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Alzheimer's Disease among American Minority Populations: An Ecological Exploratory Study

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ARTICLE INFO	ABSTRACT
	A significant public health concern with regards to increasing rates of Alzheimer's is that it disproportionately affects minority groups in the United States. The present ecological exploratory study uses secondary aggregate data from the fifty United States in the year of 2019. The purpose of this study was to address the disparities in Alzheimer's in minority populations in the US and explore associated factors. The "minority" populations considered were African American and Hispanic populations, and the "majority" population was referred to as "white". The data were extracted from the United States Census Bureau, the CDC National Center for Health Statistics, and the Behavioral Risk Factor Surveillance System (BRFSS) Dataset. The prevalence rates of Alzheimer's disease are greatest in both older Hispanic (12.2%) and African Americans (13.8%), compared to older whites (10.3%) in the investigated time period. Our results showed that being over 65 years old (p=.009), with a below-average ($62,843) median household income (p=.024), history of stroke (p=.029), and being a part of the Hispanic population (p=.036), were significantly associated with Alzheimer's mortality rates in the United States. By identifying disparities in access to Alzheimer's healthcare and at-risk communities, more comprehensive intervention strategies can be developed to promote change and advocate for more Alzheimer's education and resource allocation for minority populations.

1. Introduction

Alzheimer's disease is defined as a brain disorder that progressively gets worse over time [1]. According to the National Institute on Aging, Alzheimer's is "irreversible" and slowly inhibits an individual's ability to carry out basic bodily tasks that are necessary for survival [1]. Generally, individuals will begin to dis-play symptoms of Alzheimer's around the age of 65 [1]. Though quite rare, those who display symptoms between the ages of thirty to early sixties, are classified as "early-onset" [1]. According to Healthy People 2020, "Alzheimer's disease is the most common form of dementia" [2]. In general, "Dementia" inhibits an individual's ability to function independently, maintain good health, and optimal well-being; symptoms typically

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include memory loss and problems understanding language and communicating [2].

Alzheimer's develops from a variety of factors that include genetics, lifestyle choices, environment, with the greatest risk factor being over the age of 65 [3]. Though some factors are impossible to prevent, it is important for individuals to protect the brain from substantial head injury, maintain a healthy heart, healthy diet, exercise, socialization, and avoid alcohol or tobacco in order to age in the healthiest way [3]. Brain health is strongly associated with heart health; so, conditions like heart disease, diabetes, and stroke are associated with higher risk of developing Alzheimer's [3]. Alzheimer's does not only affect the individual receiving the diagnosis but impacts the family members and caregivers that the individual must rely on [4]. To explain, the total cost of care for Americans with Alzheimer's in 2017 has been estimated to be 232 billion dollars and about 18.4 billion hours of care [4]. Such extensive amounts of time and money that come with caring for an individual with Alzheimer's underscore the importance of knowing the associated factors in order to receive the earliest diagnosis so that symptoms do not become more severe.

The prevalence of Alzheimer's is increasing globally but varies by country due to cultural and socioeconomic differences [5]. Generally, prevalence is greater in more developed countries and lower in underdeveloped countries [5]. It is most prevalent in the Americas and is least prevalent in less developed countries, such as Africa and the Middle East [5]. The proportion of individuals from developed countries with Alzheimer's is expected to be 71.2% by 2040; an increase from 60.1% in 2001 [5]. The disparity in prevalence of Alzheimer's in developed countries versus underdeveloped countries can be supported by differences in average life expectancy. Typically, individuals living in developed countries will have a longer lifespan as compared to individuals in underdeveloped countries [6]. Older age is highly associated with developing Alzheimer's [6]. It is predicted that the number of individuals over 65 living in developed countries is expected to hit 1 billion by 2030, which will affect future incidence rates of Alzheimer's [6].

Currently, 5.8 million Americans aged 65 and older are living with Alzheimer's disease (1 in ten Americans) [7]. It is the sixth leading cause of death in the United States overall, and the fifth-leading cause of death in individuals over 65 years old [7]. Individuals with Alzheimer's experience a high level of morbidity caused by years of poor health and disability, which gradually becomes more severe. Mortality generally results from complications related to years of living with poor health [6]. Reported deaths from Alzheimer's has increased 146.2% from 2000 to 2018 in the US [8]. According to the CDC, age-adjusted death rates by state range from 13.9 to 46.5 in New York and Georgia, respectively [9]. Death rates are generally the lowest for states in the North-East, and the highest for states in the South-East United States [9]. Trends indicate that incidence/prevalence of Alzheimer's will continue to increase as people continue to live longer and longer [1].

According to the Alzheimer's Association, "older Hispanics are about one-and-a-half times as likely as older whites to have Alzheimer's and other dementias, while older African-Americans are about twice as likely to have the disease as older whites" [3]. This disparity served as the basis for this present study. Currently, there is a gap in Alzheimer's research amongst minority populations in the United States as compared to the majority population [8]. The "minority" populations for this study refer to African Americans and Hispanic populations, while the "majority" refers to mostly whites. The purpose of this study is to address the disparities in Alzheimer's in minority populations and explore influencing factors.

The overall research goal is to analyze the recent trends of Alzheimer's mortality in the United States in minority populations compared to the majority and address possible explanations. Our hypotheses are first, Hispanic & African American populations had the highest prevalence of Alzheimer's in 2019. Second, Ethnic groups in the US that fall within the minority will show higher rates of Alzheimer's onset. The null hypothesis is the distribution of Alzheimer's mortality in the investigated period is not associated with being a part of a minority population in the United States.

2. Methods

The goal of our study was to test a potential association between Alzheimer's mortality rates with being a part of a minority population in the United States. We designed an analytical ecological exploratory study using secondary aggregate data. Each individual state in the United States represented a single unit of analysis.

The major outcome of our study was mortality due to Alzheimer's disease, which served as our dependent variable. To reiterate, Alzheimer's is defined as a brain disease that progressively worsens over time and eventually makes it impossible for individuals to carry out basic bodily functions [1]. Mortality due to Alzheimer's is increasing in the United States, as death results from

years of living with health complications that progressively worsen [8]. Our research specifically focused on disparities in mortality rates among minority populations versus majority. This is because we wanted to recognize the gaps that currently exist in Alzheimer's research in minority populations. In sum, we explored an association between being a part of a minority population in the United States with Alzheimer's mortality, along with several other explanatory variables.

The dependent variable was Alzheimer's mortality rates [number of people that died due to Alzheimer's disease in the year of 2019 divided by the total population of the same year]. The independent variables in our study consist of each state's general population, and the percentage of each state's population of individuals over 65 years old. The main exposure we are investigating is being a part of a minority race population. So, we included the percentages of people that belong to "White alone", "African-American", and "Hispanic" populations. Other variables included; percentage of the population that has a bachelor's degree or higher, percentages of the population without health insurance, median household income [total income divided by the number of people living the household], adult obesity rates [people with BMI => 30 divided by total population size], prevalence of stroke [number of Americans who have had a stroke divided by total U.S. population], and prevalence of diabetes [number of Americans diagnosed with type II diabetes divided by total U.S. population].

The secondary data used in this study were extracted from the United States Census Bureau, the CDC National Center for Health Statistics, and the Behavioral Risk Factor Surveillance System (BRFSS) Dataset. We chose these sources of data because they are reliable, widely recognized open-access databases that include expansive information on each of the 50 states. We completed statistical testing using SPSS statistical software. The statistical tests we applied were bivariate analysis, followed by multivariate analysis and linear regression.

First, we tested our main outcome and every single variable first to determine if there was any association with our dependent variable, Alzheimer's mortality. All variables that had a level of significance equal to or below 0.2 were included in the regression analysis. Next, we took the associated independent variables and performed a linear regression using the "Enter" method. As a result, we were able to determine which variables remained associated with our dependent variable when influenced by our other independent variables.

3. Results

The main objective of our study was to explore any possible association with Alzheimer's mortality and being a part of a minority race in the United States. So, we considered data belonging to the African American population and the Hispanic population as representing "minorities", while White alone represents the "majority". We also tested for possible association with other independent variables on Alzheimer's mortality as well. The results of our statistical testing are explained in the following paragraphs.

3.1 Descriptive Analysis

Descriptive analysis shows that of the total United States (N = 50), the mean of the population aged over 65 years old is roughly 17%, 8% are uninsured, and 32% have achieved a bachelor's degree or higher. In terms of race distribution in the United States population, 79% are White alone, 11% are African American, 12% are Hispanic. These percentages are rounded up or down by 1% by looking at the closest decimal point. Descriptive analysis also showed high rates of other comorbidities, obesity, stroke, and diabetes. The mean rates of obesity, stroke and diabetes in the United States are 32%, 37%, and 22%, respectively (Table 1).

Table 1. Descriptive statistics according to investigated variables. USA, 2019.

Variables	Minimum	Maximum	Mean	Std. Deviation
Total Population	578,759.00	39512223.00	6550855.4800	7389409.68284
People aged 65+	11.40	21.20	16.9680	1.92359
Race/Ethnicity White alone	25.50	94.40	78.7100	12.31678
Race/Ethnicity African American	.60	37.80	11.1900	9.62656
Race/Ethnicity Hispanic	1.70	49.30	12.2660	10.45349
Median Income	43567.00	81868.00	60172.0000	9920.06437
Obesity Prevalence	23.80	40.80	32.1020	3.86763
History of Stroke	24.40	51.80	36.8080	6.10807
Uninsured	2.80	17.70	8.1940	3.04305
Education Bachelor's Degree or Higher	20.30	79.30	31.6502	8.58020
Diabetes Prevalence	14.60	36.20	21.9500	4.39147

Table 2. Bivariate analysis among Alzheimer's mortality rates and investigated independent variables.

Variables	Significance Level
Total Population	.846
People aged 65+	.053
Race/Ethnicity White alone	.713
Race/Ethnicity African American	.114
Race/Ethnicity Hispanic	.086
Median Income	.001
Obesity Prevalence	.002
History of Stroke	.000
Uninsured	.008
EducationBachelor's Degree or Higher	.181
Diabetes Prevalence	.002

Median income (.001), obesity (.002), history stroke (.000), being uninsured (.008), prevalence of diabetes (.002), being over 65 years old (.053), education level (.181), being African American (.114), and being Hispanic (.086) were inserted in the linear regression Model (Table 3). After controlling by the above-mentioned variables, being over 65 years old (p=0.009), median income (p=0.024), history of stroke (p=0.029), and being Hispanic (p=0.036) were strongly associated with Alzheimer's mortality in the United States.

Table 3. Final model regression analysis.

Variables	B*	Std. Error*	Beta**	t	Sig.
(Constant)	77.032	29.097		2.647	.012
People aged 65+	-1.712	.623	-.384	-2.749	.009
Race/Ethnicity African American	-.117	.137	-.131	-.851	.400
Race/Ethnicity Hispanic	-.252	.116	-.308	-2.174	.036
Median Income	.000	.000	-.480	-2.355	.024
Obesity Prevalence	-.550	.471	-.248	-1.169	.249
History of Stroke	.595	.262	.424	2.269	.029
Uninsured	.020	.446	.007	.045	.964
Education-Bachelor's Degree or Higher	.119	.143	.119	.829	.412
Diabetes Prevalence	.229	.384	.117	.596	.554

Dependent Variable: Alzheimer's Mortality; * Unstandardized Coefficients; ** Standardized Coefficients

4. Discussion

Associations between being a part of a minority group with an increased incidence of certain diseases in the United States have been discussed in existing literature. According to the National Institute of Allergy and Infectious Diseases, it has been widely "recognized that racial and ethnic differences affect susceptibility to infection and disease" [9]. Examples of these disparities include African Americans "represent almost half of new AIDS diagnoses", asthma disproportionately affects African American and Hispanic children in the inner-city, African Americans account for some of the "highest rates of chronic Hepatitis C and Hepatitis C-related deaths", and systemic lupus erythematosus can be up to three times more common among African American and Hispanic women [9].

It is also important to recognize other significant Alzheimer's disease patterns throughout the United States. Existing data from the CDC show that age-adjusted death rates due to Alzheimer's are highest in the southeastern region of the U.S., with the exception of Florida [10]. States with death rates ranging from 44.9 – 46.5 include: Alabama, Tennessee, Washington, Mississippi, and Georgia, respectively [10]. On the other hand, states with the lowest death rates due to Alzheimer's are generally located in the northeastern region of the United States [10]. States with death rates ranging from 13.9 – 19.5 include: New York, Maryland, Connecticut and Massachusetts [10]. Florida and Hawaii also have some of the lowest death rates due to Alzheimer's nationally, but are not a part of the northeastern region [10]. Recognizing differences in the disease patterns of Alzheimer's in the U.S. is important for determining if states with higher death rates also have higher populations of minority groups.

The Centers for Disease Control and Prevention (CDC) have concluded that Hispanic and African American populations will experience the largest increase in Alzheimer's disease and related dementias [7]. In the United States minority populations will be affected the most by Alzheimer's disease by the year 2060, when it is predicted that cases will rise to about 1 million people [7]. Our results showed significant associations among being Hispanic (p=.036), being over 65 years old (p=.009), median income (p=.024), and history of stroke (p=.029) with onset of Alzheimer's in the United States. According to the CDC, within the next 40 years Alzheimer's cases among Hispanic populations will increase seven times over today's estimates, and four times over today's estimates among African Americans [7]. This underscores why the main objective of our study was to investigate the association between being a part of either the Hispanic popula-

tion or African American population in the United States with Alzheimer's disease. The significant association we found with being Hispanic and Alzheimer's disease in the United States corroborates with existing literature from the Alzheimer's Association [7].

The significant association we found between being over 65 years old and the onset of Alzheimer's has also been discussed in existing literature [1]. The National Institute of Aging points out that age-related changes in the brain may harm neurons and affect other types of brain cells to contribute to Alzheimer's damage [8]. It is imperative to recognize that the general population of the United States is not only aging, but also living longer. This aging population impacts not only the morbidity rates of Alzheimer's in the United States, but also contributes to large increases in the costs of Alzheimer's treatment.

We understand that it was important to take into account other social determinants of health that minorities in the United States face that may account for increased risk for developing Alzheimer's. Instead of considering only two specific ethnic populations, we also analyzed social determinants of health that may affect these minority populations. The National Institute on Aging informs that a variety of health, environmental, and lifestyle factors beyond genetics and natural aging can play a role in the onset of Alzheimer's [8]. This served as the basis for what other explanatory factors we chose as independent variables in our study.

Disparities in education, income, and access to health care/insurance that minorities experience can impact Alzheimer's onset [7]. For example, we found that income is a significant predictor of developing Alzheimer's. This association relates to how minority populations tend to have lower median income levels compared to majority populations in the U.S. low socioeconomic status among minority populations exacerbates the social determinants of health that may contribute to Alzheimer's onset. To explain, lower household income is associated with a lack of health insurance coverage, access to health screenings, adequate health education and consistent healthcare. All of which increase the risk for developing Alzheimer's disease. Moreover, the relationship between income level and being a part of a minority in the U.S. can largely account for the increased prevalence of Alzheimer's rates in minority populations.

Additional research suggests that vascular conditions such as stroke, diabetes, and obesity contribute to developing Alzheimer's [8]. Our results show that stroke is associated with the onset of Alzheimer's. According to the National Heart, Lung, and Blood Institute there are a variety of risk factors that increase the probability of having a stroke [9]. These factors include an unhealthy diet, lack of exercise, and an excessive use of alcohol and/or tobacco [9]. We understand that it is not justifiable to generalize the overall health habits of an entire ethnic population. However, we do acknowledge that minority populations are typically but not always, more susceptible to the environmental/lifestyle factors and social determinants of health that can increase risk for stroke. The association we found between stroke and Alzheimer's could account for disparities in rates of Alzheimer's in American minority populations.

It is also imperative to address the current chronic disease epidemic. Incidence of obesity, Type 2 diabetes, non-alcoholic fatty liver disease (NAFLD) and neurodegenerative diseases are increasing globally [11]. Obesity and type 2 diabetes prevalence is predicted to rise to 30% of the global population, and prevalence of NAFLD in Western countries is currently at 30% [11]. Unhealthy diets and sedentary lifestyles are the major contributors to developing the aforementioned chronic diseases [11]. To reiterate, we understand that it is not justifiable to make generalizations, but we do recognize that minority populations may be more highly susceptible to the lifestyle factors that may contribute to such chronic diseases that ultimately impact Alzheimer's development. For example, the Hispanic population in the United States has the highest rates of diabetes in adults and children, compared to any other race group [12]. Prevalence and incidence of type 2 diabetes is higher than the national average, despite Hispanics being the largest minority population in the United States [12]. Because additional research suggests that diabetes and obesity contribute to developing Alzheimer's, we cannot ignore that Hispanics are affected by the diabetes epidemic and are therefore at higher risk for developing Alzheimer's [8].

Nutritional and environmental factors impact the repression of certain anti-aging genes. To explain the anti-aging gene Sirtuin 1 is calorie sensitive, and therefore inactivated by unhealthy diets [13]. Research suggests that Sirtuin 1 (Sirt 1) is linked to the chronic disease epidemic discussed in the paragraph above [13]. There is an association between Sirt 1 being repressed early in the aging process due to chronic and neurogenerative diseases (including Alzheimer's disease) and programmed cell death [14]. According to the *Journal of Diabetes & Metabolic Disorders*, "Unhealthy western diets and lifestyles lead to circadian rhythm disorders with defective nutrient and caffeine metabolism associated with NAFLD, cardiovascular disease and T3D diabetes in the developed world" [15]. Implementing nutritional interventions in the United States would be an effective way to confront the chronic

disease epidemic because overeating is directly associated with increased risk for the chronic diseases that are associated with a defective Sirt 1 gene [15]. Moreover, Sirtuin 1 is an anti-aging gene proven to become defective in the presence of unhealthy diets and is exacerbated by the chronic disease epidemic disproportionally affecting minority populations in the United States [13].

5. Study Limitations & Strengths

The first limitation of this study that should be considered is the ecological fallacy. The present study used secondary data to gather information from all of the 50 United States. We used secondary data from the Census.gov for each state's general population, including the percentage of that entire state population that is either Hispanic or African American. By considering the entire United States population, we recognize that there is a limitation with how many individuals actually contribute personal data to the Census. Thereby possibly skewing the accuracy of our generalized population data due to those who chose not to participate.

A second limitation relates to our method. We decided to focus on Hispanic and African American populations because they are the two largest minority populations in the United States, considering Census data. But we recognize that there are various other minority populations in the United States that we did not consider, and that various other minorities should be considered in future studies and research on the same topic. It should be noted that our analysis did not confirm that African Americans were associated with and faced equal disparities to Hispanic populations, however other studies pointed out the contrary. This can be due to reverse causation and or due to the fact that this data could be under reported.

Other limitations include not being able to follow up on participants of a study to understand if their health conditions have improved and how it impacts their current overall health in regard to having Alzheimer's. Also, this study is the first ecological study using secondary data that both of the researchers had completed. So, we recognize that there may be limitations with regards to our prior knowledge and experience.

Some strengths in this study are that the collection and interpretation of data help to fill in gaps in the literature published in regard to research conducted to analyze minority populations such as Hispanics and African American communities. Filling in this gap in current literature will promote future research on this topic to identify which factors are impacting minority populations the most. Which can possibly result in the identification of key components that lead to increased rates of Alzhei-

mer's mortality. It will shed light on the importance of minority populations and their health in relation to Alzheimer's disease which evidence clearly shows that disparities exist. Furthermore, the probability of having a stroke and disparities regarding education, income, and access to health care/insurance that minorities experience can impact Alzheimer's onset.

6. Conclusions

Our results showed that being a part of the Hispanic population, being over 65 years old, history of stroke, and income are significantly associated with mortality due to Alzheimer's disease. We rejected our null hypothesis, which was that being a part of a minority group in the United States is not associated with increased risk for dying of Alzheimer's.

We hope that our study promotes minority research and recognizing gaps in healthcare by majority and minority. In addition, by pointing out disparities in access to healthcare and identifying at risk communities who suffer the most because of Alzheimer's, a comprehensive intervention strategy can be developed to promote change and advocate for more resources. We can infer that minority populations are much more likely to experience social determinants of health that negatively impact health outcomes, and thereby increase risk of dying from Alzheimer's disease.

Our findings explain how an association exists between Alzheimer's mortality rates with being a part of a minority population in the United States. Furthermore, the study found that mortality due to Alzheimer's is indeed increasing in the United States, and death results from years of living with progressive negative health conditions. We found that specific factors such as access to healthcare could possibly impact Alzheimer's mortality in the United States and minority populations face disparities in comparison to other populations.

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