



The Prevalence of Alzheimer's Disease and Hospital Readmissions Rates: A Retrospective Study

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ABSTRACT

Alzheimer's disease is a progressive neurodegenerative disease primarily affecting the elderly population and is a major public health challenge worldwide. The objective of this retrospective quantitative study was to investigate the prevalence rates of Alzheimer's Disease (AD) in the United States within the population aged 65 and above and explore variations within the study population. In addition, the study also examined the AD prevalence and readmission rates in comparison with other specific chronic conditions to provide a holistic understanding of Alzheimer's disease. The study's primary data source was the specific chronic conditions data derived from the CMS (Centers for Medicare and Medicaid Services) from the year 2018, which included specific chronic conditions, patient demographics, prevalence and hospital readmission rates, emergency room visits, beneficiary status and medicare payments. The study conducted a comprehensive literature review to better understand the complex interplay of different key variables in the context of Alzheimer's disease. The next step was data mining, followed by descriptive and inferential analysis to investigate the dataset. The study observed significant correlations between age and Alzheimer's disease, along with noteworthy variations based on gender, ethnicity and location. The study also observed significant differences in the hospital readmission rates and healthcare utilization metrics when compared to other specific chronic conditions. The study findings reflect the unique healthcare challenges associated with Alzheimer's disease and offer valuable information to the key stakeholders encouraging further research and futuristic healthcare designs to optimize care strategies and resource allocation to mitigate the impact of Alzheimer's disease.

Keywords: Alzheimer's disease; Dementia; Age; Gender; Chronic diseases; Modifiable and unmodifiable risk factors; Prevalence; Hospital readmissions; Financial burden; Prevention and intervention strategies; Resource allocation; Caregiver support; Retrospective study; Descriptive analysis; Regression analysis

INTRODUCTION

Alzheimer's Disease (AD) is a progressive and degenerative brain disorder and it is the most common type of dementia,

primarily affecting areas of the brain involved in memory, thinking and behavior. Alzheimer's disease ranks as the 7th leading cause of death worldwide and it usually begins with mild memory loss and gradually progresses to a decline in

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cognitive function that interferes with an individual's ability to perform daily activities. Alzheimer's disease is caused by the accumulation of abnormal protein deposits in the brain, primarily beta-amyloid plaques and tau tangles [1]. These deposits interfere with brain cell communication and normal functioning, leading to their degeneration and death. **Figure 1** shows the physiological structure of a healthy brain and the Alzheimer's disease brain with beta-amyloid plaques and tau neurofibrillary tangles [2].

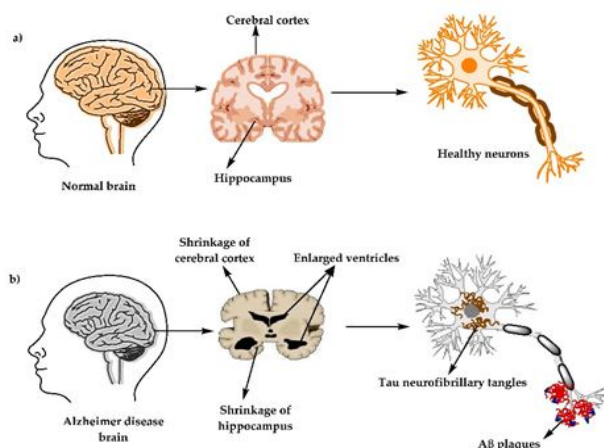


Figure 1: Normal brain vs. Alzheimer's disease brain.

Common symptoms of Alzheimer's include memory loss, cognitive decline, impaired judgment, disorientation and confusion, difficulty with language and communication and changes in personality and behavior. As the disease progresses, individuals may have difficulty with daily activities and living, such as bathing, dressing and eating and may become increasingly dependent on others for their care.

The exact cause of Alzheimer's disease is not fully understood and unfortunately, there is no cure yet. However, it is crucial to explore the various facets of Alzheimer's disease management and care, with one critical aspect being the rate of hospital readmissions. Often, patients, after being discharged from the hospital, return for treatment, usually due to complications or inadequate management of their condition; hospital readmissions pose a significant burden on the healthcare system and patients. Hospital readmissions also signal the potential gaps in the care and support provided to Alzheimer's patients [3].

A high readmission rate may indicate inadequate follow-up care or incomplete patient treatment and discharge instructions and it is frequently used as an indicator of hospital/provider care quality. The study aimed to identify potential modifiable variables and trends in the disease rates to provide insights that could help mitigate the burden of Alzheimer's disease on individuals, families and healthcare systems. This effort aligns with the broader goal of advancing our knowledge of Alzheimer's disease and improving the quality of life for aging populations. The article underscores the need for comprehensive healthcare strategies considering the interplay between the risk factors and care coordination and advocates for preventive measures that target chronic

disease management and reduce hospital readmissions in aging populations [4].

MATERIALS AND METHODS

Research questions

Prevalence rates

- Are there variations in the prevalence rates of Alzheimer's disease by age, location, gender or ethnicity?
- Is there a significant regional or demographic pattern in Alzheimer's disease prevalence rates among the study population?

Hospital readmission rates

- Is there a notable variation in the hospital readmission rates among individuals with Alzheimer's disease compared to those with other chronic conditions?
- Are there significant patterns in Alzheimer's disease hospital readmission rates among the study population within specific locations or demographics?

Hypothesis

Null hypothesis (H_0): There are no significant regional or demographic variations in the prevalence rates or hospital readmission rates of Alzheimer's disease.

Alternative hypothesis (H_1): Alzheimer's disease prevalence and hospital readmission rates exhibit significant differences based on age, gender, ethnicity and geographical location.

Justification of study

Understanding Alzheimer's disease trends and reducing the prevalence and preventable hospital readmissions are a financial imperative and a measure of improving care quality and delivery to enhance the efficiency of healthcare systems for better patient outcomes. The study's outcomes collectively provide a nuanced understanding of the various factors influencing Alzheimer's disease prevalence and hospital readmissions and provide actionable insights for policymakers and healthcare practitioners to effectively address these challenges.

Literature search

A comprehensive literature search was conducted across multiple search engines, such as PubMed, Google Scholar, ScienceDirect, AGS (American Geriatrics Society), Web of Science and PsycINFO, using keywords such as Alzheimer's disease, prevalence, hospital readmissions, individuals 65 and older, risk factors, healthcare utilization, caregiver support and health information exchange were utilized as inclusion criteria. The search criteria were set to identify articles published within the last decade, focusing on primary research studies, systematic reviews and meta-analyses that examined prevalence and hospital readmissions in the context of Alzheimer's disease in the United States. This time restriction

ensured that the study used and gathered up-to-date information from original research and high-level summaries of existing research. The study's extensive literature search and review focused on delivering a comprehensive perspective on the topic, which is essential for identifying and addressing the disease's complexities. The study prioritized open-access articles, ensuring that the information gathered is readily available to all researchers, which can be especially valuable for transparent and collaborative research [5].

This comprehensive literature review systematically investigated and analyzed variations in the prevalence and hospital readmission rates of Alzheimer's patients within the demographics of individuals aged 65 and older. This review aimed to identify and provide a comprehensive understanding of the contributing factors responsible for these variations, including demographic, clinical and healthcare system-related factors. By integrating existing research, this review contributes to a better understanding of the challenges and opportunities in the early detection of Alzheimer's disease, co-morbid conditions that increase the risk of the progression of the disease and care and management for older adults with dementia. Also, the review exposes the literature gaps and informs future research and healthcare practices in this field [6].

Prevalence

Dhana et al., conducted a population-focused study analyzing cognitive data from the Chicago Health and Aging Project (CHAP) and combined that data with the National Center for Health Statistics (NHCS 2020 bridged-race population estimates [6]. Their study aimed to determine the prevalence of Alzheimer's disease among individuals aged 65 and older, providing estimates for both the national and regional levels, including 50 US states and 3142 counties. The study results indicated that the eastern and southeastern regions of the US had a greater prevalence of AD, with the highest rates found in Maryland (12.9%, New York (12.7% and Mississippi (12.5%, based on the first-ever research of the disease's occurrence by county. Texas, Florida and California states had the largest populations of Americans with AD and the counties with the highest prevalence of AD were Bronx County, New York; Miami-Dade County, Florida; and Baltimore City, Maryland [7].

The Dhana et al. study provides a rationale for the variations in the prevalence of AD and increased occurrence in regions with higher densities of older adults and black and hispanic residents. The study recommends using state- and county-specific estimates as a valuable tool in directing resources toward public health programs and the development of tailored care strategies to reduce the burden of Alzheimer's disease. In conclusion, the existing literature supports the study hypotheses and underscores the existing regional and ethnic variations in Alzheimer's disease. Therefore, it is crucial to recognize and address these variations and develop targeted interventions that enhance our ability to

comprehensively address the challenges posed by Alzheimer's disease on a global scale [8].

Risk factors

Non-modifiable risk factors: Age, heredity, family history and certain health conditions like Down syndrome, Huntington's disease, Creutzfeldt-Jakob disease, Gerstmann-Strausler-Scheinker syndrome and fatal familial insomnia are unmodifiable risk factors for the development of Alzheimer's disease. According to the 2020 Alzheimer's disease facts and figures report, based on the data from the Chicago Health and Aging Project (CHAP), approximately 5.8 million Americans aged 65 and older were diagnosed with AD dementia in 2020. Furthermore, this number is projected to increase within the United States to reach 7.1 million by the year 2025 and 13.8 million by the year 2050, given that no significant medical developments occur with regards to curing or delaying the progression of AD. The results are consistent with the study's initial hypothesis and results, underscoring the dire need for breakthroughs in the field to enhance the quality of life of individuals affected by the condition. **Figure 2** illustrates common modifiable and non-modifiable risk factors including age, genetics, lifestyle and chronic conditions [9].

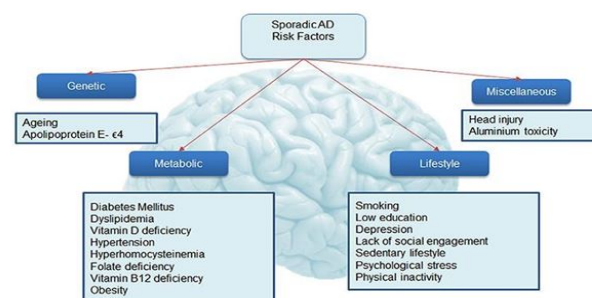


Figure 2: Modifiable vs. non-modifiable risk factors.

Modifiable risk factors

Diet: Various factors such as a person's socioeconomic status, level of education, level of physical activity and diet, in addition to other unmodifiable risk factors like aging and genetics, can influence their risk of developing dementia. A novel strategy was suggested by the researchers following a health and retirement study (n=5,907) [17]. Research on the effects of neuroprotective dietary strategies, the Mediterranean diet (MedDiet) and the MIND diet (a combination of the DASH (Dietary Approaches to Stop Hypertension) and MedDiets) have shown that following these diets has a positive impact on the cognitive health of elderly individuals. Adherence to the MIND and MedDiet diets has been directly linked to a lower risk of cognitive impairment and improved cognitive function [10].

Physical activity: Physical activity plays a vital role in primary and secondary prevention of CVD (Cardiovascular Disease) by reducing the impact of the disease, delaying progression and preventing recurrence. Similarly, regular physical activity

prevents dementia due to AD and slows down the progression of the disease. Engaging in aerobic physical activity is especially beneficial for cardiovascular health. It enhances endothelial function by inducing nitric oxide production, reducing vascular inflammation and promoting vascular regeneration. Studies have shown that individuals with some physical activity had a 25%-38% lower risk of AD compared to those without any activity, while those with increased physical activity had a 33%-48% lower risk of AD [11].

The observational cohort study conducted by Dhana et al., analyzed the data from two projects, Chicago Health and Aging Project (CHAP) (1,845 participants) and the Rush Memory and Aging Project (MAP) (920 participants), focusing on Alzheimer's dementia. Over a median follow-up of 5.8 years for CHAP and 6.0 years for MAP, 379 and 229 participants, respectively, developed Alzheimer's dementia [7]. After analyzing multivariable-adjusted models, the researchers found that each additional healthy lifestyle factor was associated with a 27% reduction in the risk of Alzheimer's dementia. The key findings include a pooled Hazard Ratio (HR) of 0.73 (95% CI 0.66-0.80) for Alzheimer's dementia per each additional healthy lifestyle factor. Compared to individuals with 0 to 1 healthy lifestyle factor, those with 2 to 3 factors had a 37% lower risk (pooled HR 0.63, 95% CI 0.47-0.84) and those with 4 to 5 factors had a 60% lower risk (pooled HR 0.40, 95% CI 0.28-0.56) of developing Alzheimer's disease. The study findings complement our hypothesis that adherence to a healthy lifestyle reduces the risk of a neurodegenerative condition [12].

Chronic diseases

An increase in Alzheimer's disease and other neurological disorders in the United States, more specifically, the rapid advancement of dementia in these individuals has been directly linked to the rise in age-related chronic diseases such as cardiovascular disease, diabetes, high cholesterol, kidney disease and cognitive impairment from brain injury/accidents that accelerate the development and progression of Alzheimer's disease [13].

Cardiovascular disease and Alzheimer's disease

Neuropathological studies suggest that the presence of ischemic microvascular lesions is significantly higher in the brains of patients diagnosed with Alzheimer's disease. The incidence of neuropathologically confirmed Alzheimer's disease cases was 11-fold higher in women who had cerebral infarctions evident at autopsy. One of the biggest risk factors for Alzheimer's disease has been proposed to be chronic hypertension. Hypertension adversely affects the structural integrity of cerebral blood vessels, forms atherosclerotic plaques in cerebral arteries and induces hyperlipidemia.

Dementia risk may be decreased by antihypertensive treatments and alterations in lifestyle. Active hypertension medication decreased the risk of dementia by 50% as compared to the control group in a double-blind, placebo-controlled research. The study's findings support our hypothesis on gender disparities in the prevalence of

Alzheimer's disease and an increased risk associated with chronic illnesses [14].

Diabetes and Alzheimer's disease

Alzheimer's diabetes or type 3 diabetes is characterized by insulin resistance in the brain and has a significant impact on neurocognition. T3D results from a brain condition in which neurons lose their ability to react to insulin, a neurotransmitter necessary for fundamental functions like memory and learning. Nguyen et al., state that it is critical to recognize T2DM as a risk factor that contributes to the buildup of amyloid- β deposits (amyloidosis) in the brains of dementia sufferers. The buildup of A β inside the neurons and ongoing insulin exposure were linked in a harmful loop. The intracellular domain of Amyloid Precursor Protein (APP), A β protein and insulin are all regulated in vivo by the Insulin-Degrading Enzyme (IDE). Diabetes and Alzheimer's disease-related insulin resistance can result in hyperinsulinemia, which saturates Insulin-Degrading Enzymes (IDE) and prevents the breakdown of A β and insulin. Because of altered glucose metabolism and its dependence on cell death pathways, insulin resistance or malfunction of insulin signaling (a universal hallmark of type 2 diabetes) serves as the foundation for the connection between T2D and Alzheimer's disease [15].

The literature review highlights the intricate network of factors that impact Alzheimer's disease and delves into a deeper understanding of the disease's patterns. The aim is to use this knowledge to create more targeted interventions or policies for addressing Alzheimer's disease [16].

Hospital re-admissions

Patients with dementia exhibited a noticeably greater readmission rate as compared to those without dementia and all-cause 30-day readmission rates, which varied from 7% to 35%, were most observed among dementia patients. Kamdar and colleagues conducted a retrospective cohort study and analyzed the Michigan value collaborative data from 2012 to 2017, focusing on 722,911 hospitalization episodes, out of which 66,676 were related to patients with Alzheimer's Disease and Related Dementias (ADRD) and 656,235 were related to patients without ADRD. After matching, within 30 days readmission rates were 21.5% for ADRD patients and 14.7% for non-ADRD patients. The 30-day readmission cost was \$467 higher for ADRD patients and total 30-day episode costs were \$2794 higher. The study's results align with our hypothesis, underscoring the significance of comprehensive assessments and clear discharge instructions for patients with Alzheimer's disease and related dementia to reduce hospital readmissions [17].

Bykovskyi and colleagues conducted a retrospective cohort study using 100% medicare fee-for-service claims from all 2014 hospitalizations nationwide among medicare enrollees with dementia. The study aimed to explore the relationship between self-reported race (black, non-hispanic white) and all-cause 30-day readmissions. The study involved 1,523,142 hospital stays among 945,481 beneficiaries and the results

indicated that black beneficiaries had 37% higher readmission odds compared to white beneficiaries, even after adjusting numerous factors. The study findings suggest the association between neighborhood disadvantage and readmissions varied by race, highlighting racially patterned disparities in care that contribute to the observed differences. In conclusion, the study found significant racial and geographic disparities in 30-day readmission rates among medicare beneficiaries with dementia diagnoses, with distinct mechanisms influencing different subpopulations [18].

Hospital readmissions that can be prevented can be decreased by various approaches, including identifying high-risk patients, determining the clinical causes of index hospitalization and readmission and instituting home-based, tailored care provided by an interdisciplinary team. Comprehensive assessment and care planning, including follow-up and support, caregiver education and robust discharge guidelines are strongly advised for this vulnerable patient group to improve quality of life and reduce hospital readmissions. Caregiver support and education are essential for providing efficient care to individuals with Alzheimer's disease and to reduce hospital readmissions since Alzheimer's disease not only has a profound impact on those affected by the disease but also on their families and caregivers [19].

Care coordination

Effective care coordination strategies can significantly improve the quality of life and care received by individuals suffering from Alzheimer's disease. Health Information Technology (HIT) systems, such as Electronic Health Records (EHRs), Health Information Exchanges (HIEs) and automated notifications about care transitions, can effectively facilitate care coordination. For instance, sending automated alerts to primary care providers about ED (Emergency Department) visits, hospital admissions and discharges may lower the incidence of readmissions and preventable ED visits and encourage timely follow-ups [20].

The Wang et al. study delved into the impact of hospital-adopted Health Information Technology (HIT) on reducing preventable Emergency Department (ED) visits for patients with Alzheimer's Disease and Related Dementias (ADRD). The study aimed to illustrate the association between hospital-based HIT care coordination strategies and patient engagement strategies and the rate of preventable ED visits for older adults with ADRD. Since there was limited existing literature on the topic, the study utilized data from various sources, including patient-level data from 2015 State Emergency Department Databases (SEED), county-level data from the 2015 Area Health Resources File (AHRF), hospital-level organizational and HIT data from the 2015 American Hospital Association Annual Survey Information Technology supplement (AHAIT). The researchers focused on seven states, AZ, FL, KY, MD, NC, VT and WI, due to the availability of necessary variables and linkage to hospital and county data [21].

The key findings from the Wang et al. study indicate that hospitals employing HIT functionalities, such as using

electronic patient health information from outside providers, providing electronic notifications to the patient's primary care physician and implementing HIT patient engagement strategies, were associated with significantly lower rates of preventable ED visits for ADRD patients. The researchers suggest that specific HIT features fostering communication and information exchange among patients, caregivers and providers can play a crucial role in reducing preventable ED visits for individuals with complex health needs. The findings support the study hypothesis that HIT functionalities promoting care coordination and patient engagement can lead to better outcomes for ADRD patients, contributing valuable insights to the existing literature on the subject [22].

Methodologies employed

The predominant methodologies in the reviewed literature reveal a prevalence of retrospective studies, retrospective cohort studies and systematic reviews. Retrospective studies in the literature review involved analyses of historical patient health data from national or regional health repositories and the data from surveys or research findings to gain insights into historical trends, patterns or outcomes. Descriptive statistics and regression analyses were the prevalent methodological approaches used within this field. Descriptive statistics were used to summarize and describe the key features of data and regression analyses were used to explore the causal relationships between variables, indicating a quantitative approach to data analysis [23].

Analysis of work relevance

The literature review findings are consistent with our initial hypothesis regarding gender, regional and racial disparities in the prevalence and hospital readmission rates. The literature review reinforces the importance of adhering to a healthy lifestyle to reduce the risk of neurodegenerative conditions. It also highlights the impact of disadvantaged neighborhoods on hospital readmissions. Additionally, the literature emphasizes the benefits of Health Information Exchange (HIE) adoption, for better care coordination and improved communication to achieve better patient outcomes. The current literature review findings consistently support our original hypothesis and align with the anticipated study outcomes. This underscores the urgent need for breakthroughs in the field to enhance the quality of life of individuals affected by neurodegenerative conditions [24].

The insights from the existing literature emphasize the critical role of addressing health and healthcare disparities, promoting healthy lifestyles and embracing advanced healthcare technologies to enhance patient care and outcomes. The literature review and the study objective harmonize with the evolving healthcare landscape, embracing futuristic models that integrate electronic health records. The emphasis on promoting health information exchange and employing health informatics strategies reflects a dedication to improving care coordination, aiming for high-quality care and improved patient outcomes [25].

Research methodology

Building upon the insights gained from the comprehensive literature review, the study aimed to address the gaps identified and contribute new findings to the existing body of knowledge. In this section, we describe the methodology, participant selection process, data collection and cleaning procedures and statistical analyses employed to thoroughly investigate the prevalence of Alzheimer's disease and hospital readmission rates based on key variables [26].

Research design

The study adopted a retrospective cohort design to examine Alzheimer's disease prevalence and hospital readmission rates in the United States. Retrospective design was more efficient and cost-effective than prospective designs because the data already exists and the researchers were able to access a large amount of information virtually from any location without the need for additional data collection. The study applied quantitative methods and used a combination of Exploratory Data Analysis (EDA) and inferential analysis techniques like correlation, regression and ANOVA to analyze the dataset and test the hypotheses to unveil insights from our dataset [27].

Data source and retrieval

This retrospective cohort study analyzed the specific chronic conditions data from the year 2018 obtained from the CMS (Centers for Medicare and Medicaid Services) chronic conditions data warehouse, which included administrative enrollment and claims information for original medicare members. Pre-defined indicators for both mental health and chronic diseases were available in the CMS CCW (Chronic Conditions Data Warehouse) database. Data on 21 specific chronic conditions identified based upon ICD-10 (International Classification of Diseases) codes among original medicare participants was available in the specific chronic conditions dataset. The dataset included data on the prevalence and hospital readmission rates, ER visits and medicare payments for various chronic diseases, including Alzheimer's disease, categorized by age, gender, region and beneficiary status. The study used de-identified data, ensuring that any personal information that could lead to the identification of individual participants has been removed to protect the privacy and confidentiality of the study participants. The study analyzed data from a specific year (2018) and established a baseline for understanding the prevalence and readmission rates during that period. This baseline can serve as a reference point for future comparisons and analyses [28].

Justification of study design

The study aimed to provide insights into the significant disparities in the prevalence and hospital readmission rates of Alzheimer's disease across various states nationwide, as well as demographic variations. The researcher's primary goal was to identify and understand these significant variations for targeted interventions and policy enhancements [29].

Cohort selection

The study commenced with the deliberate selection of the study group, chosen based on specific criteria related to the disease and then further data mining was done to ensure homogeneity and enhance the dataset's consistency concerning the condition. The study focused on evaluating both the prevalence and hospital readmission rates, stratified by age, gender, ethnicity and location. This targeted approach allows for a nuanced examination of potential patterns and variations in healthcare outcomes across different demographic and geographic categories within the cohort. The study also focused on people aged 65 and older, which corresponds to the typical age range for Alzheimer's disease. This cohort selection ensures a concentrated exploration of the condition within the broader dataset [30].

Data analysis

Data cleaning and preprocessing: The study used Microsoft Excel and R studio to analyze the CMS Alzheimer's dataset from 2018. First, we examined the dataset's structure and identified missing values. In our initial assessment, we observed that the dataset contains 11,244 observations across 12 variables, with 30,974 missing values. Notably, variables such as `PrvInc`, `Tot_Mdcr_Stdzd_Pymt_PC`, `Tot_Mdcr_Pymt_PC`, `Hosp_Readmsn_Rate` and `ER_Visits_Per_1000_Benes` exhibited significant instances of missing data. To ensure our analysis's integrity, we removed the missing values in the `PrvInc` variable, followed by a similar approach for `Hosp_Readmsn_Rate`, before performing descriptive statistics. Additional data preprocessing stages involved addressing inconsistencies, encoding categorical variables, dealing with outliers, transforming historical data and dividing data for validation. These processes are critical for assuring data quality and preparing the dataset for subsequent analysis in the study [31].

After removing rows with missing values in the prevalence column (`PrvInc`), our dataset comprised 9,326 observations. We then examined the distribution of data across different geographic levels. The majority of observations were at the county level (7,827 observations), followed by the state level (1,469 observations), with a smaller subset at the national level (30 observations). Subsequently, we analyzed hospital readmissions data, which consisted of 54 observations distributed across different geographic levels. Notably, most of these observations were at the state level (53), with only one at the National level. To gain deeper insights into the data, we proceeded with the summary statistics to assess the percentage of prevalence and hospital readmission rates by location [32].

Descriptive analysis

Descriptive statistics, including measures of central tendency (mean, median, mode), dispersion (range, variance, standard deviation, IQR (Inter Quartile Range), MAD (Mean Absolute Deviation)), quartiles and percentiles, were employed to aggregate the prevalence and readmission rates of Alzheimer's disease, which offer a foundational understanding

of the data's characteristics. The descriptive statistics provided a concise summary of the data and helped to understand the variables' central tendency and distribution.

Geospatial analysis

Geographic variations were assessed through geospatial analyses using Tableau to explore region-specific patterns and contribute valuable insights into the regional dynamics of Alzheimer's disease prevalence and hospital readmission rates. The study aimed to identify spatial trends, clusters or disparities across different geographic locations and present the findings with clear visualizations for easy comprehension for key stakeholders [33].

Subgroup analysis

The study conducted a detailed subgroup analysis based on gender and ethnicity to unveil further insights into the prevalence rates of Alzheimer's disease. By segregating the data according to gender and ethnicity, the analysis aimed to discern potential variations and patterns specific to different populations and provide a more comprehensive understanding of how Alzheimer's disease manifests and influences healthcare outcomes differently. The gender- and ethnicity-stratified approaches enhanced the granularity of our investigation.

Inferential analysis

Correlation analysis: The study used correlation analysis to explore the relationships among key independent variables, age, gender and location and the prevalence rates of the outcome variable, Alzheimer's disease. The study aimed to identify potential correlations to understand the intricate dynamics between these variables and the observed rates of Alzheimer's disease within the studied population [34].

Regression analysis: Building upon the insights gained from correlation analysis, the study employed regression analysis to quantify and model the associations between the dependent and the key independent variables. The study aimed to offer insights into the multifaceted factors that influence the prevalence of Alzheimer's disease in different demographic contexts. This analytical approach goes beyond correlation, letting us assess the strength and direction of relationships and predict the impact of these demographic factors on disease prevalence. The regression analysis results provide a more robust understanding of the nuanced relationships among these variables, offering predictive insights into how demographic factors may influence the prevalence rates of Alzheimer's disease in different demographic contexts.

ANOVA analysis: Finally, the study employed ANOVA analysis to compare the mean prevalence rates across diverse demographic groups. This statistical approach allowed us to identify the significant differences in prevalence rates between these groups, thereby providing insights into the potential influence of demographic factors on disease prevalence. This comprehensive analysis enabled us to gain a

nuanced understanding of the epidemiology of Alzheimer's disease, providing essential information for targeted interventions and policy development [35].

Statistical software and tools

The study used a combination of Microsoft Excel, RStudio, Tableau and Power BI for comprehensive data analysis. Microsoft Excel was employed for initial data management, data organization, data cleaning and basic statistical analysis. Its user-friendly interface was very useful for preliminary data exploration and fundamental calculations. RStudio, a programming language and software environment specialized for statistical computing and graphics, provided a high level of flexibility for advanced statistical applications. Tableau and Power BI played a crucial role in transforming the data into dynamic and interactive visualizations, aiding in exploring geographic patterns in the study and enhancing the comprehension of intricate datasets for researchers and audiences. This combination of statistical tools ensured a robust approach to data analysis, balancing statistical rigor with effective communication through meaningful visualizations.

Ethical considerations

The study utilized de-identified data from the 2018 specific chronic conditions data sourced from the CMS chronic conditions data warehouse. Before starting the research, the Institutional Review Board (IRB) approval was obtained from the Harrisburg University of Science and Technology. The researchers provided a comprehensive overview of the study's purpose, methodologies and the utilization of de-identified CMS data during the IRB application process. The IRB approval emphasizes the research team's commitment to ethical practices, prioritizing participants' confidentiality, credibility and reliability of the study by adhering to relevant guidelines governing the use of healthcare data [36].

RESULTS

Alzheimer's disease/Dementia has an average prevalence rate of 10.22%, ranking it among the higher prevalence conditions. AD (Alzheimer's Disease) also has a high average hospital readmission rate of 21.25% (Figure 3).

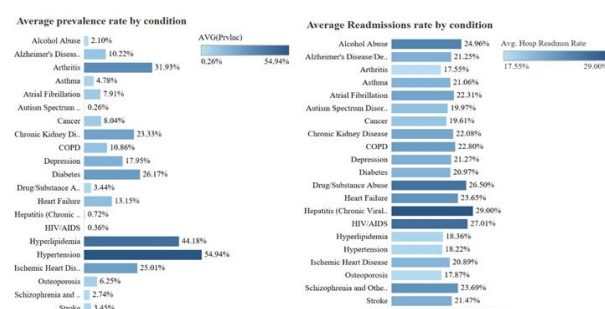


Figure 3: Beneficiary condition and the average prevalence and hospital readmission rates. **Note:** The Tableau visualization illustrates the average prevalence and hospital readmission rates for various medical conditions based on the CMS data from 2018.

Descriptive statistics

Table 1 provides a comprehensive overview of Alzheimer's disease prevalence rates at National, state and county levels, presenting key descriptive statistics by location. This comprehensive analysis provides valuable insights into the distribution and variability of prevalence within each geographic location. At the state level, the prevalence rate has a central tendency with a mean of 0.0917, revealing a positively skewed distribution with potential outliers and non-normality.

The variability ranges from 0.000 to 0.3915, with a precise mean estimate indicated by the 95% confidence interval (0.0889 to 0.0946). The table summarizes prevalence rates statistics by various geographic locations and offers insights into central tendency, dispersion and distribution, with the confidence interval adding precision to the mean estimate and quartiles providing additional measures of central tendency. Analyzing the data across national, state and county levels yields distinct insights and highlights the necessity of more in-depth analyses for a comprehensive understanding of Alzheimer's prevalence.

Table 1: Descriptive statistics of Alzheimer's disease prevalence rates by location.

Prevalence	National	State	County
Mean	0.097	0.091	0.088
Median	0.102	0.086	0.095
Mode	0.029	0.0319	0
Minimum	0.029	0	0
Maximum	0.293	0.3915	0.3206
Range	0.2643	0.3915	0.3206
Standard deviation	0.054	0.056	0.038
Standard error	0.0099	0.0015	0.0004
Sample variance	0.0029	0.0031	0.0014
Kurtosis	6.7378	9.0945	3.0291
Skewness	1.47	1.962	-0.075
Lower bound CI	0.077	0.088	0.087
Upper bound CI	0.118	0.095	0.089

Note: Descriptive statistics for Alzheimer's disease prevalence rates across all demographic groups at the national level, including the 50 states, the district of Columbia, Puerto Rico, the Virgin Islands and at the county level

Table 2 provides crucial insights into hospital readmission rates across 50 states and territories. The mean readmission rate is 21.22%, with a median and mode at 21.55% and 21.53%, respectively. The range of 15.96% to 25.83% signifies variability, while the skewness of -0.2260 suggests a slightly left-skewed distribution, indicating that while most states have higher readmission rates, there are a few states with lower rates. The study highlights the need for further analysis to focus on both ends of the spectrum to understand the disparities and develop targeted interventions to reduce readmission rates. The kurtosis value of 2.4630 indicates a

moderately peaked distribution, suggesting a clustering of states around the average readmission rate. The Confidence Interval (CI) for the mean (Lower bound: 20.55%, upper bound: 21.89%) adds precision to the estimate, considering the variability in the data. This comprehensive analysis enhances our understanding of Alzheimer's prevalence and hospital readmission rates across diverse geographic levels and highlights variations in state performance.

Table 2: Alzheimer's disease hospital readmissions rates descriptive statistics.

Readmissions rates	Value
Mean	0.2122
Median	0.2155

Mode	0.2153
Minimum	0.1596
Maximum	0.2583
Range	0.0987
Standard deviation	0.0241
Standard error	0.0033
Sample variance	0.00059
Kurtosis	2.463
Skewness	-0.226
Lower bound CI	0.2055
Upper bound CI	0.2189

Note: Hospital readmissions data from 50 states and the district of Columbia, Puerto Rico and the Virgin islands, including all age groups and all demographic levels. The data for hospital readmission rates is primarily available at the state level, with only one observation at the national level

Geospatial analysis

The geospatial analysis of Alzheimer's disease prevalence rates across various locations, as shown in **Figure 4**, reveals significant disparities between states. In terms of overall prevalence encompassing all age groups, west Virginia has the highest at 16.97%, closely followed by Florida, New Jersey, Alabama, Kentucky, Delaware, Louisiana and Mississippi, all exceeding 16%. On the other hand, Alaska exhibits the lowest prevalence at 11.73%, alongside Oregon, Washington, Colorado, Vermont, Montana, Minnesota, Wyoming, the Virgin Islands and New Mexico, all below 13%. However, focusing on the 65+ age group, Puerto Rico tops the list with 19.55%, followed by West Virginia, Alabama, Florida and several others, surpassing 17%. Conversely, Alaska reports the lowest prevalence at 12.16%, along with Oregon and Colorado, both below 13% (**Figure 5**).

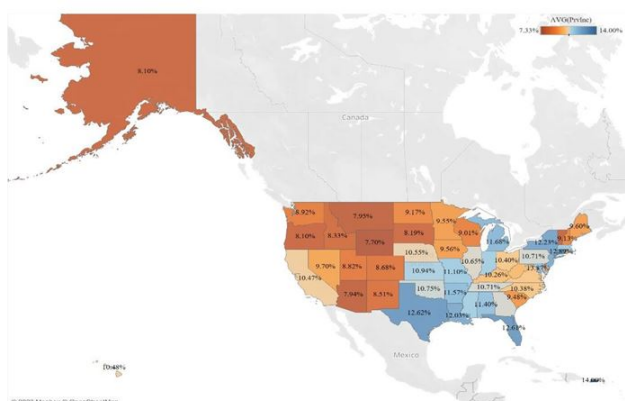


Figure 4: Average prevalence rates by location. **Note:** The Tableau visualization depicts the average prevalence rates of Alzheimer's disease, displaying variations by location.

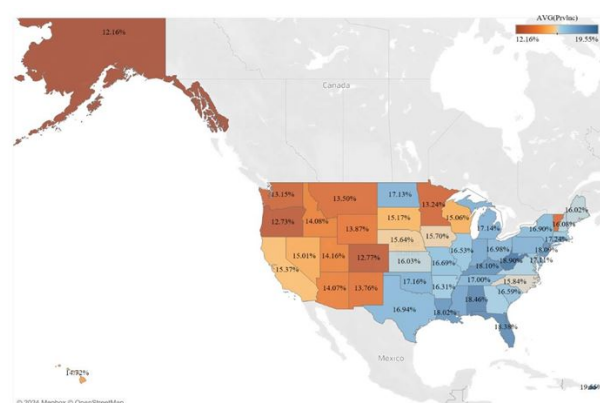


Figure 5: Average prevalence rates by location in 65+ age groups. **Note:** The Tableau visualization depicts the average prevalence rates of Alzheimer's disease in the study population, displaying variations by location.

The hospital readmission rates for Alzheimer's disease present a different picture compared to the above results as shown in **Figure 6**. The Virgin islands exhibit the highest readmission rate at 25.83%, followed by Nevada, DC, Massachusetts, Maryland and West Virginia, all exceeding 24%. On the other hand, Hawaii records the lowest readmission rate at 15.96%, accompanied by Montana, Utah and Wyoming, all below 18%. These findings underscore the multifaceted nature of Alzheimer's disease management, where geographical variations play a significant role in prevalence and healthcare outcomes.

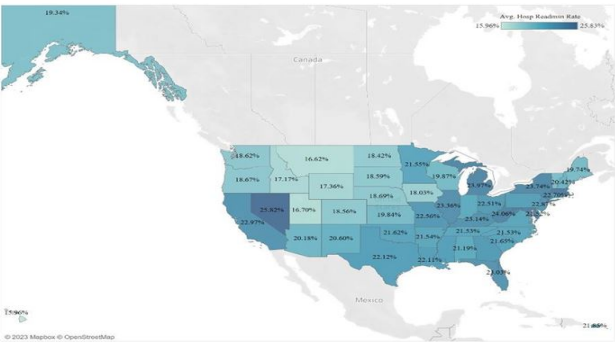


Figure 6: Average hospital readmissions rates by location. **Note:** The Tableau visualization depicts the average hospital readmission rates of Alzheimer's disease by location.

Subgroup analysis

The subgroup analysis of Alzheimer's disease prevalence rates provided comprehensive insights into demographic disparities across age, gender, location and ethnicity. The data visualization (Figure 7) highlights that prevalence rates notably vary by age (2833 observations in both the age groups of 65+ and <65), with individuals aged 65 and above exhibiting significantly higher rates (11.92%) compared to the overall average rates across all age groups (10.18%). Gender disparities, as shown in Figure 8 (54 observations in each group), reveal that females aged 65 and above have a markedly higher prevalence rate (12.81%) than males (9.56%). Further analysis (Figure 9), focusing on the 65+ age group, uncovers variations in prevalence rates by location and gender, with the highest rates observed in men in DC (14%) and women in Puerto Rico (19%), while the Virgin Islands have the lowest rates for both genders.

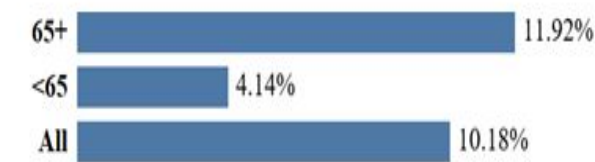


Figure 7: Average prevalence rates by age groups. **Note:** The Tableau visualization illustrates the average prevalence rates of Alzheimer's disease categorized by age groups, revealing notable disparities. The prevalence rates are significantly higher in the 65 and above age group, with an overall average of 10.18% across all age levels.



Figure 8: Average prevalence rates by age and gender. **Note:** The Tableau visualization depicts the average prevalence rates of Alzheimer's disease, categorized by gender and age, highlighting the gender disparities; the rate is significantly higher in females ages 65 and above than in males.

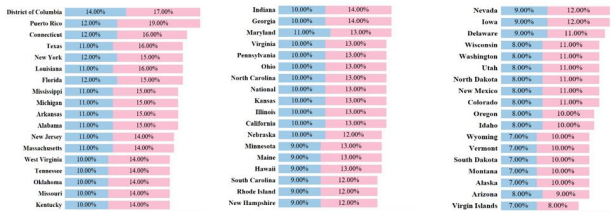


Figure 9: Average prevalence rates of Alzheimer's disease by location and gender in 65+ age groups. **Note:** The Tableau visualization depicts the average prevalence rates of Alzheimer's disease in the study population, highlighting variations by both location and gender. Average prevalence rates range from 6.65% (Wyoming) to 13.72% (DC) in males, whereas in females, average prevalence rates range from 7.96% (Virgin Islands) to 18.51% (Puerto Rico).

Additionally, Figure 10 illustrates variations in prevalence rates among different ethnic groups, with non-hispanic black individuals exhibiting the highest rate (13.93%), followed by native Americans (12.94%), non-hispanic whites (11.12%), hispanics (10.55%) and the lowest rates among Asian Pacific Islanders (8.95%). Figure 11 provides more information on ethnicity and location-specific findings in the 65+ age group, highlighting further disparities. Notably, hispanics have the highest Alzheimer's disease prevalence rate in Florida (22%), native Americans show the highest rate in North Carolina (19%) and non-hispanic blacks have the highest at 19% in Michigan and DC. Non-hispanic whites have the highest at 14%, observed in Louisiana, CT and Alabama and Asian Pacific Islanders exhibit the highest rate at 15% in only one state, NY. Figure 11 indicates that the average prevalence rates among whites are severe when compared to other ethnicities. The demographic and regional variations in Alzheimer's disease prevalence and variations in readmission rates support our hypothesis and literature review findings. The study focused on Alzheimer's disease prevalence for additional insights into the complex interplay of demographic factors in Alzheimer's disease prevalence.

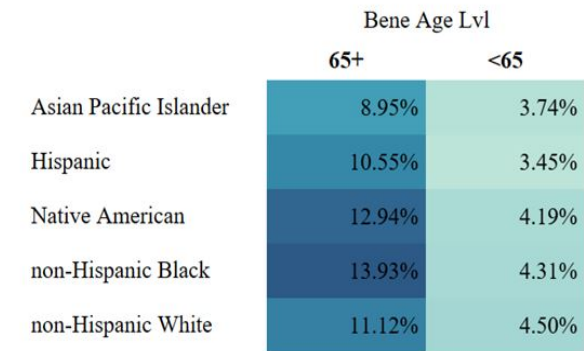


Figure 10: Average prevalence rates by age and ethnicity. **Note:** The Tableau visualization shows the average prevalence rates of Alzheimer's disease categorized by ethnicity. The comparative analysis sheds light on potential disparities, contributing to a better understanding of the epidemiology of Alzheimer's disease within diverse communities.



Figure 11: Average prevalence rates by ethnicity and location in 65+ age groups. **Note:** The Tableau visualization presents an analysis of average prevalence rates of Alzheimer's disease among various ethnic groups, further stratified by location within the 65+ age group.

Inferential analysis

After exploring descriptive statistics, geospatial and subgroup analysis, we transitioned to inferential analysis to delve deeper into the strength and type of relationships between variables and Alzheimer's disease prevalence rates. The correlation analysis revealed significant but modest correlations among the variables of interest related to Alzheimer's disease prevalence rates. One notable finding was a positive correlation ($r=0.1828$) between age and Alzheimer's disease prevalence rates, indicating that certain age groups may be more susceptible to the disease. This implies that as individuals age, there is a corresponding increase in the prevalence of Alzheimer's disease. Additionally, the correlation between demographic description (which includes both gender and race) and Alzheimer's disease prevalence rates was found to be positive but weak ($r=0.0584$). The weak correlation with demographic description suggests that variables such as gender and race may also contribute to the disease's prevalence.

The study employed generalized logistic regression analysis to investigate the impact of age and demographic description on Alzheimer's disease prevalence rates. The analysis revealed significant associations between age, demographic description, and Alzheimer's disease prevalence rates. Age demonstrated a strong positive correlation with prevalence rates ($\beta=0.0083$, $p<0.001$), indicating that as individuals age, the likelihood of Alzheimer's disease prevalence increases. Additionally, demographic description displayed a notable positive association with prevalence rates ($\beta=0.0009$, $p=0.0342$), emphasizing its importance in understanding the disease's prevalence patterns. These findings underscore the critical role of age and demographic factors in elucidating Alzheimer's disease epidemiology, providing valuable insights that support our hypothesis and literature review.

Additionally, ANOVA analysis was employed to assess the variation in Alzheimer's disease prevalence rates across different age groups and demographic descriptions. The results revealed significant differences in prevalence rates across different age groups and demographic descriptions. In terms of age group analysis, the F-value of 963.5 ($p < 0.001$) indicated a substantial influence of age on disease prevalence,

suggesting that as individuals age, the likelihood of Alzheimer's disease increases significantly. Similarly, demographic descriptions also exhibited notable variations in prevalence rates, as indicated by an F-value of 11.98 ($p < 0.001$). ANOVA findings underscore the significant roles played by both age and demographic factors in shaping Alzheimer's disease prevalence within populations.

DISCUSSION

Our research study revealed an average Alzheimer's prevalence rate of 10.22% and a 21.25% average hospital readmission rate in the general population. These rates indicate the severity and complexity of the condition and the challenges in the management of the condition once diagnosed and highlight the significant impact on healthcare utilization compared to other conditions. The consistently higher hospital readmission rates compared to prevalence rates highlight a potential gap in the continuity of care and the need for enhanced care coordination and post-discharge support for individuals with Alzheimer's. Descriptive statistics by location highlight central tendency and variability in Alzheimer's prevalence rates across national, state and county levels. The positively skewed distribution of prevalence rates at the state level suggests potential outliers and non-normality, indicating the need for further investigation into underlying factors contributing to these disparities. Similarly, hospital readmission rates exhibit variability across different states and territories, underscoring the necessity for targeted interventions to address disparities for better healthcare outcomes.

Geospatial analysis visually depicts the variations in prevalence and hospital readmission rates across different geographic regions. These visualizations provide valuable insights into the spatial distribution of the disease, enabling policymakers and healthcare providers to allocate resources and tailor interventions to specific regions. Subgroup analysis reveals demographic disparities, with higher prevalence rates among individuals aged 65 and above, particularly among females. Ethnic disparities are also evident, with non-hispanic black individuals exhibiting the highest prevalence rates. However, when considering location, Alzheimer's disease shows the highest prevalence rate of 22%, in hispanics, indicating the influence of both demographic and geographic factors on disease occurrence.

Inferential analysis indicates a positive correlation between age and Alzheimer's prevalence rates, highlighting the significant role of age in disease occurrence. However, the positive but weak correlation between demographic description and prevalence rates suggests that there are other contributing factors beyond gender and race. Regression analysis further confirms the positive correlation between age and prevalence rates, emphasizing the critical role of age in understanding the epidemiology of Alzheimer's disease. Additionally, ANOVA analysis findings underscore the significant influence of both age and demographic factors on disease prevalence within populations. While correlation analysis provides valuable insights into potential associations

between variables, it is essential to recognize that correlation does not imply causation. Further investigation is needed to determine causality accurately, considering confounding factors. Overall, correlation, regression and ANOVA strategies collectively provide a comprehensive understanding of the relationships between variables and Alzheimer's disease prevalence rates, shedding light on the factors that may contribute to the disease's occurrence within diverse populations. Inferential analysis findings support and complement the results obtained from descriptive, geospatial and subgroup analyses, enhancing our overall understanding of Alzheimer's disease epidemiology. The study findings provided compelling evidence to reject the null hypothesis, indicating significant differences in Alzheimer's disease prevalence rates across various age groups and demographic descriptions.

Real-world implications of the study findings are significant for better healthcare practices and policy development to improve outcomes. Understanding demographic and geographic disparities in Alzheimer's prevalence rates is crucial for targeted interventions, resource allocation and effective prevention and management strategies for Alzheimer's disease.

Strengths

This retrospective study is well-defined and has a clear focus with precise and measurable research questions and hypotheses. The study comprehensively examines both the prevalence and hospital readmission rates, presenting a holistic perspective on the impact of Alzheimer's disease. The research design considers essential demographic factors such as age, gender and location, which contributes to a nuanced understanding of the condition. The research directly addresses a major public health concern and holds the potential to generate valuable insights for healthcare planning, targeted interventions and resource allocation.

Table 3: Healthcare utilization metrics.

Bene cond	Avg. Hosp Readmsn..	Avg. Tot Mder Py..	Avg. ER Visits Pe..
Alcohol abuse	26.05%	26841	2291
Alzheimer's disease/Dementia	22.29%	26896	1545
Arthritis	18.43%	16890	1014
Asthma	22.12%	22389	1675
Atrial fibrillation	23.10%	27124	1500
Autism spectrum disorders	20.89%	8894	1153
Cancer	20.24%	21795	1019
Chronic kidney disease	22.75%	23983	1358
COPD	23.64%	27255	1737
Depression	22.09%	21811	1462

Limitations

This study is limited by the aggregate usage of percentages rather than individual-level records containing comprehensive variables such as age, location, gender, ethnicity, lifestyle and other concomitant comorbid illnesses data. This limitation restricts the depth of our analysis and may obscure important patterns or correlations in the context of AD prevalence and hospital readmissions. Access to individual health records is essential for conducting a more precise analysis and could provide a more nuanced understanding of the factors contributing to hospital readmissions.

Furthermore, this study is limited by the absence of information on the hospital readmission rates in individuals aged 65 and above, demographic details and the concomitant or comorbid illnesses that could potentially account for hospitable readmissions in the data.

Additional information regarding primary care accessibility, which could contribute to the variations in incidence, prevalence or hospital readmissions across different regions is another limitation. It is not clear if the results can be applied to a larger population or globally, further limiting the scope of the study.

Recommendations and future directions

Even with the best care possible, not all diseases or readmissions can be prevented. As a starting point, it is imperative to prioritize the reduction of readmissions as a preliminary goal. Assessing the economic impact of disease and hospital readmissions is necessary for informing strategies to mitigate healthcare costs and enhance care coordination. **Table 3** outlines potential avenues for future research, focusing on healthcare utilization metrics related to beneficiary conditions, socio-economic determinants, disease prevalence and hospital readmission rates.

Diabetes	21.88%	17380	1027
Drug/Substance abuse	27.78%	26301	2482
Heart failure	24.44%	30940	1731
Hepatitis (Chronic Viral B and C)	30.36%	28015	1972
HIV/AIDS	28.58%	21093	1522
Hyperlipidemia	19.03%	14970	886
Hypertension	18.91%	15514	948
Ischemic heart disease	21.57%	21138	1234
Osteoporosis	18.44%	18948	1040
Schizophrenia and other Psyc...	24.95%	23875	2047
Stroke	22.56%	34627	1991

Note: The Tableau visualization provides a comprehensive overview of Healthcare Utilization Metrics for Various Conditions, offering valuable insights into the healthcare landscape and resource allocation.

Understanding these factors is vital for refining intervention and care coordination strategies, particularly in the context of medicare funding. By investigating these areas, policymakers and healthcare professionals can develop more efficient and equitable healthcare systems tailored to the needs of aging populations, mitigate the economic burden and improve overall healthcare outcomes.

The research findings also emphasize the need for a proactive approach focusing on futuristic healthcare strategies, comprehensive care coordination programs, caregiver support and enhanced patient-provider communication strategies to improve health outcomes.

Alzheimer's disease research holds promise in diverse areas. Exploring health information exchange's role in disease management, investigating EHR (Electronic Health Records) adoption's impact on readmission rates and assessing telehealth interventions for patient and caregiver support are key avenues. Early detection possibilities through AI-driven analysis of writing and driving patterns present exciting prospects. Concurrent analysis of various data sources, alongside AI (Artificial Intelligence) and ML (Machine Learning) applications, can provide an integrated approach to understanding and treating Alzheimer's.

CONCLUSION

In conclusion, our study enhances our understanding of Alzheimer's disease epidemiology, uncovering insights into prevalence, hospital readmission rates and demographic variations across diverse populations. Through rigorous statistical methods, we validate our hypotheses and contribute to the existing literature, advancing our knowledge of this complex condition. The study's findings underscore the need for further research, considering significant factors such as socioeconomic status, lifestyle, health status, healthcare

access and care coordination. Comprehensive and tailored interventions are crucial to address the complex challenges posed by Alzheimer's disease. By elucidating the factors influencing disease prevalence and healthcare outcomes, the study informs public health initiatives aimed at improving the well-being of affected individuals and communities. However, additional research and collaboration are essential to refine our understanding and implement evidence-based interventions for effective prevention, treatment and management strategies.

ETHICAL APPROVAL

This study utilized de-identified data from the CMS chronic conditions data warehouse. Ethical approval was obtained from the Institutional Review Board (IRB) of Harrisburg University of Science and Technology. The research adhered to the guidelines provided by the IRB to ensure participant confidentiality and data integrity.

CONFLICT OF INTEREST

No conflict of interest was reported.

FUNDING

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AVAILABILITY OF DATA AND MATERIALS

The datasets generated and/or analyzed during the current study are publicly available from the Centers for Medicare and Medicaid Services (CMS) chronic conditions data warehouse.

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