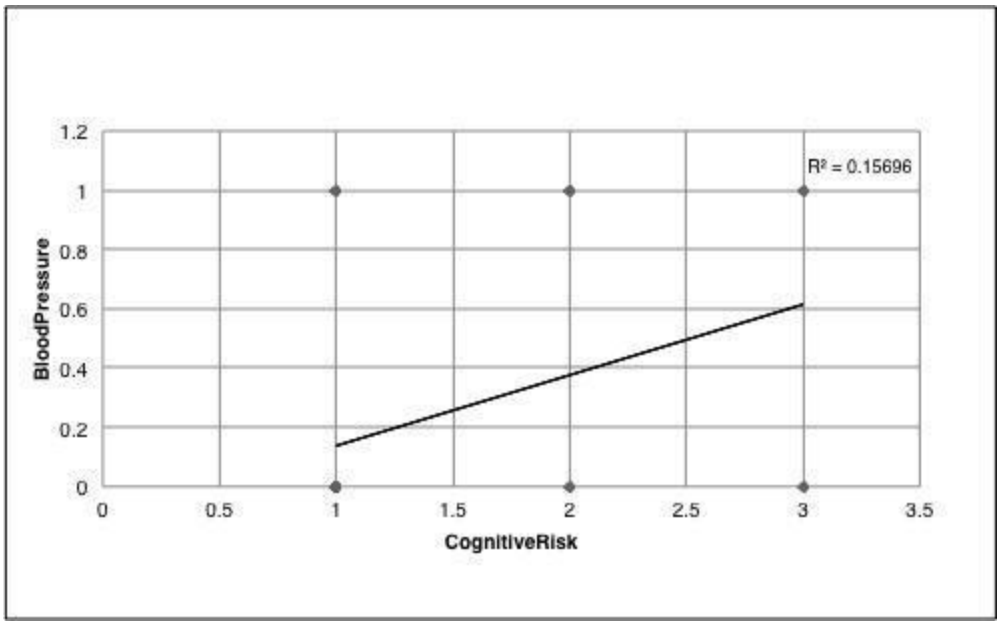

Figure 1. Scatter Plot of Relationship Between Blood Pressure and Cognitive Risk.

Figure 1 illustrates a moderate positive correlation between blood pressure and cognitive risk, with a Pearson correlation of 0.40 (R^2 = 0.16). The scatter plot shows that those with higher blood pressure were at greater risk for becoming cognitively impaired.

Table 3
Sociodemographic Risk Factors – One Sample t-test

Test Value = 0 (N = 52)	*t*	*df*	*Sig. (2-tailed)*	*Mean Difference*	*95% Confidence Interval of the Difference (Lower Bound)*
Blood Pressure	13.682	47	0.000	1.39583	1.1906
Sleep	9.807	45	0.000	1.10870	0.8810
Cognitive Risk	3.934	49	0.000	0.24000	0.1174

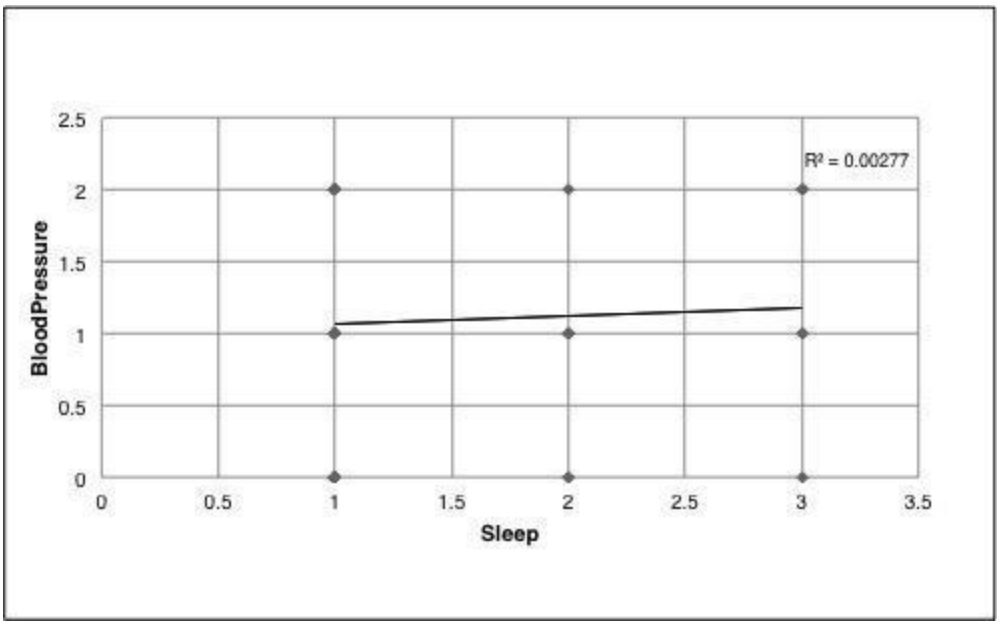

Figure 2. Scatter Plot of Relationship Between Blood Pressure and Sleep.

Figure 2 illustrates a negligible correlation between blood pressure and sleep. The Pearson correlation of 0.05 (R^2 = 0.003) between the two variables further demonstrates this weak relationship. This is in contrast to findings in the literature that poor sleep quality can exacerbate hypertension, but this result may be due to the smaller population sample (n = 52). Examining these variables in larger studies may yield different results.

Figure 3 represents the participants who were at risk for high blood pressure or cognitive impairment. The results show that the majority of the participants were not at risk for either biomarker. Based on the results, the demographic of the population shows that although they have limited resources (health care, education, income), the chronic disease of blood pressure was being managed effectively within this population.

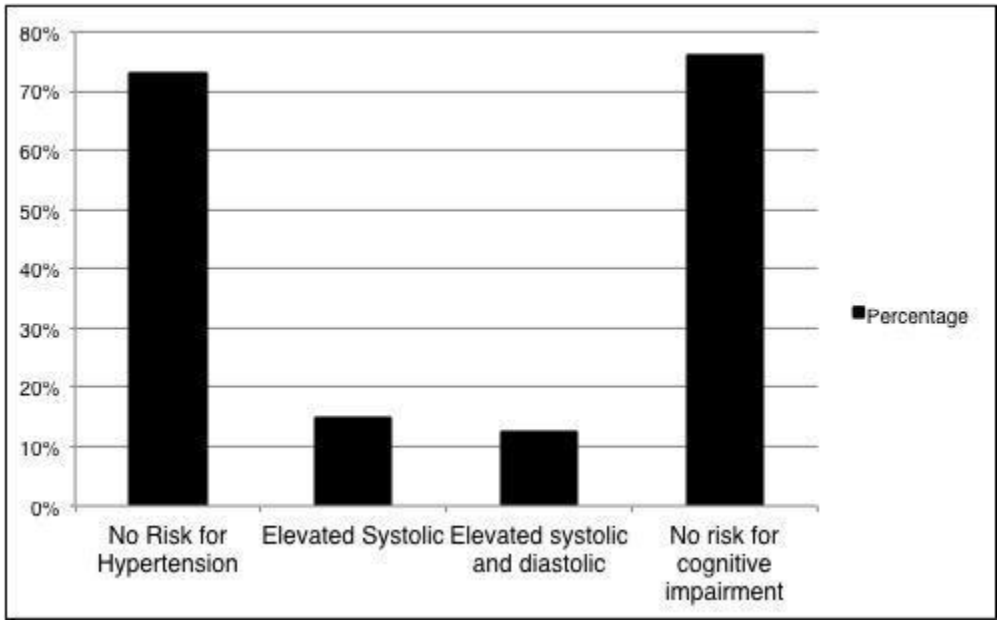

Figure 3. Bar Chart of Hypertension, Blood Pressure, and Cognitive Impairment Risk in Rural Cohort

Discussion

Findings related to Blood Pressure

The majority (73%) of the participants were not at risk for hypertension based on the study survey results. This was a surprising finding, because 81% of the participants were African Americans, which typically face a higher risk for hypertension. Deaths due to high blood pressure in the US are the greatest among African Americans (Spikes et al., 2019). Studies have shown that there are genetic and sociocultural risk factors for hypertension (Fuller, McCarty, Seaborn, Gravlee, & Mulligan, 2018). These risk factors tend to manifest differently across racial groups.

Findings related to Sleep and Cognitive Impairment

We found that the percentage of participants who had fair to excellent sleep was 65.2%, while 34.8% of the remaining participants indicated poor sleep. About 23.1% were at risk of cognitive impairment based on the Mini-Cog™ (Borson et al., 2003). However, the majority of the participants reported no prior memory testing by their local provider. Only one was previously diagnosed with AD.

Some studies show that sleep disturbances are common among patients who have some form of dementia, which includes AD (Brzecka et al., 2018). Deep sleep potentially has the ability to cleanse the brain and prevent the formation of plaques and tangles (Tarasoff-Conway et al., 2015). When individuals experience poor sleep, they may have a higher chance of obtaining dementia, compared to the individuals who have a normal sleep patterning (Ballard et al., 2011).

Influence of Rural Farmwork Lifestyle

The results showed that the majority of individuals were not at risk for hypertension and did not exhibit poor sleep or cognitive impairment. This raised the question that if these individuals lack the basic needs of the average civilian such as proper healthcare, education, and a sufficient income, then how did the majority of individuals maintain such good health? One explanation may be that participants demonstrated and reported fewer problems with blood pressure, sleep, or memory loss because of health-seeking behaviors motivated by relationships with local providers. Almost all (98%) were eligible for Medicaid/Medicare benefits and saw a provider at least annually, and often quarterly. Eighty percent of participants reported being on antihypertensives, although half reported that they were not consistent in taking it daily. However, the participants frequently spoke of their attempts to "watch my salt" during monthly blood pressure screenings, and many said that they walked to the nearby store or pharmacy several times a week. The majority of these residents were seen during monthly blood pressure checks, which are offered by the PI as community service, and could state the date of their next provider appointment. We considered that these favorable blood pressure readings, in contrast to the large percentage of reported hypertension diagnoses, may be related to the participants' status as former farmworkers. Their consistent physical activity may have provided an opportunity for increased vascular circulation (Bouchard, Blair, & Katzmarzyk, 2015). Furthermore, these retirees still live in close proximity to

fresh fruits and vegetables, where fresh fruits and vegetables are more readily available in the nearby store for consumption, which can also contribute to improved heart health (Borgi et al., 2016). However, these potentially confounding variables would need to be investigated further as a future implication.

Living alone. The majority of the participants were living alone due to separation, divorce, or spousal death. The percentage of single individuals was 88.5%; the remaining five persons were married and living together. Prior work has shown that social and familial support tend to have an influence on an individual's blood pressure (Fuller et al., 2018). For example, family relationships could have a negative impact on someone's health; therefore, people with many family members living with them tend to have higher blood pressure. Fuller and colleagues (2018) found that larger family networks were related to higher diastolic blood pressure. It is thought that this may be related to the underlying stress of having a large family. African Americans are more likely to live with their extended families. The emotional labor of giving support to large volumes of family members tends to cause greater social stressors for African Americans (Fuller et al., 2018). Since most of the participants lived alone, this could be a mediating factor on hypertension. Although the majority of participants reported having high blood pressure, it was often being managed, according to our screening results. In a different subset of questions in this population, the majority indicated that they indeed were happier living alone (Wiese & Williams, 2018).

Limitations

The studied was useful in exploring the relationship between hypertension, sleep, and cognitive impairment within subsidized minorities. However, our study was limited by its small sample size of 52 participants. Additionally, our study lacked information pertaining to the participant's diet and exercise, which would be helpful in understanding why the health outcomes

of blood pressure, sleep quality, and cognitive risk were lower than expected. Lastly, the sample collection area was limited to the Glades, Florida, which limited the opportunity to include participants from varied education, economic, social, and other types of diverse backgrounds.

Comorbidities may have contributed to the findings, but in-depth medical histories were not included in this study. There were measurements in places during the screenings to exclude participants who were diagnosed with depression, dementia, and certain cognitive inabilities. However, the comorbidity in individuals with some form of dementia is usually greater than in people without it, being that there is a substantial correlation between AD and vascular dementia (Ashraf et al., 2016). One of the main differences is that AD is characterized by the buildup of beta-amyloid plaques and neurofibrillary tangles in the brain, while vascular dementia is characterized by ischemic damage due to impaired blood flow to the brain. (Kalaria, 2018). These two diseases are independent of each other, although they do overlap in effect on cognitive function (Ashraf et al., 2016). The overlap of two chronic diseases is one of the potential confounding factors that contributed to the limitations of this research.

Conclusion

Previous research has shown that a diminished sleep quality may increase risk for hypertension and dementia. However, sleep quality in this small cohort of rural, ethnically diverse farmworkers did not significantly influence either blood pressure or cognition. It was encouraging that during anecdotal conversations, these retired migrant farmworkers expressed an overall desire to maintain good preventive medicine and lifestyle habits that contributed to their overall health. These findings suggest that examining potential cultural influences on sleep and hypertension as risk factors for dementia is needed.

About a quarter (23.1%) of the residents identified as being at risk for cognitive decline were not aware that they were at risk for dementia. However, it is inspiring that many (73%) of the subsidized housing residents who were invited (n = 70) chose to participate in follow-up education and research activities, which have been shown to be helpful for improving health in rural settings (Fahs et al., 2013). Future efforts will concentrate on expanding this work, and providing more education, screening, and services to cohorts of older retired farmworkers. However, without the involvement of providers to participate in focused cognitive care, these efforts will not likely result in assisting older adults to age-in-place. A continuing education program titled "Alzheimer's training for Health Care Providers" available at the Sanders-Brown Center for Aging at the University of Kentucky (n.d.), is cited by the National Institute of Aging (n.d.) as a helpful resource for providers in underserved areas. The training program includes nine modules regarding detection, treatment, and management of persons at risk for AD, and can support future efforts to improve the health and wellbeing of this underserved population.

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