The Relationship between Sleep and Racial-Ethnic Demographics as Protective Factors against Cognitive Decline

by

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Abstract

Despite nearly four decades of advocacy and month-long awareness campaigns, Alzheimer's disease (AD) continues to slowly deteriorate the minds of millions of Americans (James et al., 2022). Although genetics accounts for two-thirds of the risk of developing AD, behavioral factors may pose a greater risk (Silva et al., 2019). Certain racial-ethnic groups produce AD preventative proteins in much higher concentrations, whereas others are born into healthier environments (Qin et al., 2021). Behavioral practices such as sleep may reduce AD incidence. Sleep is crucial to the central nervous system and has been linked to halting the progression of many neurodegenerative diseases (Borges et al., 2019). When researching whether self-reported sleep quality was predictive of cognitive decline, sleep was found to be a significant independent predictor of cognitive decline ($X^2(2) = 677.012$, $p < 0.001$). Similarly, a significant relationship was found ($X^2(7) = 68.20$, $p < 0.001$) between cognitive decline and one's self-reported race/ethnicity. Additional research can highlight the exact association between each racial-ethnic group and cognitive decline. Further analysis is required to understand the complex role of sleep on cognition and AD incidence.

Key Words: Alzheimer's disease, Cognitive decline, Sleep, Racial-ethnic, United States.

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While my brain tumor has made life undoubtedly much harder, I could not feel more blessed. My parents have always been there for me, my friends are essentially my brothers and sisters, and my professors have always helped me achieve greater heights. Through all their support, my long and painful path has gone smoother. Thank you, mom, thank you, dad, thank you, grandma, thank you, grandpa; I love you all more than you will ever know.

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Introduction

Dementia and Alzheimer's Disease

Degradation and decades should be synonymous with one another. As humans age, telomeres lose vital genetic information, and malformations occur more frequently (James et al., 2022). Spines start to shrink, hair grows white, and memories begin to fade. While minimal cognitive degradation is inevitable, mild-to-severe cognitive impairment is not (James et al., 2022). Loss of autonomy and thought processing indicates neurodegenerative diseases such as dementia and Alzheimer's disease (AD) (Breijyeh & Karaman, 2020). AD is the most significant contributor to dementia as it constitutes nearly three-fourths of all dementia cases (John, 2019). As a progressive disease, age exacerbates the AD's pathology, nearly doubling in prevalence among individuals 65 or older (John, 2019).

Despite diagnosing the first case over a century ago, much is still unknown since Alois Alzheimer's first encounter with this form of dementia (Lane et al., 2018). Scientists have made strides in filling the neurophysiological gaps since its discovery. While multifaceted in origin, at its core, AD is the result of cholinergic and amyloid deformation (Breijyeh & Karaman, 2020). The insoluble amyloid-beta peptide (Aβ) present in the extracellular plaques and high concentration of hyperphosphorylated tau protein (P-tau) in the neurofibrillary tangles (NFT) contribute to AD's unique neurophysiology (Uddin et al., 2020). Collectively, the Aβ plaques and P-tau NFTs result in distinct neuropathology (Breijyeh et al., 2020). Upon examination, tau immunohistochemistry has revealed another prominent characteristic of AD, neuroinflammation, because of tangle and plaque formation (Silva et al., 2019).

Overwhelming neuronal decay of the surrounding cerebral cortex, medial ventricles, and internal hippocampus produces cortically less dense brains (Breijyeh et al., 2020). Consequently, reduced neuronal networks potentially increase the length or inhibit synaptic pathways, thus exacerbating cognitive latency (Breijyeh et al., 2020).

Although many potential treatments exist, only two drugs are globally recognized as approved treatments (Breijyeh & Karaman, 2020). Existing treatments are further limited by their function. Rather than preventing or even curing AD, these drugs aim to remedy present dementia symptoms. Ultimately, the treatments will improve the patient's quality of life through decreased mental fog or increased mood (Breijyeh & Karaman, 2020). Current research aims to inhibit the irregular tau protein metabolism, β-amyloid formation, and cholinergic deterioration to derail AD progression (Breijyeh & Karaman, 2020).

Despite all the technological advancements since its discovery, scientists remain unable to inhibit the disease pathology (Lane et al., 2018). Globally, this is attributed to the complex interplay between risk factors. The most common risk factors include genetics, traumatic brain injuries, vascular diseases, increasing age, and a culmination of environmental factors (Breijyeh & Karaman, 2020). While genetics can account for over two-thirds of the risk of developing Alzheimer's disease or related dementias (ADRD), genetics fails to paint the entire picture (Wu et al., 2016). When focusing on known genotypes, early-onset AD accounts for less than 7% of cases (Silva et al., 2019).

Therefore, research highlights the importance of risk factors in the progression of ADRD. Most notably, cardiovascular disease (CVD) can lead to hemorrhagic and ischemic infarctions and vasculopathy, deplete blood supply to the cortex and ultimately cause the death of white matter (Silva et al., 2019). Exacerbating CVD is hypertension which can increase strain on vascular walls and dysfunction of the blood-brain barrier (Silva et al., 2019). More downstream effects of unhealthy diets and lack of physical activity are obesity and diabetes, which contribute to a poorer quality of life. Among the most beneficial protective factors for AD are common behavioral factors for reducing CVD (Silva et al., 2019). Strives in CVD management have reduced the risk of diabetes, hypertension, and other vascular diseases, as well as ADRD (Wu et al., 2016). CVD-based campaigns may have contributed to the recent decrease in ADRD incidence in men across western countries (Wu et al., 2016).

Alzheimer's Impact on a Global Scale

Globally combined, ADRD is the seventh-leading cause of death in 2020-2021 (World Health Organization [WHO], 2020). Dementia may afflict countries differently, yet the world suffers from this public health crisis. Dementia accounts for nearly 13% of deaths in Wales and England (John, 2019). Worldwide, approximately one new case is reported every four seconds (WHO, 2020). In 2019 alone, a staggering 7.7 million new cases were reported (Brito-Aguilar, 2019). The incidence demonstrated a strong risk factor for the world's fastest-growing elderly populations (WHO, 2020). Where 46% originated from Asia, 31% from Europe, 16% from the Americas, and 0.5% from Africa (Brito-Aguilar, 2019).

Across the globe, prevalence estimates were severely limited due to a large portion of probable cases being excluded. Nevertheless, these highly conservative reports ushered in a new wave of studies. In many underdeveloped countries, the lack of standard practices and medical systems fails to capture the number of afflicted individuals (Calderón-Garcidueñas et al., 2019). Environmental factors such as increased pollution in urban cities across South America may contribute to the mass underreporting, masking the true incidence (Calderón-Garcidueñas et al., 2019). Standard safety practices in developed nations, such as the United States Environmental Protection Agency (USEPA) regulations on particulate matter, are either not being met or enforced (USEPA, 2019). Across Mexico, large metropolis cities are filled with continuous toxic exposures to known AD-associated ozone (O_3) and fine particulate matter ($PM_{2.5}$) (Calderón-Garcidueñas et al., 2019). In Mexico City alone, Calderón-Garcidueñas estimates that 55% of the population may suffer from cognitive impairment. Taiwan's Biobank links abundant air pollutants to mental degradation (Chen, 2021).

Aligning with many studies, the data indicate that countries with older populations suffer from inflated prevalence rates. In a systematic review of nearly fifty dementia analyses, prevalence ranked highest to lowest: in Europe, North America, Asia, Africa, and South America, respectively (Cao et al., 2020). Generally, underdeveloped nations cannot afford screening and testing, thus limiting many studies which argue differently (Vipin et al., 2021). Similar to Calderón-Garcidueñas, Chen, and many other researchers, the lack of medical infrastructure perpetuates

inadequate testing, thus, identifying the actual toll ADRD takes on the globe (Vipin et al., 2021).

Across the world, Japan ranked among the lowest prevalence of dementia, while the Americas, specifically Latin American countries, ranked among the highest (Rizzi et al., 2014). Since 2001 dementia has ranked highest, with over 60% in underdeveloped countries (Rizzi et al., 2014). The increased disproportion in women is attributed to women's increased life expectancy (Rizzi et al., 2014). Other general trends highlighted were gender disproportionality, as women are nearly twice as likely to develop ADRD, and AD is the most common form of dementia (Cao et al., 2020). Cross examinations among non-industrialized and industrialized communities worldwide have demonstrated the disproportion in prevalence among women, age categories, and those with CVD (Lopez & Kuller, 2019). External global factors contributed to the uptick in dementia prevalence and incidence (Mok et al., 2020). The Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2) pandemic was correlated with increased ADRD prevalence as dementia patients were unable to socially distance, raising "impaired consciousness" among those who tested positive (Mok et al., 2020). While the 2019 coronavirus pandemic impacted the entire world, America was the hardest hit.

Alzheimer's Impact within the US

Despite nearly four decades of advocacy and month-long awareness campaigns, AD continues to slowly deteriorate the minds of millions of Americans (James et al., 2022). Among individuals aged 65 and older, AD remains the fifth-leading cause of death in the United States (James et al., 2022). Across America, a

post-mortem analysis from 2000 through 2017 revealed the severity of ADRD. Of the 261,914 dementia-related deaths, 46% were from AD alone (Kramarow & Tejada-Vera, 2019). Consistent with other studies, age-adjusted prevalence remains higher in women than men (Kramarow & Tejada-Vera, 2019). Moreover, these rates were elevated in non-Hispanic White compared to African Americans and Hispanics (Kramarow & Tejada-Vera, 2019).

The United States differs from many countries in the mortality rates associated with ADRD. Metropolitan cities in underdeveloped nations perpetuate hazardous working and living conditions, which insinuates higher prevalence rates than reported (James et al., 2022). American's USEPA regulations limit toxic exposures to many pollutants; however, living in large cities still brings higher exposure to poorer air quality leading to respiratory conditions such as asthma (USEPA, 2019). Instead of mimicking other industrialized communities, the US has higher age-adjusted mortality rates in non-metropolitan communities (James et al., 2022). Rural Southern states are most afflicted, and the mortality rate more than doubled from the study's inception (James et al., 2022). These studies allude to other factors influencing ADRD besides age and air pollutants.

Sleep's Effect on Cognition

The most studied protective factors against Alzheimer's disease include diet, physical activity, and cognitive reserve (Silva et al., 2019). Lesser-known factors such as sleep may prove beneficial in reducing the risk of developing Alzheimer's disease (Borges et al., 2019). Integral to the central nervous system (CNS) physiology, sleep quality can influence the progression of neurodegenerative diseases

such as Parkinson's disease, multiple sclerosis, cerebrovascular disease, and Alzheimer's disease (Borges et al., 2019). With age, the circadian rhythm loses strength and stability (Irwin & Vitiello, 2019). Impairing the sleep-wake cycle yields diminished sleep quality, taking a toll on the psyche and physiology (Irwin & Vitiello, 2019).

Sleep disturbances interrupt memory consolidation mechanisms, increasing the risk of developing cognitive impairment and dementia (Klinzing et al., 2019). Disruption in deep sleep interferes with hippocampal replay and subsequent neuronal networks (Klinzing et al., 2019). Aside from memory and cognition, poor sleep also depletes visuospatial and language abilities, thus exacerbating or even causing behavioral disorders (Uddin et al., 2020). Chronic sleep disorders introduce more opportunities to expedite the brain's natural degradation. Studies analyzing obstructive sleep apnea (OSA) identified an association between OSA, cognitive impairment, and AD (Bubu et al., 2020). Individuals with OSA tend to develop dementia sooner, leading to the early onset of AD (Bubu et al., 2020). As seen with developed nations compared to undeveloped countries, these rates may be inflated due to increased neurological examinations (Bubu et al., 2020).

Additionally, chronic sleep loss is associated with cognitive impairment, memory loss, and psychomotor delay, which may falsely mimic dementia symptomology (Porter et al., 2015). If not properly treated, sleep disorders may exacerbate cognitive complications and underlying dementia symptoms by up to 200% (Porter et al., 2015). When analyzing sleep latency, patients who take longer than 30 minutes to fall asleep every night increase their risk of developing ADRD by

45% (Porter et al., 2015). According to the National Health and Aging Trends Study (NHATS), sleep disorders considerably affect dementia incidence. Whether it may be sleeping too little or too much, unhealthy sleeping behaviors drastically impacts cognition.

Based on the NHATS, the CDC defines sleeping patterns into three broad categories: inadequate, adequate, and excessive. The CDC recommends Americans sleep between 7 to 9 hours per night. When individuals sleep less than 7 hours per night, it is considered insufficient or inadequate (CDC, 2021). Conversely, sleeping more than 10 hours every night is classified as excessive (CDC, 2021). Deviating from the appropriate amount can impede all facets of life, including AD progression (Robbins et al., 2021). Americans who consistently fail to sleep longer than 5 hours dramatically reduce their alertness and mental fortitude while heightening their risk for dementia incidence (Robbins et al., 2021). Insufficient sleep wreaks havoc on the neuronal network, weakening synaptic connections and escalating cognitive fog (Robbins et al., 2021). On the other hand, Americans who sleep for extended durations are far more susceptible to developing a mental health condition or AD (Porter et al., 2015). Excessive sleeping can lead to depression, thus exacerbating AD symptoms such as mood swings (Porter et al., 2015). Ultimately, Americans of different racial-ethnic backgrounds suffer from these chronic sleep disorders at widely varying proportions.

Race's Effect on Cognition

Previous research trends have highlighted the socio-behavioral, genetic, and gender disparities seen in AD. Current research focuses on racial-ethnic

demographics, cognitive reserve, cellular risk, and age-disproportion contributing to ADRD incidence and prevalence rates (Babulal et al., 2019). Researchers have discovered lower tau protein concentrations in African Americans, potentially indicating a protective factor (Babulal et al., 2019). Other studies have identified an association among races, apolipoprotein E (APOE) genotypes, and AD (Qin et al., 2021). The increased levels of APOE found in African Americans further indicate ethnic-racial influence on AD. Despite African Americans' genetic advantages reducing the risk of developing AD, their prevalence ranks among the highest (Qin et al., 2021). Among the myriad of physical and social determinants of health, emerging research highlights environmental factors as a prime contributor to observed trends (Calderón-Garcidueñas et al., 2019; Chen, 2021).

Introspective studies across the United States feature racial-ethnic disparities. Multiple researchers have found that the AD prevalence of African Americans and Caribbean Hispanics is significantly higher than Mexican Hispanics, Japanese, and non-Hispanic White populations (Mehta & Yeo, 2017). Researchers contributed pre-existing health inequities and other social dynamics as the primary culprit behind the observed differences (Mehta & Yeo, 2017). Probable explanations include occupation, diet, physical activity, or other commonly studied precursors. However, this trend of racial disparities in AD prevalence perpetuates. Researchers continue corroborating this pattern even in more rigorously designed studies where age, gender, ethnicity, and race are adjusted.

More often than not, the Hispanic ethnicity and African American race will demonstrate elevated ADRD rates (Mehta & Yeo, 2017; Matthews et al., 2019). A

meta-analysis of dementia prevalence across the United States further supported the trend. African Americans and Hispanics' dementia prevalence ranked highest, followed by American Indian and Alaskan Natives, non-Hispanic Whites, and Asian and Pacific Islanders (Matthews et al., 2019). Despite evidence of these racial disparities, no neuroanatomical differences have been found among racial-ethnic groups (Babulal et al., 2019). The question remains of why studies support an opposite trend of genetic factors when they are thought to exist.

Unfortunately, these studies are limited by their inability to capture cultural practices and identities accurately. Contradictory data reinforces the environment's role on cognition and the likelihood of developing dementia and AD. Deoxyribonucleic acid (DNA) may offer some resilience to developing dementia; however, lifestyles truly influence one's susceptibility to AD. It appears external factors do play a more prominent role than genetics.

Overview of Literature

In summary, the aforementioned studies have successfully outlined the pathology and progression of dementia to Alzheimer's disease while offering prominent explanations for any observed differences across global borders, age, gender, or social standing. Regardless of these findings, much remains unknown—namely, the interplay between cognition, sleep, and racial-ethnic identities. While a century of scientific exploration has yielded a firm understanding of plaque and tangle formation, the factors influencing said mechanisms remain hidden. Countless researchers confirm AD disproportions across sleep categories and racial-ethnic groups, thus implying cognition's vital role in developing Alzheimer's disease.

Purpose of Study

This study aims to determine if there is an association between chronic cognitive degradation, sleep, and race-ethnicity. More precisely, severe cognitive decline will be used as a precursor for a positive Alzheimer's disease diagnosis. Furthermore, the role of sleep will be examined as a protective factor against developing Alzheimer's disease. The conclusions drawn from this study will apply to the Alzheimer's Association, Alzheimer's awareness month, health educators, and further research investigations. Ideally, dispersing obtained knowledge on potential proactive behaviors may help reduce the risk of developing Alzheimer's disease.

Research Questions

1. Does the quality of sleep predict cognitive decline?
2. Is there a relationship between racial-ethnic demographics and cognitive decline?

Hypotheses

The first research question hypothesizes the quality of a person's sleep can predict the development of chronic cognitive degradation. Sleep quality will be determined based on the CDC recommendations for heathy sleeping durations. Similarly, the second question hypothesizes a positive relationship between cognitive decline and certain racial-ethnic groups.

Method

Design

The current study employs a cross-sectional design, utilizing secondary data from the 2020 Behavioral Risk Factor Surveillance System (BRFSS) to determine the association between sleep, racial-ethnic demographics, and cognitive decline. The BRFSS is a national data set that originates from the Centers for Disease Control and Prevention (CDC) (CDC, 2021). The BRFSS aims to capture the following six themes associated with behavioral risk factors: (1) incidence of chronic diseases, (2) prevalence of chronic diseases, (3) the impact of preventative health measures, (4) access to health care, (5) treatment of injuries, and (6) the health risks associated with behaviors (CDC, 2021).

Procedures

The data generated for BRFSS is standardized to ensure repeatability and reliability (CDC, 2021). Data collection occurs via landline or cellular phone interviews (CDC, 2021). The interviews uphold generalizability by utilizing Computer-Assisted Telephone Interview (CATI) systems and trained administrators (CDC, 2021). Furthermore, all participants' phone numbers are randomly selected through random-digit-dialing (CDC, 2021).

The BRFSS comprises three sections, including core concerns, optional areas, and state-specific questions (CDC, 2021). Intuitively, the core element is integral to BRFSS, thus present in all states, whereas the state questions are endemic to specific states (CDC, 2021). The optional component varies depending on the annual area of

interest or the participant's previous responses (CDC, 2021). Additionally, all participants are assured their data will remain private, protected, and confidential.

Participants

Although the dataset from the 2020 BRFSS includes 401,958 participants, less than 2% were eligible for analysis. Only participants 45 years or older were offered the optional module. A sample of 5,729 American adults aged 45 years or older were included in the current study. The participant pool contains males, females, and all racial-ethnic groups.

According to G*power software, the Chi-Square Test of Independence yielded a larger sample size than the logistic regression. Therefore, the estimated minimum sample size of 165 is required to power the statistical analysis effectively. Calculations were conducted under the following parameters: a power of analysis of 0.8, a medium effect size of 0.3, and an alpha level of 0.05 (Faul et al., 2007). Thus, the acquired sample size of nearly 6,000 exceeds the calculated minimum required sample size.

Independent Variables

The independent variables include quality of sleep and racial-ethnic groups. Both independent variables were part of the core section of the BRFSS questionnaire. Sleep quality was assessed using the variable SLEPTIM1, which asks, "on average, how many hours of sleep do you get in a 24-hour period?" Responses were recorded as whole numbers, ranging from 1 to 24, with anything less than 30 minutes rounded down and anything above 30 minutes rounded up. If needed, participants could also respond as "Don't know/ Not sure" (coded as 77), or they could refuse to answer

(coded as 99). The responses for the SLEPTIM1 variable were recoded to remove any missing data and recoded into three categories, “1 (Inadequate sleep)”, “2 (Adequate sleep)”, or “3 (Excessive sleep)” based on the current CDC and National Sleep Foundation’s sleep recommendations (CDC, 2017; Hirshkowitz et al., 2015). Adequate sleep is defined as an average of 7 to 9 hours per night, whereas inadequate is 1 through 6 hours per night, and excessive is 10 to 24 hours per night (CDC, 2017).

The second independent variable of racial-ethnic demographics is measured through the _RACEPRV variable. _RACEPRV is a calculated variable computed to analyze racial group prevalence (CDC, 2021). Derived from two other calculated variables, _RACE and _IMPRACE, _RACEPRV incorporates multiple racial and ethnic variables from the demographic section. Collectively, _RACEPRV accounts for eight ethnic-racial categories: “1 (White only, Non- Hispanic)”, “2 (Black only, Non-Hispanic)”, “3 (American Indian or Alaskan Native only, Non-Hispanic)”, “4 (Asian only, Non-Hispanic)”, “5 (Native Hawaiian or other Pacific Islander only, Non-Hispanic)”, “6 (Other race only, Non-Hispanic)”, “7 (Multiracial, Non-Hispanic)”, “8 (Hispanic)”. This calculated variable excluded any missing and incomplete responses.

Although broad, these categories are comprised of various racial subsets. Simple subsets requiring no further explanation are White, Black, Multiracial, and Native American or Alaskan Native. Complex racial groups with actional subdivisions include Asians, Islanders, and Hispanics. First, Asians account for Chinese, Filipino, Japanese, Korean, Vietnamese, Asian Indian, or Other Asian ancestries. Next, the Islander classification encompasses Pacific Islander, Native

Hawaiian, Guamanian, Chamorro, Samoan, or Other Pacific Islanders. Then, Hispanics incorporate any of the following eight possibilities: Mexican, Mexican America, Chicano/a, Puerto Rican, Cuban, Another Hispanic, Latino/a, or Spanish origin. Lastly, respondents failing to fall within the scope of the previously outlined options are classified as "other race."

Dependent Variable

The dependent variable for this study was cognitive decline. The variable CIMEMLOS was used and was included in the optional module. Respondents were automatically skipped if they had not previously answered that they were 45 years of age or older. Moreover, the optional module begins with a prelude: "The next few questions ask about difficulties in thinking or remembering that can make a big difference in everyday activities. This does not refer to occasionally forgetting your keys or the name of someone you recently met, which is normal. This refers to confusion or memory loss that is happening more often or getting worse, such as forgetting how to do things you've always done or forgetting things that you would normally know. We want to know how these difficulties impact you." The prologue highlights the severity of the memory loss and confusion the section is truly seeking. The introduction is necessary to deter respondents from falsely mistaking the occasional degradation in cognition that occurs naturally with age (James et al., 2022). Cognitive decline was assessed using the question, "during the past 12 months, have you experienced confusion or memory loss that is happening more often or is getting worse?" The 2020 BRFSS dataset recorded the status of cognitive degradation in four levels "1 (Yes)", "2 (No)", "7 (Don't know/ Not sure)", and "9 (Refused)".

The responses for the variable have been recoded to include only the following two possibilities, “1 (Yes)” or “2 (No)”. All missing or impartial data was recoded as system missing and not included in the analyses. Additionally, to run the logistic regression, this variable was then recoded into dummy data where “1 (Cognitive Decline)” and “0 (No Cognitive Decline)”. The dummy data served as a precautionary measure to ensure proper directional computations of a logistic regression (University of California, Los Angeles [UCLA], 2016).

Data Analysis

The first research question will be analyzed using a logistic regression to predict a binary outcome from a continuous variable. The second research question will employ a Chi-Square Test of Independence to determine if there is a relationship between race and ethnicity and cognitive decline.

Results

Participants Demographics

As demonstrated in table 1, a total of 280,769 participants from the selected sample from the 2020 BRFSS were predominantly White (80.4%). The next largest racial-ethnic minorities were Black or African American (7.2%) and Hispanics (6.2%). The remaining five racial categories account for less than 2% each (see Table 1). Furthermore, most participants, 55.9%, identified as female. As the optional module has an age prerequisite, the average age of respondents fell between 60 and 64 years (15.1%). Moreover, a majority (66.8%) of the sample demonstrated an appropriate sleep quality with an average of 7.15 hours per night. Overall, many respondents illustrated poor sleeping practices, with 29.0% sleeping less than the CDC recommended amount and 4.2% sleeping excessively (CDC, 2017).

Major Findings

The first research question aimed to identify whether self-reported sleep quality was predictive of cognitive decline. A logistic regression was used to investigate this relationship (see Table 2). The model was determined to be a good fit and was found to be statistically significant ($X^2(2) = 677.012$, $p < 0.001$). Overall, sleep quality was found to be a significant independent predictor of cognitive decline ($p < 0.001$). Compared to sleeping adequately (seven to nine hours per night), participants who sleep inadequately (less than 7 hours) were 47% (OR: 0.534, $p < 0.001$) less likely to report cognitive decline. On the other hand, participants who sleep excessively (more than nine hours per night) were 65% more likely to report having cognitive decline compared to those who reported adequate sleep (OR: 1.656,

$p < 0.001$). Thus, results indicate that sleep quality can predict the likelihood of cognitive decline.

The second research question aimed to determine if racial-ethnic identities are associated with cognitive decline. A Chi-Square Test of Independence was calculated to determine if there was a relationship between cognitive decline and one's self-reported race/ethnicity (see Table 3). A significant relationship was found, $X^2(7) = 68.20$, $p < 0.001$. Respondents' race/ethnicity is significantly associated with cognitive decline. However, as shown in table 3, participants' cognitive decline and racial-ethnic demographics vary widely.

Discussion

Summary of Major Findings

Ultimately, the results from this study denote the value of sleep and the contribution of one's ancestry as predictors of cognitive decline. In the first research question, a logistic regression found inadequate sleep to be a significant predictor of cognitive decline ($p < 0.001$). Correspondingly, adequate sleep was found to act as a protective factor against developing cognitive decline. Respondents who slept less than seven hours were 47% less likely to report cognitive decline compared to individuals who slept the recommended amount. Contradicting results generated by Robbins et al. (2021), American adults with inadequate sleeping behaviors are twice as likely to develop ADRD. In addition to a heightened risk for ADRD incidence, sleep deprivation dramatically reduces cognitive alertness and processing (Robbins et al., 2021).

Furthermore, the study also established consistent results regarding excessive sleep. Respondents sleeping ten or more hours per night were 65% more likely to report having cognitive decline. These results corroborate with recent NHATS data, which affirm the dangers of unhealthy sleeping behaviors (CDC, 2021). U.S. adults with chronic sleeping disorders are at greater risk for ADRD incidence, and their sleep patterns can exacerbate ADRD symptoms by as much as 200% (Porter et al., 2015).

Alternatively, the second hypothesis addressed the difference in cognitive degradation among eight racial-ethnic groups. A Chi-Square Test of Independence was used to discover an association between cognitive decline and one's

race/ethnicity ($p < 0.001$). Non-Hispanic Whites were among the highest (79.9%) to report suffering from severely worsening confusion or memory loss in the past year. In contrast, Native Hawaiian or other Pacific Islanders ranked lowest in severe cognitive degradation responses with a mere 0.4%. Meanwhile, current literature indicates the complete opposite.

Multiple researchers believe employment opportunities, educational status, and other environmental factors contribute to Non-Hispanic Whites being the least likely racial group to develop ADRD (Mehta and Yeo, 2017; Matthews et al., 2019). According to Mehta and Yeo (2017), AD prevalence is significantly higher among African Americans and Caribbean Hispanics compared to other Hispanic ethnic groups, Asians, and Whites. Similarly, Matthews et al. (2019) have estimated that Hispanic and Black ADRD prevalence rates are far higher than Whites. It is feasible that the higher density of Non-Hispanic White participants in the sample influences the contradictory results.

Public Health Implications

As humans continue to live longer, a corresponding rise in chronic conditions has followed suit. In 2019, the global life expectancy was 73.4 years; meanwhile, in the United States, the mean life expectancy was 78.8 years (WHO, 2020; CDC, 2021). Americans' healthy life expectancy (HALE) remains 5.5 years behind their mean life expectancy (WHO, 2020). Although modern medicine has decreased mortality rates, HALE remains inferior to mean life expectancy due to poorer quality of life (WHO, 2020). According to WHO, an overwhelming proportion of individuals are now living with chronic disorders or disabilities. With new cases reported every

four seconds, Alzheimer's disease ranks among the top ten chronic conditions contributing to death (WHO, 2020). Therefore, the results from this study provide insight into preventative behaviors and potential cultural confounders.

As mentioned above, ADRD contributes to inferior life quality, thus diminishing HALE. Modifying individuals' sleeping behaviors could directly impact their neurological degradation and their likelihood of developing ADRD. Sleep was found to act as a protective factor against detrimental cognitive impairment and AD incidence. More specifically, this study found that sleeping less than 7 hours per night decreases the risk of AD development by 47%. In contrast, participants sleeping more than 9 hours a night increases the chance of developing AD by 65%. Promoting Americans to sleep the recommended amount is not plausible when 35.2% of American adults suffer from inadequate sleep, and nearly 40% undergo insomnia (CDC, 2014; Dopheide, 2020). Therefore, more frequent insomnia screenings and value-based assessments may improve sleeping behaviors, overall quality of life, and HALE.

This study tackles the elusive nature versus nurture conundrum when analyzing racial-ethnic groups. Researchers have long debated the importance of genetics versus lifestyle practices, and this study has consistently found supporting evidence for the role of behaviors. ADRD prevalence, incidence, and morbidity data contradict known genetic protective factors (Babulal et al., 2019; Qin et al., 2021). Therefore, cultural practices and daily behaviors are much more impactful than one's genetic composition. The public health sector should strive to reiterate the importance of healthy lifestyle choices and behaviors as they are more likely to influence their

susceptibility to ADRD. Regardless of racial, ethnic, or cultural identity, promoting healthier lifestyle practices such as diet, exercise, and sleep may decrease the United States' alarming ADRD rates.

Study Limitations

When conducting this study, six major limitations arose. Restrictive respondents' eligibility was the first limitation of this study. While the 2020 BRFSS dataset incorporates effective randomization techniques to ensure population generalizability, the dataset was highly restrictive. A mere fraction of respondents (1.42%) was eligible for analysis due to the age criteria. The dataset accurately depicts the predominantly White United States population; however, the outreach and interview methods could be a limiting factor. Automated CATI calls and live phone operators could sway many from skipping this optional module or survey altogether.

The second limitation is the inherent discrepancy that arises with using self-reported data. This data type is subjective to response bias as question length, phrasing, and response options may persuade participants to respond dishonestly. For example, the phrase "optional module" may have encouraged participants to overlook the segment. Alternatively, the wording of the first question (MCD.01), "during the past 12 months, have you experienced confusion or memory loss that is happening more often or is getting worse?" may have encouraged participants to get through the survey as fast as possible. Moreover, the lengthy prelude, "The next few questions ask about difficulties in thinking or remembering that can make a big difference in everyday activities. This does not refer to occasionally forgetting your keys or the name of someone you recently met, which is normal. This refers to confusion or

memory loss that is happening more often or getting worse, such as forgetting how to do things you've always done or forgetting things that you would normally know. We want to know how these difficulties impact you" may have discouraged participants from answering truthfully. It could be inferred that most participants would underreport their cognitive degradation for fear of dramatizing their neurological health. Conversely, strong-willed participants may have responded in denial for fear of losing their impendence. Overall, response bias takes many forms and is an unpredictable yet inevitable result of using self-reported data.

The third limitation was using cognitive decline as a precursor for ADRD. Since this study relied on this assumption, all results are limited to reported cognitive decline and not a positive Alzheimer's Disease diagnosis. Although it may be a sound assumption, the inferences drawn from the results are mere speculation.

The fourth limitation was the statistical tests implemented. The Chi-Square Test of Independence introduced an element of ambiguity. Due to the number of levels used, an odds ratio could not be calculated; thus, the observed relationships lacked directionality. Without these values, risk factors could not be generated nor implied in the results. Moreover, the multiple racial categories meant determining which levels were more or less significant was not possible. Subsequently, this ambiguity made it impossible to distinguish which groups had a higher or lower odds ratio.

Another limitation found was the unknown impact of culture on respondents' behavior. As previously mentioned, racial-ethnic influences and cultural practices heavily limited other studies in this field. Researchers continue to identify the

inherent bias based on one's racial, cultural, and religious identity (Matthews et al., 2019). For example, Hispanic respondents are less likely to acknowledge their cognitive decline because of machismo culture (Rojas et al., 2021). In preclinical settings, African American patients screened for Alzheimer's have been found to underreport their cognitive degradation (Amariglio et al., 2020). Therefore, the differences observed could be due to some other confounding variables.

The sixth limitation arose from the lack of studies in this field. While some areas have been thoroughly researched, the shift into environmental, genetics, and racial-ethnic variations has not. As science has grown, the path of the studies has evolved, shifting away from the known and venturing onto the unknown. The most recent studies are beginning to focus on the impact of O_3, $PM_{2.5}$, and other pollutants. In closing, the study was well developed yet suffered from six concerns surrounding the dataset, tools used for statistical analysis, cultural influence, and the absence of comparative subject matter.

Recommendations for Future Study

Despite distinct discerning characteristics of cognitive decline, much remains unknown about the external influences of neuronal degradation. Researchers can assist in this pursuit of knowledge via expanding their neurological studies' emphasis. One area demanding further investigation is environmental pollutants' role in ADRD development. Globally, the neurological impacts of toxic air particulates have predominately been in poorer nations. Previous studies have linked premature cognitive impairment to specific air pollutants within metropolis cities (Calderón-Garcidueñas et al., 2019; Chen. 2021). Extending research from Asia and Latin

America to developed nations will eventually allow for a comprehensive meta-analysis.

Another recommendation for future studies is to assess the relationship between genetics and ADRD incidence. Generally, AD research has shifted from managing symptoms to tracing the neurophysiological culprits. As a result, ongoing neurogenetic research has been inconclusive. Some neuroscientists have discovered protective genetic variations among individuals of African ancestry (Babulal et al., 2019; Qin et al., 2021). However, neither the decreased tau protein production nor the elevated APOE concentrations effectively shield them against AD progression. African Americans consistently rank among the highest ADRD incidence and prevalence, alongside Hispanics (Mehta & Yeo, 2017). Therefore, fostering further support in this sector will pinpoint other genetic divergences between racial-ethnic groups.

Lastly, the COVID-19 pandemic introduced a completely new avenue for ADRD research to pursue. Contrary to other viruses, COVID-19 has not affected all Americans equally. Instead, many researchers and the CDC claim that older adults (60 years or older) and ethnic minorities are disproportionally impacted (Farrell et al., 2020). Since one of COVID-19's major long-lasting symptoms is cognitive impairment, the elevated morbidity and mortality rates are potentially surging ADRD incidence and prevalence. As the novel coronavirus gradually transitions into an established disease, the influx of knowledge will shed light on these disproportionalities. Additionally, studies on the long-haul symptoms of COVID-19

will provide a new understanding of how sudden cognitive deterioration advances into dementia.

Conclusion

In conclusion, cognitive decline, dementia, and Alzheimer's disease are all highly prevalent and lethal yet severely understudied areas. This disconnect arises from an antiquated mindset among biomedical and public health researchers. Until recently, studies have focused on combating symptoms that only marginally enhance the quality of life. Moving forward, emerging studies on the influence of racial-ethnic identity and air pollutant exposure should be considered more than studies on genetic variations. This study found Non-Hispanic Whites most afflicted by cognitive degradation in the U.S. Parallel with the literature; this study found cognitive impairment disparities across the various sleep categories. Therefore, more efforts should be implemented in educating communities on the benefits of achieving the recommended amount of sleep, the common barriers, and effective strategies to reach that sleep goal. The United States can simultaneously increase its HALE while decreasing severe cognitive decline and ADRD incidence through improved awareness, increased knowledge of external factors, and healthy sleeping behaviors.

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Appendix A: Tables

Table 1

Demographic Characteristics of 2020 BRFSS Respondents

Variable	*n*	%
Sex (n=280,770)		
Male	123,844	44.1%
Female	156.926	55.9%
Race/Ethnicity (n=280,769)		
White	225,745	80.4%
Black	20,313	7.2%
Hispanic	17,307	6.2%
Asian	4,813	1.7%
Multiracial	4,522	1.6%
American Indian or Alaskan Native	4,463	1.6%
Other		
Native Hawaiian or other Pacific	2,570	0.9%
Islander	1,036	0.4%
Age (n=272,514)		
45 to 49	26,428	9.7%
50 to 54	31,110	11.4%
55 to 59	36,219	13.3%
60 to 64	41,151	15.1%
65 to 69	41,570	15.3%
70 to 74	37,972	13.9%
75 to 79	26,607	9.8%
80 or older	31,456	11.5%
Quality of Sleep (n=269,062)		
Inadequate	78,047	29.0%
Recommended	179,729	66.8%
Excessive	11,286	4.2%
Average	7.16*	
Cognitive Decline (n=66,096)		
Yes	5,667	8.6%
No	60,429	92.4%

*Mean value reported

Table 2

Logistic Regression Predicting the Likelihood of Developing Cognitive Decline based on Sleep Category

	Cognitive Decline				
	Yes	No	OR	CI	Sig.
Sleep Category					
Adequate*	2,216 (11.6%)	16,941 (88.4%)			
Inadequate	2,926 (6.5%)	41,897 (93.5%)	0.534	0.504, 0.566	0.000
Excessive	461 (17.8%)	2,128 (82.2%)	1.656	10484, 1.849	0.000

Note: n=401,958; OR= Odds Ratio; CI= Confidence Interval; Sig.= Significance Level (p). * Reference group.

Table 3

Association between Cognitive Decline and Racial-Ethnic Demographics

	Cognitive Decline	
	Yes	No
Race/Ethnicity		
White	4,575 (79.9%)	48,294 (78.5%)
Black	268 (4.7%)	2,811 (4.6%)
American Indian/Alaskan Native	141 (2.5%)	1,040 (1.4%)
Asian	107 (1.9%)	1,914 (3.1%)
Native Hawaiian/Pacific Islander	23 (0.4%)	362 (0.6%)
Other	67 (1.2%)	547 (0.9%)
Multiracial	155 (2.7%)	1,487 (2.4%)
Hispanic	393 (6.9%)	5,082 (8.3%)

Note: n=67266; %=Valid Percent. Due to table dimensions, an odds ratio or risk estimate could not be generated.