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Research Report

Comparative Study of Risk Factors Associated with Normal Cognition and Cognitive Impairment in Rural West Elderly Texans

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Abstract.
Background: Alzheimer's disease (AD) is related to one or more chronic illnesses, which may develop cognitive decline and dementia. Cognitive impairment is increasing, and public health officials must address risk factors for AD to improve the health of rural West Texas communities.
Objective: The purpose of this study was to explore the sociodemographic and chronic disease risk factors related to cognitive impairment among elderly adults living in Cochran, Parmer, and Bailey counties in rural West Texas.
Methods: Statistical methods such as Pearson's chi-squared, proportion tests, univariate binary logistic regression, and a multivariable logistic regression were utilized to analyze data. SPSS software was used to detect the significant relationship between cognitive impairment and risk factors.
Results: Summary statistics were obtained for sociodemographic and chronic diseases by using cross-tabulation analysis and comparing the county respondents with proportion tests. A univariate binary logistic regression method was utilized and found that age group 60–69, anxiety, depression, diabetes, hypertension, and cardiovascular disease were significantly associated with cognitive impairment. Using a multivariable logistic regression approach, it was found that Bailey County (age group 60–69) had a higher likelihood ($p = 0.002$) of cognitive impairment than Parmer ($p = 0.067$) and Cochran counties ($p = 0.064$). The risk of females ($p = 0.033$) in Parmer County was 78.3% lower compared to males in developing AD.
Conclusions: Identifying significant risk factors for cognitive impairment are important in addressing issues of geographic variations and integrating such factors may guide relevant policy interventions to reduce cognitive impairment incidence in rural communities within West Texas.

Keywords: Alzheimer's disease, chronic diseases, cognitive impairment, FRONTIER database, risk factors, rural West Texas, sociodemographic variables

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INTRODUCTION

Dementia encompasses a broad area of symptoms that influence memory, cognition, and day-to-day activities, mainly caused by Alzheimer's disease (AD), which is on the rise due to an aging population and lower mortality rates among the young.[1,2] AD is an explicit form of dementia which is progressive in nature considered by neuronal injury and neural death in the brain.[3] AD-related dementia includes three stages: mild (characterized by noticeable memory and intellectual deficits impairing day-to-day functions), moderate (exhibiting communication obstacles and impaired daily activities), and severe (causing physical debilitation due to neuron damage affecting movement, increasing susceptibility to various well-being issues, including blood clots and infections).[1] Late-onset AD risk factors include age, family background, and heredity, particularly the *APOE4* gene, with most cases occurring in people aged 65 and older.[1,4,5] Furthermore, modifiable risk factors, such as socioeconomic status, inadequate access to advanced education, midlife obesity, inadequate nutrition, physical inactivity, extreme alcohol intake, traumatic brain injury, exposure to polluted air, smoking, and dietary options, all of which influence the onset of AD.[2,4] Furthermore, age-related chronic illnesses also play a crucial role in the progression and rapid development of AD. These incorporate several factors such as high blood pressure, diabetes, impaired glucose metabolism, cardiovascular disease (CVD), kidney disease, and cognitive impairment stemming from brain injuries.[1,4] A study, conducted in 2022 revealed that around 37% of cases of cognitive decline in the United States (US) relate to modifiable risk factors. The Lancet Commission in 2020 suggests controlling the adjustable risk factors including chronic diseases may delay the commencement of 40% of cognitive decline cases.[5]

Globally, over 55 million people have dementia, with AD responsible for many cases (60%–70%). In the US, around 6.7 million persons (10.8%) over the age of 65 have been diagnosed with AD dementia, with women accounting for two-thirds of the total.[5,6] According to the Alzheimer's Fact and Figure reports for 2023, the total cost of caring for the population suffering from AD or different types of cognitive disorder is expected to exceed $345 billion, with estimates reaching about $1 trillion by mid-century. This considerable expansion encompasses a threefold rise in government spending allocated to programs like Medicare and Medicaid as well as out-of-pocket spending. Early recognition and proper diagnosis hold promise for substantial medical care cost savings.[3,5]

Texas is the second most populous and the fourth fastest-growing state in the US. Texas has a total resident population of more than 30 million, with 13.4% of that population aged 65 and up in 2023.[7,8] Alarmingly, Texas has recorded approximately 400,000 cases of AD, ranking fourth among the 50 states, with a total of 490,000 projected by 2025. Furthermore, Texas ranks nationally second based on the number of AD deaths. In Texas, 22.5% of people under age 65 lack health insurance, compared to 9.5% nationally. This difference is connected to the higher frequency of cognitive decline and age-related chronic factors among this cohort in Texas, namely in rural West Texas, where access to healthcare services is limited or non-existent.[9] Notably, different research conducted in Texas such as project FRONTIER (Facing Rural Obstacles to Healthcare Now Through Intervention, Education, and Research) in West Texas, Health and Aging Brain among Latino Elders (HABLE) in North Texas, and Texas Alzheimer's Research and Care Consortium (TARCC) in Texas showed age and the comorbidity of diabetes and depression significantly elevate the risk of mild cognitive impairment and Hispanic population in West Texas is more susceptible to cognitive impairment compared to other racial and ethnic groups.[9,11] Chronic conditions such as midlife hypertension, CVD, and diabetes demonstrate indispensable association with AD.[12,13] Epidemiological and biological analyses have denoted AD as "brain diabetes" or "diabetes type 3" due to its intricate pathological link with diabetes. Individuals with diabetes exhibit a 65% higher likelihood of developing AD compared to those without diabetes.[14–16] Moreover, sociodemographic factors such as low income, education, and profession are intricately linked to the onset and progression of impaired blood sugar and its complications.

Furthermore, studies indicate that approximately 25% of the adult population suffers from hypertension, with half of these individuals aged 60 or above, revealing a clear connection between hypertension, CVD, and AD.[17–19] Texas emerges as a notable case study, with several counties reporting elevated prevalence rates of diabetes, hypertension, and CVD.[19–21] These results signify the interconnection between chronic diseases and AD, while also emphasizing the significant influence of sociodemographic factors on disease presentation and progression.

Chronic diseases are a significant public health issue in rural West Texas, and their prevalence varies according to sociodemographic characteristics. In 2006, an epidemiology research initiative called Project FRONTIER commenced in four rural West Texas counties. Among the four counties, Cochran, Parmer, and Bailey are distinctive due to their various geographic locations and socioeconomic characteristics.[22] Project FRONTIER explores the long-term consequences of sociodemographic variables and chronic diseases on the physical, mental, and cognitive health of participants aged 40 and up. The data in Table 1,[23] highlights some of the socioeconomic features of these three rural West Texas counties.

The data from Table 1 indicates that Cochran County exhibits lower income levels and health insurance coverage, alongside higher poverty rates, which collectively restrict access to healthcare facilities for its residents. Furthermore, the proportion of elderly individuals (aged 65 or above) in Cochran County surpasses that of Parmer and Bailey Counties, potentially leading to a higher prevalence of chronic diseases such as hypertension, CVD, and diabetes. Education emerges as a crucial sociodemographic factor, demonstrating a notable association with cognition.[24] Notably, Cochran County displays a comparatively lower percentage of educational attainment than Parmer and Bailey Counties. These sociodemographic characteristics correlate with the elevated percentage of cognitive difficulty observed in Cochran County. In contrast, Parmer and Bailey Counties boast higher income levels, greater health insurance coverage, and lower poverty rates, facilitating improved access to healthcare services and resources for their populations. Moreover, higher educational attainment rates in Parmer and Bailey Counties contribute to increased health awareness, adoption of healthier lifestyles, access to better economic opportunities, and enhanced healthcare resources. This enhanced health knowledge empowers individuals to make informed decisions and take proactive preventive measures, thereby influencing the management of chronic diseases. Nonetheless, monitoring these trends closely and implementing preventive measures to perpetuate these advantages remains imperative. Consequently, understanding the prevailing chronic conditions and sociodemographic characteristics among participants across these counties is of paramount importance. Data from all these three counties indicate that Hispanic or Latino (of any race) is one of the predominant ethnic groups in West Texas. Hispanics and Latinos have 1.5–2 times higher chance to develop AD, or any form of dementia compared to white Americans. The suspected reasons behind that are socioeconomic status, lack of health awareness, health care discrimination and the presence of various chronic diseases including hypertension, diabetes, CVD, etc.[25]

The influence of sociodemographic traits and long-term diseases prevalence in the elderly population in West Texas is still understudied. Evidence from literature reviews and various governmental sources confirms that sociodemographic traits and chronic conditions like hypertension, CVD, and diabetes can affect cognitive decline, AD, or dementia. Thus, it's crucial to identify and understand the risk factors associated with dementia or AD to raise consciousness among public health officials and healthcare providers and take proactive steps to improve health outcomes among rural West Texans. This paper aims to examine the risk factors related to cognitive decline in AD or dementia, specifically focusing on sociodemographic characteristics and chronic diseases.

There were no published works available that compared the county level data and explained the sociodemographic and chronic diseases in elderly people residing in rural West Texas and their impact on public health. Many of these conditions may contribute to cognitive decline, AD or dementia. It is crucial to detect and understand the risk factors which are associated with dementia so that to improve health conditions in rural West Texans, public health officials or health care providers can take early precaution to reduce the risk of many chronic conditions, which in turn could reduce the risk of dementia. This paper aims to explore the risk variables of cognitive decline or dementia related to sociodemographic and chronic diseases from three rural West Texas counties data collected by Project FRONTIER (2006–2018).

MATERIALS AND METHODS

Data source and study population

A cross-sectional survey was undertaken using convenient sampling where participants attended in a hospital setting for three rural West Texas counties: Cochran, Parmer, and Bailey, and the project was named for the Project FRONTIER. It conducted research for rural communities of West Texan adults and elders exploring the natural course of

Table 1
Sociodemographic of participants by counties in rural West Texas

Sociodemographic features	Cochran county	Parmer county	Bailey county
Total population	2,547	9,869	6,904
Older people (65 or above)	16.8%	15.3%	12.4%
Income and earnings ($)	41,597	65,575	69,830
Poverty	25.8%	9.5%	12.7%
Education (bachelor's degree or higher)	8.5%	18.4%	15.3%
Health (cognitive difficulty)	8.7%	4.2%	7.5%
Health insurance without healthcare coverage	19.3%	24.2%	32.1%
Race and ethnicity (Hispanic or Latino of any race)	1,627 (63.87%)	6,504 (65.90%)	4,540 (65.75%)

Sources: https://www.census.gov/acs/www/data/data-tables-and-tools/data-profiles/.[23]

chronic disease development, and its impact on cognitive, physical, social, and interpersonal functioning.[22] Participants of this study often lack access to affordable healthcare and human services because of their rural and isolated geographic location. As a result, the information collected can be used to develop programs for effective disease management and those focused on helping preserve cognitive function throughout the lifespan. This will in turn improve the quality of overall health of individuals living in rural West Texas, FRONTIER 2006.[3]

IRB approval

This study protocol has been reviewed and approved by the TTUHSC IRB (Texas Tech University Health Sciences Center, Institutional Review Board) NUMBER: L06–028, approval date: 1/30/2006, Project Frontier. TTUHSC strictly follows high ethical standards in the Department of Public Health within the School of Population and Public Health, and its other schools.

Sample size and power calculation

The sample size was calculated by using G*Power software (version 3.1.9.7) [26]. A total of 88 subjects were sufficient to detect a statistically significant relationship between categorical variables with 5% level of significance, $\alpha = 0.05$, median effect size = 0.30, a two-sided testing procedure, and power = 80% when running a chi-squared test. Furthermore, it was determined that 197 subjects are required for the study by using logistic regression based on higher percentage of normal cognition than cognitive impairment, assuming 20% individuals higher in normal cognition than cognitive impairment, $\alpha = 0.05$, power = 80%, and a two-sided testing procedure. In most of the cases, the study samples were large enough for cross-tabulations; however, a few cases had small sample size, which led to discard from statistical analysis.

Study participants

Data were collected from Project FRONTIER and the study participants were from Cochran, Parmer, and Bailey counties in rural West Texas. Figure 1 presents information of study participations within the counties.

A cross-sectional sample was undertaken using convenience sampling technique from the individuals those who visited to a local hospital for their medical illness, located in West Texas, Lubbock, to collect the data on sociodemographic factors, chronic disease, and genetic biomarkers. A questionnaire was given to the individuals prior to routine checkups with doctor while they were in the hospital. The subjects were from the three rural West Texas counties: Cochran, Parmer, and Bailey. Our study focused on the elderly population aged 40 and above. After removing the missing individuals, there were 1,493 male and female individuals considered for statistical analysis.

Data were extracted from the FRONTIER database ($n = 1{,}527$) in the hospital setting where annual resident check-ups were conducted within three counties, Cochran ($n = 635$), Parmer ($n = 691$), and Bailey ($n = 201$). Missing participants data on cognitive disorder history was removed by data cleaning, thus reducing the sample size ($n = 1{,}493$). A questionnaire was provided to the hospital participants who visited from Cochran County, Parmer County, and Bailey County for their regular health checkups. The questionnaire pattern was binary type (yes or no). Individuals responded to the questions indicating whether they were in normal cognition or in experiencing cognitive impairment. The individuals were

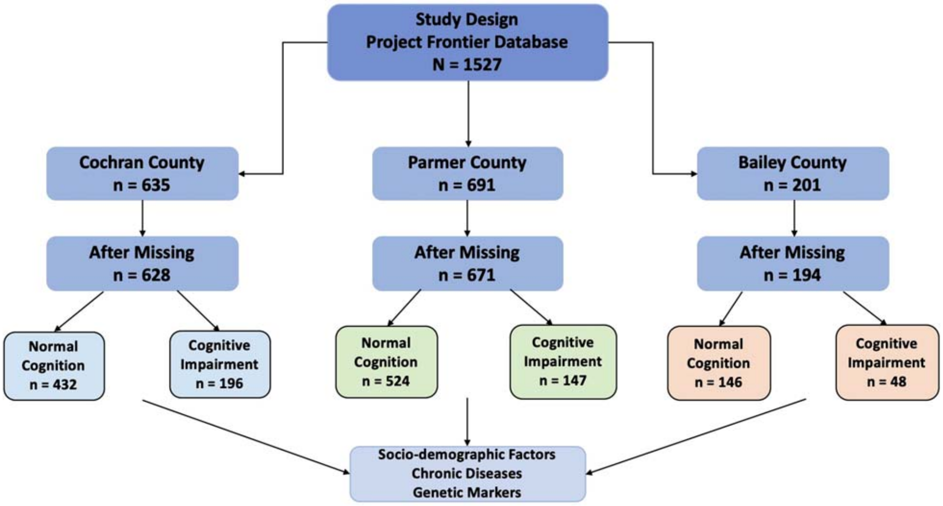

Fig. 1. Flow of participants through study. The study consists of Frontier database of Hispanic and non-Hispanic white participants ($N = 1{,}527$), who were eligible at ages 40 or above and lived in one of the counties (Cochran, Parmer, and Bailey). Participants completed their background check with sociodemographic, chronic diseases, and genetic markers as per questionnaire. After removing, small percent of missing data due to non-response error, the number of normal cognition ($n = 432$) and cognition impairments ($n = 196$) were counted for Cochran County, similarly, for Parmer County: normal cognition ($n = 524$) and cognition impairments ($n = 147$), and Bailey County: normal cognition ($n = 146$) and cognition impairments ($n = 48$), respectively. The eligible participants' data on sociodemographic, chronic diseases, and genetic markers were organized and analyzed for statistical results.

conscious of cognitive impairment prior to their treatment. No methods were used to determine cognitive impairment at the time of their visit when data were collected. County level data were collected for this study from the hospital records. Among 628 participants in Cochran County, 432 (68.8%) had a history of normal cognition and 196 (31.2%) did not. Of the 671 participants in Parmer County, 524 (78.1%) had normal cognition and 147 (21.9%) had cognitive impairment. Of the 194 participants in Bailey County, 146 (75.3%) had normal cognition and 48 (24.7%) had cognitive impairment.

Statistical analysis

The IBM SPSS (Statistical Package for the Social Sciences) software (version 29.0)[27] was used to calculate the descriptive and inferential statistics. Justification of power and sample size was considered. A summary of statistics was obtained for sociodemographic and chronic disease variables both normal cognition and cognitive impairment of the participants living in rural West Texas. Sociodemographic and chronic disease variables were summarized using descriptive statistics. Discrete variables were summarized using number (n) and percent (%), and continuous variables were summarized using mean and standard deviation. Statistical inference on the null and alternative hypotheses about proportion were used to detect significant risk variables and to compare among the counties. Cross-tabulations were used to assess the number of responses that have specific characteristics in each cell of the table. We used a binary logistic regression for univariate analysis and a multiple logistic regression (where the dependent variable was categorical, normal cognition and cognitive impairment; and the independent variables were used as their dichotomous nature of sociodemographic and chronic disease variables) for a multivariable analysis. The odds ratio and its 95% confidence intervals (CI) were calculated and the p-value (less than 0.05) was used considering the statistical level of significance alpha $(\alpha) = 0.05$ to determine an association between risk factors, and the occurrence of cognitive impairment were reported. Bar graphs of the frequencies of variables (gender, age, education, and race/ethnicity) by cognitive disorder were also displayed and interpreted.

RESULTS

In this study, we demonstrated successful implementation of a flow chart from FRONTIER database to classify the participants in three counties and compared them based on normal cognition and cognitive impairments. The number of respondents from each county was compared based on their sociodemographic factors, chronic diseases, and genetic biomarkers. Baseline characteristics of the participants were utilized to compare normal cognition and cognitive impairment using statistical analysis. Univariate and multivariable analyses were performed, and the significant risk factors were detected with significance level, $\alpha = 0.05$. The data on normal cognition and cognitive declines were visualized in terms of bar graphs for gender, age, education attainment, and race/ethnicity to compare the number of participants or to perceive the high-risk groups within the counties.

The results from the Project FRONTIER study reveals a meaningful difference between normal cognition and cognitive impairment in the prevalence rate of chronic diseases and its association with AD or dementia within rural West Texas. This study investigated the baseline participants' characteristics for various sociodemographic variables within three counties with a concentration on cognitive awareness. Table 2 demonstrates the associated risk factors and level of cognition for participants across three West Texas counties. Of the 1,493 participants, 391 (26.2%) individuals had cognitive impairment while 1,102 (73.8%) had normal cognition. The highest rate (31.2%) of cognitive impairment was noticed in Cochran County, with 196 individuals diagnosed out of 628. It was evident that the participants with cognitive impairment was more common in males than females, with rates of 32.8% and 23.3%, respectively. Table 2 also describes the results of number of participants who responded to normal cognition and cognition impairment with respect to their sociodemographic and chronic disease variables in the three rural West Texas counties. p-values were calculated using two independent sample proportion tests to compare whether there is a statistically significant difference between counties of participants for normal cognition and cognition impairment. Of the 1,493 participants with age groups 40–49, 50–59, 60–69, and 70 and above in this study, Parmer County had the largest number of participants ($n = 671$) compared to Cochran County ($n = 628$) and Bailey County ($n = 194$). The second highest number of cognitive impairments was observed in Parmer County ($n = 147$), and lowest participants ($n = 48$) were in Bailey County. The participants both in normal cognition and cognitively impaired for the age group 40–49 was found to be statistically significant ($p < 0.05$) within all counties.

The statistical analyses were carried out in terms of proportion tests to compare both normal cognition and cognitive impairment with respect to p-values for the remaining variables, gender, marital status, education, body mass index (BMI), high blood pressure, anemia, anxiety, depression, physical exercise, alcohol, smoking, family history, modified diet, illegal drugs, diabetes, hypertension, CVD, stroke, income, health care coverage, and race/ethnicity.

It was evident that for race/ethnicity, of the 838 total participants, Hispanics ($n = 392$, 46.78%) made up the largest proportion of participants in Parmer County, followed by Hispanics in Cochran County ($n = 323$, 38.54%), and the lowest Hispanic participants in Bailey County ($n = 123$, 14.68%). Parmer County exhibited the highest number of Hispanic participants with normal cognition ($n = 297$, 49.42%), followed by Cochran County ($n = 219$, 36.44%), and Bailey County ($n = 85$, 14.14%). Of the 237 cognitively impaired Hispanic participants, 104 (43.88%) were in Parmer County, 95 (40.08%) were in Cochran County, and 38 (16.03%) were in Bailey County.

Of the 587 total non-Hispanic whites, participants in Parmer County ($n = 270$, 45.99%) contributed to largest proportion compared with Cochran County ($n = 249$, 42.24%), and Bailey County ($n = 68$, 11.58%). The Cochran County had the largest cognition Hispanic participants ($n = 104$, 43.88%) compared with Parmer County ($n = 95$, 40.08%) and Bailey County ($n = 38$, 16.03%). Among non-Hispanic white participants, the Parmer County ($n = 52$, 40.31%) had the largest cognitively impaired participants compared to Cochran County ($n = 67$, 51.94%) and Bailey County ($n = 10$, 7.75%). Thus, both Hispanic and non-Hispanic white cognitively impaired participants in Parmer County may lead faster to AD than other counties.

Table 3 portrays the results of univariate analysis for sociodemographic and chronic diseases of participants living in the three counties within rural West Texas. Binary logistic regression method was carried out, where outcome variable was categorical normal cognition and cognitive impairment, and predictor variables were considered age, gender, marital status, education, BMI, high blood pressure, anxiety, depression, alcohol, diabetes mellitus, modifying eating habits to control diabetes, cholesterol (mg/dL), hypertension, modifying eating habits to control hypertension, CVD, income, health care coverage, and race/ethnicity.

There was a significant relationship between cognitive impairment and age group 60–69 (Cochran

Table 2
Baseline sociodemographic and other characteristics of participants by counties with awareness of cognition

Variables	Cochran			Parmer			Bailey		
	Normal cognition ($n = 432$)	Cognition impairment ($n = 196$)	p	Normal cognition ($n = 524$)	Cognition impairment ($n = 147$)	p	Normal cognition ($n = 146$)	Cognition impairment ($n = 48$)	p
	Cases (%)	Cases (%)		Cases (%)	Cases (%)		Cases (%)	Cases (%)	
Age group									
40–49	129 (29.9)	27 (13.8)	0.001	144 (27.5)	14 (9.5)	0.001	50 (34.2)	6 (12.5)	0.004
50–59	128 (29.6)	51 (26.0)	0.353	155 (29.6)	25 (17.0)	0.002	50 (34.2)	13 (27.1)	0.357
60–69	98 (22.7)	40 (20.4)	0.523	118 (22.5)	39 (26.5)	0.309	22 (15.1)	20 (41.7)	0.001
70+	77 (17.8)	78 (39.8)	0.001	107 (20.4)	69 (46.9)	0.001	24 (16.4)	9 (18.8)	0.712
Gender									
Male	130 (30.1)	72 (36.7)	0.098	142 (27.1)	62 (42.2)	0.001	33 (22.6)	15 (31.3)	0.226
Female	302 (69.9)	124 (63.3)	0.098	381(72.7)	85 (57.8)	0.001	113 (77.4)	33 (68.8)	0.228
Marital status									
Married	296 (68.5)	110 (56.1)	0.002	399 (76.1)	105 (71.4)	0.242	103 (70.5)	30 (62.5)	0.297
Divorced	47 (10.9)	28 (14.3)	0.223	37 (7.1)	14 (9.5)	0.319	15 (10.3)	4 (8.3)	0.695
Separated	21 (4.9)	9 (4.6)	0.883	10 (1.9)	2 (1.4)	0.657	5 (3.4)	2 (4.2)	0.811
Widowed	49 (11.3)	43(21.9)	0.001	58 (11.1)	23 (15.6)	0.132	15 (10.3)	12 (25)	0.011
Never-married	19 (4.4)	6 (3.1)	0.427	19 (3.6)	3 (2.0)	0.34	8 (5.5)	0 (0.0)	0.098
Education									
No education	259 (60.0)	141 (71.9)	0.004	361 (68.9)	122 (82.9)	0.001	76 (52.1)	39 (81.2)	0.001
Certificate	121 (28.0)	48 (24.5)	0.357	92 (17.6)	19 (12.9)	0.181	47 (32.2)	6 (12.5)	0.008
Bachelor	32 (7.4)	5 (2.6)	0.017	48 (9.2)	6 (4.1)	0.045	20 (13.7)	3 (6.3)	0.166
Master	14 (3.2)	1 (0.5)	0.038	19 (3.6)	0 (0.0)	0.019	3 (2.1)	0 (0.0)	0.317
BMI									
18.5–24.9	80 (18.5)	43 (21.9)	0.317	82 (15.6)	24 (16.3)	0.842	20 (13.7)	7 (14.6)	0.878
25–29.9	162 (37.5)	72 (36.7)	0.854	185 (35.3)	67 (45.6)	0.023	49 (33.6)	15 (31.2)	0.767
30+	181 (41.9)	76 (38.8)	0.461	250 (47.7)	54 (36.7)	0.018	74 (50.7)	26 (54.2)	0.675
High blood pressure									
No	106 (24.5)	17 (8.7)	0.001	138 (26.3)	28 (19.0)	0.07	81 (55.5)	18 (37.5)	0.031
Yes	96 (22.2)	54 (27.6)	0.147	120 (22.9)	45 (30.6)	0.055	58 (39.7)	26 (54.2)	0.079
Anemia									
No	423 (97.9)	186 (94.9)	0.041	417 (79.6)	117 (79.6)	0.998	128 (87.7)	47 (97.9)	0.038
Yes	9 (2.1)	10 (5.1)	0.041	105 (20.0)	30 (20.4)	0.921	18 (12.3)	1 (2.1)	0.038
Anxiety									
No	357 (82.6)	150 (76.5)	0.072	443 (84.5)	112 (76.2)	0.018	123 (84.2)	33 (68.8)	0.019
Yes	75 (17.4)	46 (23.5)	0.072	81 (15.5)	35 (23.8)	0.001	23 (15.8)	15 (31.2)	0.019
Depression									
No	345 (79.9)	133 (67.9)	0.001	439 (83.8)	94 (63.9)	0.001	118 (80.8)	30 (62.5)	0.009
Yes	87 (20.1)	63 (32.1)	0.001	85 (16.2)	53 (36.1)	0.001	28 (19.2)	18 (37.5)	0.009
Physical exercise									
No	91 (21.1)	40 (20.4)	0.851	61 (11.6)	25 (17.0)	0.085	0 (0.0)	0 (0.0)	–
Yes	97 (22.5)	72 (36.7)	0.001	67 (12.8)	14 (9.5)	0.283	0 (0.0)	0 (0.0)	–
Alcohol									
No	412 (95.4)	181 (92.3)	0.126	501 (95.6)	144 (97.9)	0.192	143 (97.9)	47 (97.9)	0.990
Yes	20 (4.6)	15 (7.6)	0.126	23 (4.4)	3 (2.1)	0.192	3 (2.1)	1 (2.1)	0.990
Smoking									
No	133 (30.8)	85 (43.4)	0.002	114 (21.8)	37 (25.2)	0.381	0 (0.0)	0 (0.0)	–
Yes	52 (12.0)	27 (13.8)	0.543	17 (3.2)	3 (2.0)	0.448	0 (0.0)	0 (0.0)	–
Family history									
No	169 (39.1)	101 (51.5)	0.003	165 (31.5)	54 (36.7)	0.230	4 (2.7)	2 (4.2)	0.620
Yes	42 (9.7)	14 (7.1)	0.293	73 (13.9)	13 (8.8)	0.103	2 (1.2)	1 (2.1)	0.728
Modified diet									
No	67 (15.5)	53 (27.0)	0.001	65 (12.4)	25 (17.0)	0.147	18 (12.3)	8 (16.7)	0.444
Yes	126 (29.2)	83 (42.3)	0.001	156 (29.8)	57 (38.8)	0.038	46 (31.5)	21 (43.8)	0.122

(*Continued*)

Table 2
(*Continued*)

Variables	Cochran			Parmer			Bailey		
	Normal cognition ($n=432$)	Cognition impairment ($n=196$)	p	Normal cognition ($n=524$)	Cognition impairment ($n=147$)	p	Normal cognition ($n=146$)	Cognition impairment ($n=48$)	p
	Cases (%)	Cases (%)		Cases (%)	Cases (%)		Cases (%)	Cases (%)	
Illegal drugs									
No	180 (41.7)	109 (55.6)	0.001	130 (24.8)	0 (0.0)	0.001	39 (26.7)	0 (0.0)	0.001
Yes	3 (0.7)	3 (1.5)	0.318	–	–	–	0 (0.0)	0 (0.0)	–
Diabetes									
No	332 (76.9)	118 (60.2)	0.001	414 (79.0)	85 (57.8)	0.001	112 (76.7)	25 (52.1)	0.001
Yes	100 (23.1)	78 (39.8)	0.001	108 (20.6)	62 (42.2)	0.001	34 (23.3)	23 (47.9)	0.001
Hypertension									
No	180 (41.7)	54 (27.6)	0.001	274 (52.3)	45 (30.6)	0.001	73 (50.0)	11 (22.9)	0.001
Yes	252 (58.3)	142 (72.4)	0.001	248 (47.2)	102 (69.4)	0.001	73 (50.0)	37 (77.1)	0.001
CVD									
No	395 (91.4)	156 (79.6)	0.001	499 (95.2)	126 (85.7)	0.001	136 (93.2)	41 (85.4)	0.1
Yes	37 (8.6)	40 (20.4)	0.001	23 (4.4)	21 (14.3)	0.001	10 (6.8)	7 (14.6)	0.1
Stroke									
No	197 (45.6)	68 (34.7)	0.010	222 (42.3)	60 (40.8)	0.736	117 (80.1)	40 (83.3)	0.624
Yes	2 (0.5)	0 (0.0)	0.340	4 (0.8)	0 (0.0)	0.288	2 (1.4)	1 (2.1)	0.728
Income									
≤ \$19,999	295 (68.3)	130 (66.3)	0.626	209 (39.9)	55 (37.4)	0.587	88 (60.3)	35 (72.9)	0.115
\$20,000–\$39,999	52 (12.0)	17 (8.7)	0.212	53 (10.1)	9 (6.1)	0.139	21 (14.4)	5 (10.4)	0.484
\$40,000+	13 (3.0)	4 (2.0)	0.488	12 (2.3)	1 (0.7)	0.210	6 (4.1)	0 (0.0)	0.154
Insurance									
No	150 (34.7)	44 (22.4)	0.002	142 (27.1)	37 (25.2)	0.640	48 (32.9)	22 (45.8)	0.105
Yes	282 (65.3)	152 (77.6)	0.002	381 (72.7)	110 (74.8)	0.608	98 (67.1)	26 (54.2)	0.105
Race/ethnicity									
Hispanic	219 (50.7)	104 (53.1)	0.582	297 (56.7)	95 (64.6)	0.084	85 (58.2)	38 (79.2)	0.009
Non-Hispanic whites	182 (42.1)	67 (34.2)	0.059	218 (41.6)	52 (35.4)	0.174	58 (39.7)	10 (20.8)	0.001

– indicates that data were not available due to missing; n, sample size; p, p-value; BMI, body mass index; CVD, cardiovascular disease.

County: $p=0.018$, OR: 1.950, 95% CI: (1.120, 3.395); Parmer County: $p=0.001$, OR: 3.400, 95% CI: (1.762, 6.560); Bailey County: $p=0.001$, OR: 7.576, 95% CI: (2.675, 21.456)) and 70 ≥ years of age (Cochran County: $p=0.001$, OR: 4.840, 95% CI: (2.875, 8.147); Parmer County: $p=0.001$, OR: 6.633, 95% CI: (3.545, 12.412); Bailey County: $p=0.049$, OR: 3.125, 95% CI: (0.998, 9.790)). Considering males as a referent variable, a significant association was found at a 10% significance level in females who were cognitively impairment for Parmer County ($p=0.001$, OR: 0.511, 95% CI: (0.439, 0.747)). The widowed in Cochran County were found high likely ($p=0.001$, OR: 2.361, 95% CI: (1.484, 3.757)) to be cognitively impaired. The participants with master's degrees were significantly less likely to have cognitive impairment in all counties: Cochran ($p=0.011$, OR: 0.287, 95% CI: 0.109, 0.753), Parmer ($p=0.026$, OR: 0.370, 95% CI: 0.154, 0.886), and Bailey ($p=0.048$, OR: 0.292, 95% CI: 0.082, 1.044). High blood pressure was a significant factor for all the Counties (Cochran: $p=0.001$, OR: 3.507, 95% CI: (1.904, 6.462); Parmer: $p=0.023$, OR: 1.848, 95% CI: (1.086, 3.144); Bailey: $p=0.046$, OR: 2.017, 95% CI: (1.013, 4.018)). The participants had high likely to have cognitive impairment due to Anxiety (Cochran: $p=0.073$, OR: 1.460, 95% CI: (0.965, 2.208); Parmer: $p=0.019$, OR: 1.709, 95% CI: (1.093, 2.673); Bailey: $p=0.021$, OR: 2.431, 95% CI: (1.142, 5.174)). Similarly, depression, diabetes, and hypertension were found to be significant factors ($p<0.05$) for the participants living in all three counties. Insurance was found to be a significant factor for Cochran County participants ($p=0.002$). CVD was a significant risk factor for both Cochran and Parmer counties ($p=0.001$).

Table 4 illustrates the results of multivariable analysis for the sociodemographic and chronic diseases of the participants living in three counties. All the predictor variables were considered in the model and after controlling the covariates in multivariable logistic regression analysis, it was found that Bai-

Table 3
Univariate analysis of factors associated with cognitive impairment

Variables	Cochran			Parmer			Bailey		
	Odds ratio	95% CI	*p*	Odds ratio	95% CI	*p*	Odds ratio	95% CI	*p*
Age group									
40–49	(Ref)								
50–59	1.904	1.124–3.223	0.017	1.659	0.830–3.316	0.152	2.167	0.763–6.153	0.147
60–69	1.95	1.120–3.395	0.018	3.4	1.762–6.560	0.001	7.576	2.675–21.456	0.001
70+	4.84	2.875–8.147	0.001	6.633	3.545–12.412	0.001	3.125	0.998–9.790	0.049
Gender									
Male	(Ref)								
Female	0.741	0.519–1.058	0.099	0.511	0.439–0.747	0.001	0.642	0.312–1.324	0.230
Marital status									
Married	(Ref)								
Divorced	1.603	0.956–2.687	0.073	1.438	0.750–2.758	0.275	0.916	0.283–2.966	0.883
Separated	1.153	0.513–2.595	0.730	0.760	0.164–3.522	0.726	1.373	0.254–7.439	0.713
Widowed	2.361	1.484–3.757	0.001	1.507	0.888–2.557	0.128	2.747	1.161–6.498	0.021
Never-married	0.850	0.331–2.183	0.735	0.600	0.174–2.066	0.418	–	–	–
Education									
Certificate	(Ref)								
Bachelor	0.729	0.492–1.079	0.114	0.611	0.358–1.043	0.071	0.249	0.098–0.633	0.003
Master	0.287	0.109–0.753	0.011	0.370	0.154–0.886	0.026	0.292	0.082–1.044	0.048
BMI									
Normal	(Ref)								
Overweight	0.827	0.520–1.314	0.421	1.237	0.726–2.110	0.434	0.875	0.310–2.467	0.800
Obese	0.781	0.494–1.234	0.290	0.738	0.429–1.269	0.272	1.004	0.381–2.648	0.994
High blood pressure									
No	(Ref)								
Yes	3.507	1.904–6.462	0.001	1.848	1.086–3.144	0.023	2.017	1.013–4.018	0.046
Anemia									
No	(Ref)								
Yes	2.527	1.010–6.321	0.048	1.018	0.646–1.604	0.938	0.151	0.020–1.165	0.070
Anxiety									
No	(Ref)								
Yes	1.46	0.965–2.208	0.073	1.709	1.093–2.673	0.019	2.431	1.142–5.174	0.021
Depression									
No	(Ref)								
Yes	1.878	1.283–2.749	0.001	2.912	1.934–4.384	0.001	2.529	1.237–5.169	0.011
Physical exercise									
No	(Ref)								
Yes	1.689	1.044–2.731	0.033	0.510	0.243–1.069	0.075	–	–	–
Alcohol									
No	(Ref)								
Yes	1.707	0.855–3.410	0.130	0.454	0.134–1.533	0.203	1.014	0.103–9.985	0.990
Smoking									
No	(Ref)								
Yes	0.837	0.562–1.248	0.382	0.911	0.428–1.942	0.810	2.72	1.006–7.352	0.049
Diabetes									
No	(Ref)								
Yes	2.195	1.526–3.155	0.001	2.796	1.893–4.129	0.001	3.031	1.529–6.006	0.001
Diet to control diabetes									
No	(Ref)								
Yes	0.578	0.232–1.436	0.238	0.429	0.158–1.166	0.097	0.387	0.059–2.540	0.323
Cholesterol	0.998	0.994–1.002	0.380	0.996	0.991–1.000	0.065	0.999	0.990–1.007	0.741
Hypertension									
No	(Ref)								
Yes	1.878	1.301–2.711	0.001	2.504	1.695–3.701	0.001	3.364	1.593–7.101	0.001

(*Continued*)

Table 3
(*Continued*)

Variables	Cochran			Parmer			Bailey		
	Odds ratio	95% CI	*p*	Odds ratio	95% CI	*p*	Odds ratio	95% CI	*p*
Diet to control hypertension									
No	(Ref)								
Yes	0.833	0.529–1.312	0.430	0.950	0.547–1.650	0.856	1.027	0.386–2.736	0.957
CVD									
No	(Ref)								
Yes	2.737	1.687–4.441	0.001	3.616	1.939–6.742	0.001	2.322	0.831–6.485	0.074
Income									
≤ $19,999	(Ref)								
$20,000–$39,999	0.742	0.413–1.332	0.317	0.645	0.300–1.389	0.263	0.599	0.209–1.712	0.339
$40,000+	0.698	0.223–2.182	0.537	0.317	0.040–2.488	0.274	–	–	–
Insurance									
No	(Ref)								
Yes	1.838	1.245–2.713	0.002	1.108	0.728–1.685	0.632	0.579	0.298–1.125	0.107
Race/ethnicity									
Hispanic	0.775	0.538–1.116	0.171	0.746	0.510–1.091	0.131	0.386	0.178–0.835	0.016
Non-Hispanic white	(Ref)								

– Indicates that data were not available due to small size or missing; *p*, *p*-value; Ref, referent group; CI, confidence interval; BMI, body mass index; CVD, cardiovascular disease.

ley County participants with age group 60–69 had high cognitive impairment that was found to be statistically significant ($p = 0.002$, AOR: 15.980, 95% CI: (2.675, 95.444)) compared to other counties. It was found that Parmer County had highest normal cognitive female participants ($n = 381$) compared with Cochran ($n = 302$) and Bailey ($n = 113$) counties. Females in Parmer County showed a significantly lower likelihood of cognitive impairment ($p = 0.033$, AOR: 0.217, 95% CI: 0.054, 0.881) compared to females in Cochran and Bailey counties. Depression was found to be significantly high likely for Bailey County ($p = 0.002$, AOR: 16.795, 95% CI: (2.749, 102.612)) compared with Parmer ($p = 0.097$, AOR: 3.420, 95% CI: (0.802, 14.583)) and Cochran counties ($p = 0.863$, AOR: 1.086, 95% CI: (0.426, 2.764)). Considering non-Hispanic whites as a referent group, Hispanics in Parmer County were found to be high likely cognitively impaired ($p = 0.004$, AOR: 39.188, 95% CI: (3.123, 491.671)) than other counties. Although there was a trend or pattern among Hispanic individuals, who were a large proportion in each county compared to non-Hispanic Whites, they were more likely to develop cognitively impaired due to their chronic illness. The individuals living in Cochran and Bailey Counties had high likely to have cognitively impaired (AOR: 1.807, 95% CI: (0.749, 4.360), $p = 0.188$; AOR: 1.674, 95% CI: (0.267, 10.489), $p = 0.582$) though the adjusted odds ratios are not statistically significant, on the other hand Parmer County had the highest cognitively impaired individuals (AOR: 39.188, 95% CI: (3.123, 491.671) and this adjusted odds ratio is statistically highly significant ($p = 0.004$).

Figures 2A-3B reflect the cognitive decline for some sociodemographic characteristics. The cognitive data were collected at a one-time point when the individuals visited during the time period 2006–2018. Figure 2A depicts a visual representation of cognitive disorder by gender within Cochran, Parmer, and Bailey counties. It is obvious that in the Cochran County, there were more females (302) than males (130) participants had non-cognitive decline, and there were more females (124) than males (72) in the same county had cognitive decline (72.2% higher). In Parmer County, more females had non-cognitive decline (381) than males (142), and higher cognitive decline (85) in females than males (62) by 37.1%. The Bailey County had the highest proportion of non-cognitive decline for females (113) than males (33), and higher cognitive decline in females (33) than males (15) by 120%. It is apparent that participants in both cognitive and non-cognitive decline are more likely to be female across all counties. In Cochran County, the percentage increased in the cognitive decline in females is 72.2% higher than males. Parmer County 37.1% females had higher cognitive decline than males, similarly, Bailey County females had experienced more than 100% cognitive decline than males. In all three counties, female participants exhibit a highest prevalence rate of cognitive decline than males. Among three counties, Cochran

Table 4
Multivariable analysis of factors associated with cognitive impairment after adjustment for covariates

Variables	Cochran			Parmer			Bailey		
	Odds ratio	95% CI	*p*	Odds ratio	95% CI	*p*	Odds ratio	95% CI	*p*
Age group									
40–49	(Ref)								
50–59	2.008	0.704–5.727	0.192	2.106	0.387–11.456	0.389	1.602	0.341–7.521	0.551
60–69	3.138	0.937–10.514	0.064	4.885	0.897–26.605	0.067	15.98	2.675–95.444	0.002
70+	2.927	0.740–11.582	0.126	8.830	0.727–107.170	0.087	3.507	0.397–30.951	0.259
Gender									
Male	(Ref)								
Female	0.497	0.212–1.166	0.108	0.217	0.054–0.881	0.033	0.439	0.125–1.548	0.201
Marital status									
Married	(Ref)								
Divorced	1.416	0.533–3.758	0.485	5.338	0.483–59.033	0.172	0.730	0.066–8.116	0.798
Separated	1.995	0.419–9.511	0.386	–	–	–	2.142	0.345–13.296	0.414
Widowed	0.895	0.314–2.550	0.836	8.468	0.903–79.431	0.061	–	–	–
Never-married	0.363	0.031–4.231	0.419	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–
Education									
Certificate	(Ref)								
Bachelor	0.682	0.284–1.638	0.392	2.879	0.486–17.055	0.244	0.156	0.027–0.919	0.040
Master	–	–	–	–	–	–	0.139	0.012–1.599	0.113
BMI									
Normal	(Ref)								
Overweight	1.391	0.501–3.866	0.527	0.235	0.036–1.520	0.129	0.575	0.104–3.170	0.525
Obese	0.920	0.322–2.624	0.876	0.056	0.007–0.434	0.434	0.569	0.119–2.710	0.479
High blood pressure									
No	(Ref)								
Yes	1.344	0.387–4.663	0.641	9.848	0.250–387.330	0.222	0.256	0.032–2.040	0.198
Anxiety									
No	(Ref)								
Yes	2.079	0.744–5.805	0.163	3.936	0.919–16.852	0.065	0.715	0.138–3.712	0.689
Depression									
No	(Ref)								
Yes	1.086	0.426–2.764	0.863	3.420	0.802–14.583	0.097	16.795	2.749–102.612	0.002
Alcohol									
No	(Ref)								
Yes	2.971	0.512–17.221	0.225	0.266	0.018–4.018	0.339	1.350	0.046–39.877	0.862
Diabetes									
No	(Ref)								
Yes	0.677	0.059–7.785	0.754	5.793	0.454–73.915	0.176	6.002	0.322–111.830	0.230
Diet to control diabetes									
No	(Ref)								
Yes	0.542	0.076–3.858	0.541	1.911	0.145–25.145	0.622	0.150	0.003–8.957	0.363
Cholesterol	0.995	0.987–1.003	0.239	0.996	0.983–1.010	0.580	1.001	0.988–1.014	0.928
Hypertension									
No	(Ref)								
Yes	0.815	0.235–2.835	0.748	336.808	4.256–6769.80	0.011	2.066	0.406–10.514	0.382
Diet to control hypertension									
No	(Ref)								
Yes	3.146	0.958–10.329	0.059	3233.692	5.752–181808.00	0.012	1.998	0.234–17.064	0.527
CVD									
No	(Ref)								
Yes	1.940	0.604–6.233	0.266	12.382	0.389–394.390	0.154	0.745	0.066–8.452	0.812
Income									
≤ $19,999	(Ref)								
$20,000–$39,999	2.293	0.513–10.242	0.277	0.262	0.019–3.606	–	2.015	0.363–11.194	0.423
$40,000+	0.176	0.012–2.590	0.205	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–

(*Continued*)

Table 4
Multivariable analysis of factors associated with cognitive impairment after adjustment for covariates

Variables	Cochran			Parmer			Bailey		
	Odds ratio	95% CI	*p*	Odds ratio	95% CI	*p*	Odds ratio	95% CI	*p*
Insurance									
No	(Ref)								
Yes	0.930	0.406–2.133	0.865	1.577	0.373–6.667	0.536	0.324	0.082–1.270	0.106
Race/ethnicity									
Hispanic	1.807	0.749–4.360	0.188	39.188	3.123–491.671	0.004	1.674	0.267–10.489	0.582
Non- Hispanic whites	(Ref)								

– Indicates that data were not available due to small sample size or missing; *adjusted odd ratio (AOR); *p*, *p*-value; Ref, referent group; CI, confidence interval. Anemia, smoking, and physical exercise were not included in the model due to small sample participants. BMI, body mass index; CVD, cardiovascular disease.

County had the highest number of females in cognitive decline.

Data on normal cognition and cognitive decline with various age groups are shown in Fig. 2B. The ages divided into four groups: 40–49, 50–59, 60–69, and 70 and above. Compared with normal cognition, the cognitive decline in various age groups within the counties are displayed. The data from the Cochran County appears to be lower counts when compared with other two counties, especially in terms of cognitive decline. Bailey County shows a relatively lower cognitive decline for age group 40–69, whereas Parmer County has a higher proportion of individuals with cognitive decline. Individuals aged 70 or older had a higher rate of cognitive decline in Cochran and Parmer Counties except Bailey County. Of the 156 cognitively impaired individuals aged 70 or older, Bailey County had the lowest percent (5.8%) of experience in AD.

Data on several educational levels within the counties are exhibited in Fig. 3A. The counties (Cochran, Parmer, Bailey) and educational levels (no education, certificate, bachelor's, and master's) are shown on x-axis. The number of participants on both normal cognition and cognitive declines within each county were presented with bar graphs. In terms of educational qualification, participants with no education had more cognitive decline than other educational levels. It is evident that a large proportion of individuals with no education had normal cognition in each county, and the percent of the cognitive declines were 54.4%, 33.8%, and 51.3% in Cochran, Parmer, and Bailey counties, respectively.

In comparison, among the normal cognitive individuals, the Cochran County showed a large proportion of certificate educators compared with Parmer and Bailey counties. The certificate individuals in Cochran County, 28.4% had cognitive decline, which was the highest percent decline compared to Parmer (17.1%), and Bailey (11.3%) counties. In the case of bachelor's education, the normal cognitive individuals were observed higher (66.7%) in Parmer County compared to Cochran County and Bailey County. Among the 38 normal cognitive individuals who had master's degree, 14 were in Cochran County, 21 were in Parmer County, and three were in Bailey County. There were several master's individuals who had no experience in cognitive decline observed either in Parmer or Bailey County. It was indicated from the bar graphs that there is a trend of lower cognitive decline with the level of education.

Figure 3B shows a visual comparison of Hispanic and non-Hispanic white individuals, on their rates of prevalence for normal cognition and cognitive decline. Hispanic individuals are exhibited a large proportion of normal cognition in Parmer County compared to Cochran and Bailey counties. About 26.3% percent higher Hispanic individuals those who are in normal cognition observed in Parmer County compared with Cochran County. Consequently, Bailey County had 71.4% fewer individuals with normal cognition compared to Parmer County. On the contrary, Cochran County showed its predominance in individuals with cognitive impairment compared to other counties. The Cochran County Hispanic individuals had the highest percent of cognitive decline compared to Parmer County (9.5%) and Bailey County (173.7%). Non-Hispanic white individuals showed lower representation in terms of normal cognition and cognitive decline in all over the counties.

DISCUSSION

It was found by univariate analysis in Table 3 that the prevalence rate of cognitive impairment for older individuals with aged 60 and above within the counties are at the higher risk ($p < 0.05$) which may lead to AD.

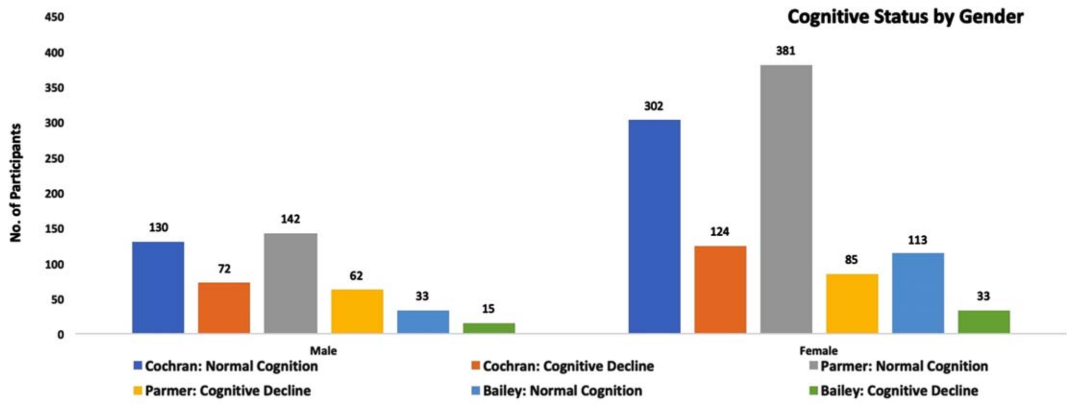

Fig. 2A. Comparison of normal cognition and cognitive decline between males and females. Gender-specific cognitive status within three rural West Texas counties. The number of participants belong on the y-axis and gender on the x-axis of the graph. Each of the bar indicates the number of participants. Project FRONTIER collected data from three counties (2006–2018): Cochran County (for males, normal cognition $n = 130$, cognitive decline $n = 72$; for females, normal cognition $n = 302$, cognitive decline $n = 124$), Parmer County (for males, normal cognition $n = 142$, cognitive decline $n = 62$; for females, normal cognition $n = 381$, cognitive decline $n = 85$), and Bailey County (for males, normal cognition $n = 33$, cognitive decline $n = 15$; for females, normal cognition $n = 113$, cognitive decline $n = 33$).

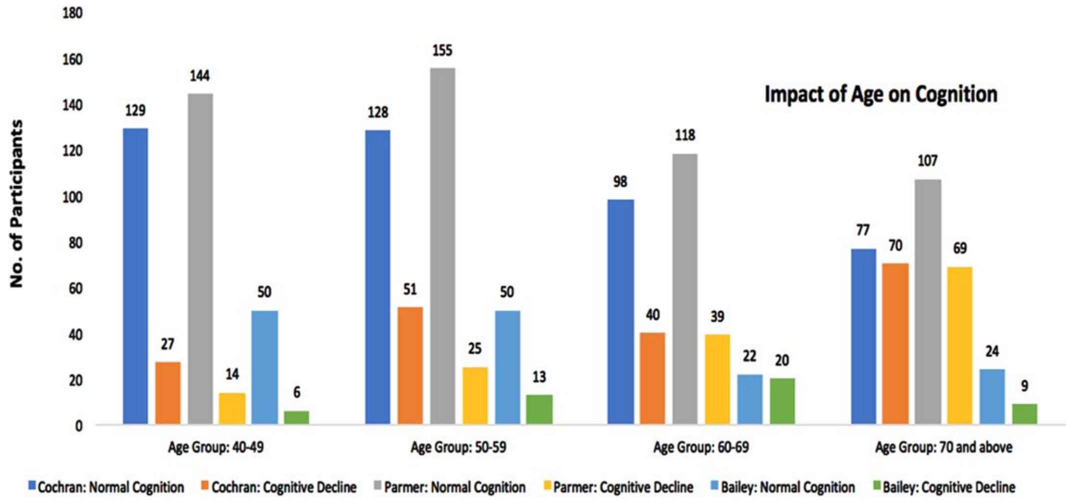

Fig. 2B. Cognitive dysfunction with age groups in rural West Texas. Age-specific cognitive status within three rural West Texas counties. The number of participants belong on the y-axis and age groups on the x-axis of the graph. Project FRONTIER collected data from three counties (2006–2018): Cochran County with age groups 40–49, 50–59, 60–69, 70+(normal cognition $n = 129$, 128, 98, 77; cognitive decline $n = 27$, 51, 40, 70), Parmer County with the same age groups (normal cognition $n = 144$, 155, 118, 107; cognitive decline $n = 14$, 25, 39, 69), and Bailey County with the same age groups (normal cognition $n = 50$, 50, 22, 24; cognitive decline $n = 6$, 13, 20, 9).

This finding is consistent with the published work.[1] The study divulged that the prevalence and incidence of AD are increasing with age. AD is the fifth-leading cause of death among Americans aged 65 and older. It was estimated that 6.2 million Americans aged 65 and older are living with AD or dementia.[1] Among the participants in the three rural West Texas counties, a large proportion of females reported their cognitive status compared with male counterparts. Females in Bailey County were less cognitively impaired ($p = 0.230$) compared with Cochran County ($p = 0.098$) and Parmer County ($p = 0.001$).

Ojo and Brooke[28] reviewed the association between diabetes mellitus, cognitive decline, and dementia. They searched strategies through electronic databases such as EBSCOhost Research and SwetsWise, and found that the duration of diabetes, glycated hemoglobin levels, and glycemic fluctuations were associated with cognitive decline and dementia. Khan et al.[3] found that there was a sig-

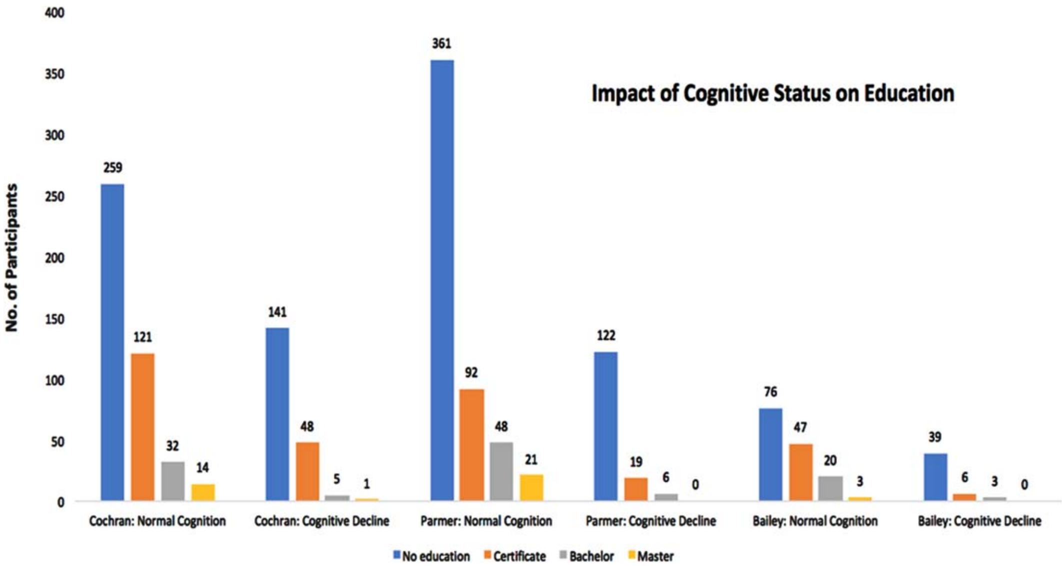

Fig. 3A. Cognitive Dysfunction on Education. Education-specific cognitive status within three rural West Texas counties. The number of participants belong on the y-axis and education on the x-axis of the graph. Project FRONTIER collected data from three counties (2006–2018): Cochran County on education levels, no education, certificate, bachelor, master (normal cognition $n = 259$, 121, 32, 14; cognitive decline $n = 141$, 48, 5, 1), Parmer County on same education levels (normal cognition $n = 361$, 92, 48, 21; cognitive decline $n = 122$, 19, 6, 0), and Bailey County on same education levels (normal cognition $n = 76$, 47, 20, 3; cognitive decline $n = 39$, 6, 3, 0).

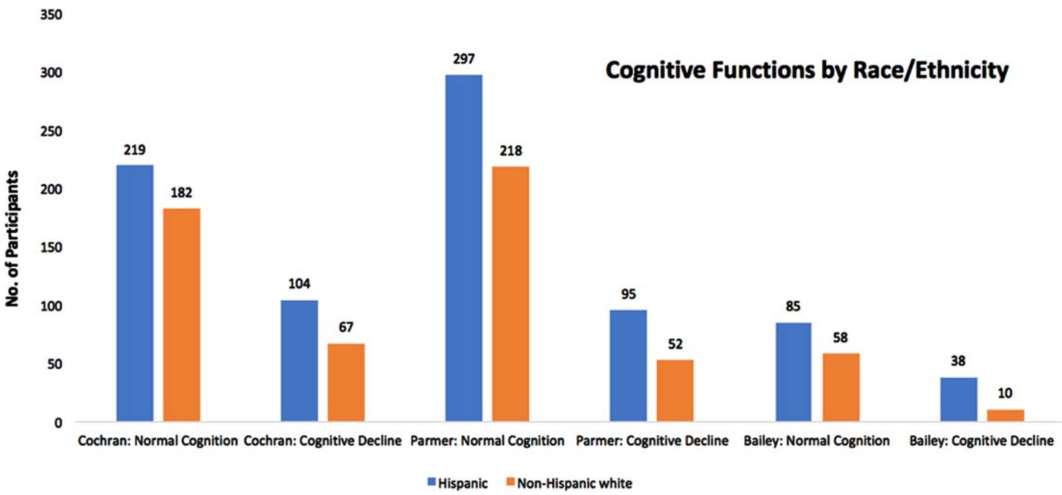

Fig. 3B. Cognitive Dysfunction by Race/Ethnicity. Race/ethnicity-specific cognitive status within three rural West Texas counties. The number of participants belong on the y-axis, and race/ethnicity on the x-axis of the graph. Project FRONTIER collected data from three counties (2006–2018): Cochran County by race/ethnicity (Hispanics normal cognition $n = 219$, non-Hispanic whites normal cognition $n = 182$; Hispanics cognitive decline $n = 104$; non-Hispanic whites cognitive decline $n = 67$); Parmer County by race/ethnicity (Hispanics normal cognition $n = 297$, non-Hispanic whites normal cognition $n = 218$; Hispanics cognitive decline $n = 95$; non-Hispanic whites cognitive decline $n = 52$); and Bailey County (Hispanics normal cognition $n = 85$, non-Hispanic whites normal cognition $n = 58$; Hispanics cognitive decline $n = 38$; non-Hispanic whites cognitive decline $n = 10$).

nificant association between diabetes mellitus and cognitive decline in both males and females, and the rate of the decline was higher in males than females at the beginning of age 40–64 of cognition.

Shyama and Reddy conducted a study[4] and stated that age-related chronic diseases such as CVD, high cholesterol, diabetes, and kidney disease within the US are significantly associated with the direct increase of AD or rapid progression of dementia. Jefferson et al.[29] stated that CVD and related risk factors were associated with AD. Khan et al.[3] found significant association between CVD and age for both males and females.

It was found that individuals with no education in Cochran County had higher rate of cognitive impairment compared to Parmer and Bailey Counties. The highest number of cognitively impaired individuals was found in Cochran County compared with Parmer and Bailey Counties for those who had completed the certificate program. For cognitive impairment, Parmer County had a larger proportion of participants who had completed a bachelor's degree compared to Cochran County and Bailey County. It was found that participants with higher education are potentially at high risk of cognitive impairment within the counties. The prevalence rate of cognitive impairment in Cochran and Parmer Counties had less risk of having education than Bailey County. Our findings are consistent with Seyedsalehi et al.,[30] where the authors stated that higher educational attainment is observationally associated with lower risk of AD. The protective effect of education on AD may be mediated via increased brain reserve.[30] Our findings also agree with Shyama and Reddy[4] stated that low educational attainment is the higher risk of developing AD.

Table 1 contents based on general Census information on the related to the sociodemographic characteristics of the counties.[23] The selected sample was collected from the individuals who visited for a routine health checkup in a hospital setting. Individuals were visited the hospital from the three counties: Cochran, Parmer, and Bailey. The individuals were not representative samples from the census frame of the listed counties. The prevalence of high blood pressure was found to be significant for cognitively impaired individuals in Cochran and Parmer Counties, where the Bailey County showed less cognitive impairment, it could be due to better health insurance and better income or maintain quality of health (Table 1). Our findings agree with the authors divulgence, high blood pressure, also called hypertension, is blood pressure that is higher than normal. Hypertension affects two-thirds of participants aged >60 years and significantly increases the risk of both vascular cognitive impairment and AD.[31] Similarly, depression was found to be highly significant risk factor for cognitively impaired individuals in all counties which agrees with the findings of Khan et al..[3] Anxiety was found to be highly significant risk factor for cognitively impaired individuals in Parmer and Bailey counties, and barely significant ($p = 0.073$) in Cochran county, where Khan et al.[3] found that anxiety was significant for females' cognitive dysfunction compared to male participants. CVD was found significant risk factor for cognitively impaired individuals in Cochran and Parmer counties, and not found significant ($p = 0.108$) in Bailey County.

After adjusted for the covariates in a multivariable analysis, results are given in Table 4, it was found that age group 60–69 highly significant for Bailey County and mildly significant ($p = 0.067$) for the participants in Cochran and Parmer Counties. The age group 60–69 showed a significant presence of cognitively impaired individuals for all three counties, as demonstrated by univariate analysis. This result is consistent with findings from a study,[32] which analyzed data from the Chicago Health and Aging Project (CHAP) and reported that approximately 5.8 million Americans aged 65 and older were diagnosed with AD dementia in 2020.

The incidence of female participants in Parmer County had highest cognitive impairment ($p = 0.033$) than those of Cochran ($p = 0.108$) and Bailey ($p = 0.201$) counties. The males in the Parmer County were 78.3% less likely to have cognitive impairment than the females. The risk of cognitive impairment in female individuals was 56.1% lower than in males in Bailey County. The risk of cognitive impairment in female individuals within Cochran County was 50.3% lower compared to males.

Education in Bailey County was found to be significant risk factor to reduce cognitive impairment compared to Cochran and Parmer Counties. The risk of cognitive impairment is 84.4% lower in Bailey County due to educational attainment compared to the lower risks of 75.6% (Parmer County) and 31.8% (Cochran County), respectively.

Depression was found to be highly significant risk factor for cognitively impaired individuals in Bailey County ($p = 0.002$), which agrees with the findings of Khan et al..[3] It was significant at 9.7% significance level in Parmer County, not found significant in Cochran County.

Those individuals age greater than 60 and above, hypertension increases the risk of cognitive impairment and AD.[31] Individuals living in Parmer County found both hypertension and diet to control hypertension were significant to decrease the risk of cognitive impairment. Individuals residing in Cochran County found 18.5% lower risk of cognitive impairment. Khan et al.[3] found hypertension was significantly associated with cognitive disorder in both genders. Bailey County individuals had high likelihood of developing cognitive impairment due to both hypertension and diet to control hypertension. We obtained some dissimilar results, previous published works of Khan et al.[3,9] found that there were some variables such as CVD, depression, alcohol, diabetes, and hypertension are significantly linked to cognitive impairment. However, we did not perceive the significant of these variables.

Hispanic Texans are now the largest demographic group in the state, exceeding white Texans by nearly 129,000 people, according to the latest U.S. census estimates. The new population figures show Hispanic Texans made up 40.2% of the state's population last summer, barely edging out non-Hispanic white Texans, who made up 39.8%.[33] Shyama and Reddy conducted a study[4] and found that Hispanic participants were the lowest level of educational attainment when directly compared to non-Hispanic whites in rural West Texas. Although they accounted for over 40% of the total population of Texas in 2018, only 15.2% of Hispanics held a bachelor's degree or higher.[34,35] The participants who had a bachelor's degree were 31.8% less risk of developing cognitive impairment than those of certificate degree in Cochran County. The likelihood of cognitive impairment was 2.879 times higher in bachelor's degree holders than the certificate degrees in Parmer County.

The percent increase in Hispanic participants (82.7%) compared to non-Hispanic whites in Parmer County had highest cognitive impairment ($p = 0.004$) than those increase in Hispanics participants (55.2%) compared to non-Hispanic whites within Cochran ($p = 0.188$) County. The lowest Hispanics participants in cognitive decline compared to non-Hispanic whites was observed in Bailey ($p = 0.582$) County. A study conducted on Hispanic Americans with AD projected through 2060 by age group indicated that aging is the highest growing risk factor for AD or dementia.[36]

We know genes can increase the risk of developing AD and dementia. One of the most significant genetic risk factors is the apolipoprotein E (*APOE*) gene This *APOE* protein carries cholesterol and other types of fats or lipids in the bloodstream, which may impair brain cells' normal activity and may cause AD or dementia. The *APOE4* gene is a significant risk factor causing such disease. We investigated the FRONTIER database and found that it captures some information on *APOE* gene. In Cochran County, of the 503 participants, only 3 (<1%) carried APOE4 whereas in Parmer County, of the 401 participants, 6 (1.50%) carried APOE4 gene. The APOE3 gene was not thought to be a harmful risk factor for AD or dementia. The APOE3 gene were present in 129 (26%) cognitively impaired individuals in Cochran County compared to 66 (16%) in Parmer County. Due to low APOE gene presence in the participants it was decided not to include in the statistical data analysis. Previous findings have stipulated that APOE4 allele inheritance convey strongest association with the development of AD than any other identified genetic biomarkers.[37] Studies found that APOE4 allele is strongly associated with the development of AD within the Hispanic population.[37,38] In our study the effect of APOE4 allele on the development of AD or dementia was not predominant due to lower response rate of participants for each county. The response from research participants may occur if they are unaware of the genetic biomarker, resulting in a very low response rate.

Project FRONTIER was initiated in the year 2006 as the Cochran County Aging Study with the primary focus on the interaction between cardiovascular risk factors and the development of cognitive dysfunction, particularly AD and dementia. Due to the lack of physicians, healthcare facilities, and practitioners, the residents in the counties are still experiencing poor health or lifestyle, and the study of their sociodemographic factors, chronic diseases, and genetic markers would be useful in identifying the most commonly risk factors and implementing urgent interventions in the rural West Texas region.[4]

National plan to address Alzheimer's disease (NAPA), a federal strategic plan to prevent future cases of AD and related dementia, started in 2011 with six ambitious goals. Important goals of this AD prevention program are to accelerate action to promote healthy aging and reduce risk factors for AD and related dementias as well as to decrease disparities in AD for racial and ethnic minority populations that are at higher risk for AD. Results of our study showed sociodemographic factors (such as low educational attainment and less access to healthcare), depression, and age-related chronic diseases (diabetes, hypertension, CVD) are significant risk factors in developing AD or other forms of dementia in three West Texas counties. Additionally, we found the Hispanics people are more vulnerable to developing AD. These findings from our study emphasize that Interventions of prevention programs could include targeted outreach efforts, culturally sensitive education initiatives, and community-based awareness services aimed at reducing risk factors and promoting cognitive health. In addition, Medicare, and Medicaid services should include clinical care funds and long-term services and support for rural and Hispanic ethnic people of West Texas counties.[39]

Study strengths and limitations

Strengths: This is the first study to investigate the various sociodemographic, chronic disease, and genetic risk factors that influence cognitive impairment in the rural West Texas population. It was conducted on the elderly participants living in rural West Texas counties, and the study was approved by an IRB at TTUHSC, Lubbock, TX. The normal cognition and cognitive impairment for the counties at the baseline were compared with proportion test and statistical significance were determined with p-values. A binary logistic regression method was used for univariate analysis for each sociodemographic and chronic disease variable. A multivariable logistic regression was performed to detect the high-risk variable of cognitive impairment and to implement interventions. Considering the preliminary results, it would be a better indication to collect the missing data, and data for the remaining missing individuals within counties or its neighboring counties with an extended study period. Project FRONTIER is still collecting data from rural West Texas participants. This study is the first large observational study to investigate various risk factors that influence healthy aging in the rural West Texas population.

Limitations: County-specific data were not available for some variables due to small sample sizes or missing participants; therefore, no statistical analysis was conducted. Data were not available to study environmental variables, only the genetic variable APOE4 was studied for a few available participants but was not found a harmful for AD or dementia. There were no publicly available records regarding family history of deaths from chronic or genetic diseases. This study considered data from Project FRONTIER 2006 to 2018 for the statistical analysis. No longitudinal data were collected from the participants during the study period, and no reports were found regarding how certain factors have resulted in lower risk levels. The Project FRONTIER should include the neurotoxicity related to high levels of arsenic in ground and well water. There was no such data collected yet by the Project FRONTIER. This study did not consider data between different subgroups within the Hispanic population, we acknowledge the importance of such specificity in understanding the diversity within this demographic. Future research could explore the unique characteristics and health outcomes of various Hispanic subgroups to provide a more comprehensive understanding of their needs and experiences.

Conclusions

A cross-sectional study design was used to collect data from Project FRONTIER data which comprised from the resident of rural West Texas counties. This study allows researchers to compare different variables at the same time and to identify the significant risk factors of cognitive impairment in elderly adults. The findings revealed the prevalence of cognitive impairment among county-level participants, comparing two groups: those with normal cognition and those with cognitive impairment with their sociodemographic status and chronic diseases. The large proportion of cognitively impaired individuals was found in Cochran County and the second large proportion was observed in Parmer County. Research findings suggest that Hispanic participants are more prone to chronic diseases due to predisposing genetic factors, age-related chronic diseases, lack of physical activity, unhealthy food choices, low socioeconomic status, poor lifestyle choices and low educational attainments. Future research should explore how Cochran, Parmer, and Bailey Counties compare to surrounding counties, such as Lubbock, whose population is rapidly increasing.

The findings have significant implications for intervention planning and public health resource allocation for Cochran, Parmer, and Bailey Counties in rural West Texas. Public health practitioners can explore additional risk factors by mapping the target population within counties or to conduct possible intervention to reduce the incidence of AD or dementia. Further studies are needed to investigate the individuals living in rural West Texas counties to explore their awareness regarding genetic markers associated with the development of AD or dementia.

AUTHOR CONTRIBUTIONS

Hafiz Khan (Conceptualization; Data curation; Formal analysis; Supervision; Writing – original draft); Fardous Farhana (Writing – review & editing); Fahad Mostafa (Data curation; Writing – review & editing); Aamrin Rafiq (Writing – review & editing); Effat Walia Nizia (Writing – review & editing); Refaya Razzaq (Writing – review & editing); Rumana

Atique (Writing – review & editing); Megan Dauenhauer (Writing – review & editing); Zawah Zabin (Writing – review & editing); Komaraiah Palle (Writing – review & editing); P. Hemachandra Reddy (Conceptualization; Supervision; Writing – review & editing).

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CONFLICT OF INTEREST

The authors have no conflict of interest to report.

DATA AVAILABILITY

It would be enlightened to the reader that the data supporting the findings of this study may not be available upon request as the institution strictly follows high ethical standards and is committed to maintaining the confidentiality of participants' information. We appreciate their understanding and respect for the ethical guidelines of the institution.

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