Comparing Social Determinants of Health and Health Outcomes Among Southwest Native Americans with Other Races While Controlling for Rurality

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ABSTRACT

COMPARING SOCIAL DETERMINANTS OF HEALTH AND HEALTH OUTCOMES AMONG SOUTHWEST NATIVE AMERICANS WITH OTHER RACES WHILE CONTROLLING FOR RURALITY

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Native American populations are known to have worse mean health outcomes compared to other racial groups that are shaped by their comparatively worse social determinants of health (SDOH). Similar disparities are known to exist when comparing rural populations to their urban counterparts. Given that Native Americans are a disproportionately rural population, an important question arises: Are poor Native American health and SDOH outcomes primarily attributable to rurality, or are there additional factors at play? This study investigates whether Native American populations in the Southwest exhibit worse mean outcomes in health and SDOH metrics compared to White and Hispanic populations while controlling for rurality. GIS software was used to classify census tracts in the Southwest (California, Arizona, New Mexico, Colorado, Utah, and Nevada) based on rurality and largest racial group by population. Rurality was divided into four levels: urban (RU0), fringe rural (RU1), distant rural (RU2), and remote rural (RU3), based on proximity to urban areas.

Findings indicate that Native Americans tend to perform worse than White populations across all rurality levels (RU0, RU1, RU2, RU2) and exhibit worse or similar outcomes compared to Hispanics at most rurality levels (RU1, RU2, RU3). The disparities are most pronounced in health metrics and the economic, educational, healthcare, and social/community context domains of SDOH. These disparities suggest

that factors beyond rurality may contribute to Native American health and SDOH outcomes in addition to their rurality, including historical traumas, systemic underfunding of healthcare services, and structural socioeconomic inequities. However, the study also finds that Native Americans, on average, fare better in the housing domain of SDOH compared to other groups, highlighting an area of relative resilience. The results for Native Americans suggest that targeted policy interventions and resource allocation strategies that go beyond addressing rural disparities alone are needed to create equitable outcomes. Without adequately considering the unique historical, economic, and structural challenges faced by Native communities, broad rural-focused policies may fail to address the root causes of health and SDOH inequities. Future research may consider exploring different health and SDOH metrics, racial group comparisons, conceptions of rurality, and regional focuses.

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List of Acronyms

ACA	Affordable Care Act
ACS	American Community Survey
ANOVA	Analysis of Variance
CDC	Centers for Disease Control and Prevention
GIS	Geographic Information System
IHS	Indian Health Service
NCES	National Center for Education Statistics
PLACES	Population Level Analysis and Community Estimates
RU	Rural-Urban
RU0	Urban
RU1	Fringe Rural
RU2	Distant Rural
RU3	Remote Rural
SDOH	Social Determinants of Health
WHO	World Health Organization

Chapter 1: Introduction

1.1: Measures of Health

Health as a concept is multifaceted and encompasses one's physical, mental, and social well-being. In 1946, the World Health Organization (WHO) defined health as "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity" (WHO, 1946). This was later amended for specificity in 1986, when the WHO added the following: "To reach a state of complete physical, mental and social well-being, an individual or group must be able to identify and to realize aspirations, to satisfy needs, and to change or cope with the environment. Health is, therefore, seen as a resource for everyday life, not the objective of living. Health is a positive concept emphasizing social and personal resources, as well as physical capacities" (WHO, 1986). Therefore, to present a complete picture of health within the context of this definition, one must consider not only health outcomes, but the determinants of health.

Public agencies, policymakers, and researchers alike rely on various data collection methods and statistical models to understand and estimate health trends, identify disparities, and guide interventions. One common method used to measure health is through the administration of national or regional surveys. These surveys collect information about health behaviors, chronic conditions, and healthcare access directly from individuals. Examples of national and regional surveys include the Behavioral Risk Factor Surveillance System (BRFSS), National Health Interview Survey (NHIS), and the Medical Expenditure Panel Survey (MEPS). The BRFSS collects health data through annual telephone surveys, the NHIS collects data on disease prevalence,

disabilities, and healthcare access, and the MEPS tracks factors such as the cost of healthcare, insurance coverage, and medical utilization (AHRQ, 2023; CDC, 2023; AHRQ, 2023). Though issues exist when using self-reported surveys, such as recall bias, subjectivity bias, social desirability bias, sampling bias, and a lack of verification in some cases, it remains a valuable tool when combined with more objective measures of health to provide a more comprehensive understanding of health trends. This may come in the form of clinical data from hospitals, electronic health records, and insurance claim records that provide more direct measurements of disease prevalence, chronic ailments, and healthcare usage. Direct measurement data can be harder to obtain due to access restrictions, privacy concerns, and a lack of uniform reporting across healthcare systems (McCartney, 2019). Nonetheless, a combination of survey data and direct measures of health combine to create a strong sense of population health and trends.

Some resources aggregate a variety of health and community factors to estimate health. Different aggregations of health data and the geographic granularity of the data provided can serve different purposes. One example is the U.S. County Health Rankings evaluates the health of nearly every county in the country through assessments of lifespan, mortality, and quality of life expectancy as estimated by self-reported health status. Metrics such as tobacco use, diet, physical activity, access to healthcare, education, employment, income, air quality, and water quality are considered for the purpose of ranking counties in a state by these health metrics (CHRR Methods). Other community reports include the Climate and Economic Justice Screening Tool (CEJST) that seeks to identify environmentally disadvantaged

communities to target for federal funding, the Human Development Index (HDI) that assesses the level of development for an area using life expectancy, education, and standards of living, and the Community Resilience Estimates (CRE) that assesses natural resources, economic factors, and health metrics to assess a community's ability to withstand and recover from natural, economic, and health disasters (Dean & Esling, 2024; U.S. Census Bureau, 2025; United Nations). Surveys and community health reports aim to provide an estimate of community health in some form or another. Each estimate uses one or a combination of survey and direct measurement data to provide their estimates.

This study focuses on CDC: PLACES estimate of community health. The PLACES project (Population Level Analysis and Community Estimates) is a public health initiative designed to estimate chronic disease prevalence, risk factors, and healthcare access at a local level. The locality of the dataset in both rural and urban areas and the focus on health outcomes and factors that contribute to health outcomes make it a perfect starting point for comparing similarly rural communities. PLACES data is intended to help health officials, policymakers, community planners, nonprofits, and researchers at the state and local level better understand the health of their communities. PLACES combines multiple datasets to generate community health estimates, including data from the BRFSS and the American Community Survey (ACS), which is an annual survey that estimates the social and economic characteristics of the U.S. population as administered by the Census Bureau. Using the sample of data available from its chosen resources, a multilevel regression with poststratification is applied to estimate population health trends of local geographies. PLACES dataset

includes health outcomes, health risk and prevention metrics, self-reported health status measures, and measures of disability in order to capture major risks that lead to illness, suffering, and early death due to chronic diseases and conditions. The datasets are available in several geographic units, with data available for census tracts being the most granular unit and the unit desired for this study (CDC, 2024). The wide availability and standardization of health metrics from this source is invaluable for comparing communities big and small across large regions.

Each estimation of community health achieved through surveys, reports, and indices attempt to provide their own understanding of population health trends and disparities using varying methodologies. Self-reported data offers insight into individual health perceptions and behaviors. Combining self-reported data with objective health measures strengthens the reliability and utility of these health estimates. Datasets provided through tools such as PLACES integrate multiple data sources to provide a more comprehensive picture of local and community health, making them effective for public health planning and research. The PLACES dataset also includes several metrics that are not directly health metrics, but factors that contribute to health outcomes. These contributors to health outcomes may also be known as the social determinants of health (SDOH).

1.2: The Social Determinants of Health

According to the CDC, the social determinants of health (SDOH) encompass five domains: healthcare access and quality, education access and quality, social and community context, economic stability, and neighborhood and built environment (Healthy People 2030). These determinants of health are interconnected, and changes

in one area, positive or negative, can lead to changes in other areas. Understanding the various factors that comprise the five domains of SDOH is essential in building an understanding of what is contributing to community health outcomes.

Figure 1: The 5 Domains of the Social Determinants of Health

The WHO Global Commission on the Social Determinants of Health identified that inequities in the conditions in which people are born, live, work, and age, which are fueled by inequities in power, money, and resources, further determines inequities in health. Thus, SDOH inequities are a major contributor to global health inequities, including disparities in disease burden, chronic illnesses, and life expectancy (CSDH, 2008). Individuals experiencing disadvantages in one or several SDOH domains are more likely to suffer from chronic disease, have limited access to healthcare services, and have decreased lifespans and quality of life. A focus on improving SDOH conditions and resource inequities across the world is needed to ensure everyone's health is supported globally as well as at local levels (Donkin et al., 2018). Using SDOH metrics to compare communities can provide insight on what factors are contributing to the health outcomes seen within communities.

Education influences health by shaping behaviors, employment opportunities, and health literacy. Higher educational attainment is associated with increased health knowledge, healthier lifestyle choices, and better access to healthcare. Education can also improve one's knowledge of ways to maintain, promote, and restore health and wellness individually and in their community (Cutler & Lleras-Muney, 2006; Kolahdooz et al., 2015). Studies show that individuals with lower education levels are more at risk of communicable diseases and have higher rates of smoking, poor diet, and limited physical activity, all of which contribute to chronic illnesses (Kolahdooz et al., 2015). Access to healthcare services is essential for disease prevention and management. However, many populations across the Americas face significant barriers, including financial constraints, lack of healthcare facilities, and systemic discrimination (CSDH,

2008). Geographic isolation further limits access to essential healthcare services, leading to poor health outcomes, especially in Native American communities (Gracey & King, 2009). Access to healthcare directly influences early detection, preventative care, and rates of chronic diseases. Appropriate housing conditions can be identified through adequate daily living facilities, and equipment, sufficient number of private living spaces, and housing affordability. Inappropriate housing conditions and homelessness are associated with high-risk behaviors such as higher rates of smoking, drinking, substance abuse, as well as increased mortality rates (Kolahdooz et al., 2015). In terms of the physical and social environment, poor housing conditions, exposure to poor air and water quality, and lack of access to food or healthy food options contribute to adverse health outcomes (Krieger, 2012). Economically, research also shows that individuals living in lower income neighborhoods have higher rates of respiratory diseases, obesity, and mental health disorders due to environmental stressors and limited access to healthcare facilities (Diez Roux & Mair, 2010). Poverty limits access to basic needs, including food, safe housing, and healthcare, which is further compounded by unemployment. Chronic disease and ailments are also more common for low-income individuals, which contributes to a higher mortality rate. Low-income status is also directly related to findings for how unemployment is closely linked to health inequities. High rates of unemployment are also linked to higher risk lifestyle choices, unhealthy diets, physical inactivity, and domestic violence (Kolahdooz et al., 2015). Strong social connections and cohesive communities have been shown to enhance physical and mental health, health behaviors, and reduce stress (Salinsky, 2023). On the other hand, experiences of discrimination, social isolation, and community violence undermine

individual and community physical and mental health outcomes in a social and community context (Raza et. al., 2020).

The domains of SDOH all play important roles in shaping health outcomes for individuals and their communities. Disparities in SDOH factors lead to disparities in direct health measurements as well as self-reported health metrics. Continued efforts to reduce social and economic inequalities will be essential in improving health outcomes and ensuring equitable healthcare access for all. The CDC's Healthy People 2030 initiative in the U.S. aims to improve health equity by addressing economic and social conditions that contribute to health disparities, which, in part, has led to the development of the *PLACES: Local Data for Better Health dataset*. With a focus on both urban and small rural communities, this dataset is well suited for comparing small and large communities in terms of SDOH and health outcomes.

1.3: Native American, Hispanic, and White People in the American Southwest

The American Southwest (California, Arizona, New Mexico, Colorado, Utah, and Nevada) is a region of rich cultural and demographic diversity, shaped by centuries of migration, settlement, and conflict. Though people of every demographic inhabit the Southwest today, focus will be placed on the role Native Americans, Hispanics, and White people in the region. Before European contact, the region was home to a vast array of indigenous nations, each with distinct languages, traditions, and ways of life. The arrival of Spanish explorers and colonists in the 16th century provoked a profound demographic transformation in the region, introducing European influences that would reshape the social fabric of the Southwest. Over the centuries, shifting political boundaries, economic opportunities, and federal policies played pivotal roles in shaping

the region's demographics, particularly among Native American, Hispanic, and White populations. While these groups have experienced different historical trajectories, which have been marked by resilience, displacement, assimilation, and expansion, they all continue to contribute to the Southwest's unique identity.

Prior to European contact, the demographics of the American Southwest were a diverse population of indigenous groups. This diverse group of indigenous people includes varying tribes inhabiting what is now modern-day America and Mexico. Pre colonization, these groups had developed complex societies with distinct agricultural practices, trade networks, and spiritual traditions. Spanish colonization in the 16th century, followed by Mexican and U.S. territorial expansion, dramatically altered indigenous demographics through displacement, forced assimilation, and disease

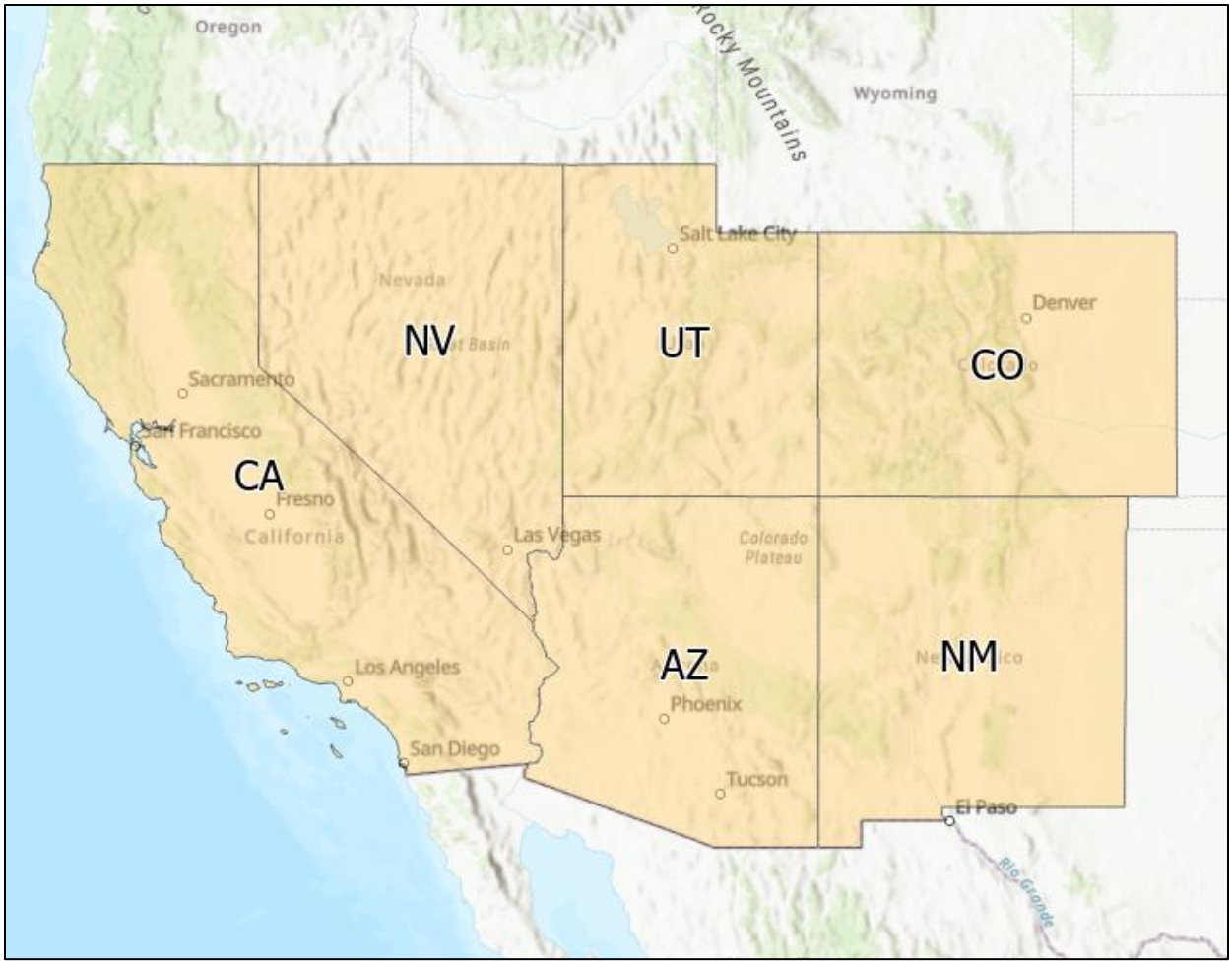

Figure 2: The American Southwest

epidemics. The 19th and 20th centuries saw further demographic shifts due to land dispossession, federal policies such as the Indian Removal Act and boarding school system, and economic marginalization (Thornton, 1987). Fortunes began to change in 1970 as Self-Determination policy became the official legislative and executive objective federally in relation to U.S. Native Americans (Berger, 2008). Despite the challenges they have faced throughout their history, indigenous populations have demonstrated resilience throughout this period of history and are one of the fastest growing demographic groups in the United States with many communities experiencing population growth in recent decades due to improved healthcare access, cultural

revitalization, and continual efforts made toward tribal sovereignty (Fixico, 2013; Sánchez-Rivera, 2023). Despite recent gains made for the Native people of what is now the United States, disparities in economic opportunity, healthcare, and education continue to shape the demographic landscape of indigenous groups in the region today.

Hispanic people have inhabited the American Southwest dating back to the beginning of Spanish colonization in the 16th century. Due to colonization, indigenous and European cultures blended together as the Spanish established missions, presidios (military forts), and towns in the region. The Hispanic population grew during the following centuries, including the Hispanic population that was of partial or majority indigenous Mexican and Mexican American descent. Following Mexican independence from Spain in 1821, the Southwest remained under Mexican control until the Treaty of Guadalupe Hidalgo (1848), which ceded much of the Southwest to the United States. This transition led to large demographic and political changes, as many Mexicans became U.S. citizens. The shift led to many instances of discrimination, land dispossession, and legal challenges (Weber, 1982). The late 19th and early 20th centuries saw increased migration from Mexico into the American Southwest due to economic opportunities in agriculture, mining, and railroad construction, as well as political instability during the Mexican Revolution (1910–1920) (Escamilla-Guerrero et al., 2023). Throughout the 20th century, Hispanic populations in the Southwest grew rapidly due to both immigration and high birth rates. Today, immigration policies, economic shifts, and social movements have shaped contemporary Hispanic demographics, with ongoing debates surrounding issues such as citizenship, labor rights, and healthcare access (Velasco-Mondragon, 2016). Despite historic and

structural barriers, the Hispanic population continues to be a major demographic in the Southwest, with many cities and locations reflecting the strong Latin American, Spanish, and Mexican influence on the region.

The presence of White populations in the American Southwest can be traced back to the early period of European colonization in North America, with the Spanish being the first Europeans to establish a foothold in the region in the 1500s. Spanish colonial rule was more firmly established by the late 16th and early 17th centuries through a network of missions, presidios , and settlements, most notably in present-day New Mexico, Arizona, and California (Weber, 2000). During this period, Spanish colonization led to a demographic transformation through forced labor systems, such as the encomienda, which subjugated indigenous peoples while also introducing mestizaje (racial mixing) between Europeans, indigenous people, and later African slaves (Reséndez, 2016). The presence of White settlers in the Southwest also significantly increased following the signing of the Treaty of Guadalupe Hidalgo in 1848 as Mexican control of the region was largely transferred to the U.S., leading to a wave of Anglo-American migration into the region (Weber, 1982). The discovery of gold in California in 1848 as well as silver in Nevada and Colorado further drove migration into the region. The migration of White settler populations into the Southwest fueled conflicts with indigenous populations, leading to harmful U.S. policies such as the Indian Removal Act and reservation system that forced many Native Americans off of their ancestral lands (Jenkins & Gray, 2023). By the early 20th century, White populations had become dominant in the economic and political structures of the Southwest. Large irrigation projects, such as the creation of the Hoover Dam and the Central Arizona Project,

transformed the region, spurring further influxes of White migrants from the Midwest (Parker, 2010). Though the American Southwest remains one of the most diverse regions in the U.S., White populations remain well represented and continue to hold significant political and economic influence in the region.

1.4: Disparate Native American Health outcomes

Native American Communities in the United States experience disparities in both health outcomes and conditions of social determinants of health (SDOH) in comparison to other demographic groups in the United States. These disparities are likely rooted in their traumatic history concerning the colonization of the Americas. Centuries of historic traumas, forced displacement, cultural and linguistic erasure and assimilation, systemic marginalization, and ongoing socioeconomic challenges have shaped the disparities seen in metrics of health and SDOH. Native Americans today experience disproportionately high rates of chronic diseases, mortality, mental health disorders, physical and mental distress, and substance abuse (CDC, 2024; Indian Health Services, 2019). Health issues in Native American populations are shaped and compounded by poor SDOH conditions as their communities often struggle with resource access, healthcare access and quality, education access and quality, and economic opportunities. Understanding health and SDOH disparities in the Native American population is essential in order to address the inequities observed in health outcomes and the determinants of health.

In the household environment, a disproportionate number of Native Americans, particularly on reservation lands, lack adequate housing, and access to complete plumbing facilities, leading to an increased risk of chronic and acute diseases (Gasteyer

et al., 2016). Inside and outside the home, Native Americans are more likely to encounter contaminated water sources and outdated infrastructure. Outdated infrastructure and/or ingesting contaminated sources contributes to higher rates of gastrointestinal diseases, disorders, and other infectious viruses and diseases (Lewis et al., 2017).

Access to healthcare remains a persistent barrier for many Native Americans due to geographic, financial, and systemic limitations. Though helpful, the Indian Health Service (IHS) is underfunded, often only providing limited access to specialized care and medications (U.S. Commission on Civil Rights, 2018). Many Native Americans remain uninsured or underinsured, making it difficult to receive timely and adequate care. Numerous Native American communities are located in remote areas with limited access to the few healthcare facilities, requiring long travel distances for medical services (Artiga et al., 2020; Davy et al., 2016). As an additional environmental factor, numerous Native American communities rely on land-based practices for food, economic stability, and spiritual health. Additionally, many Native American traditions have significant ties to their ancestral lands, which in many cases have been taken away during colonization or are now threatened by climate change, extreme weather, or resource depletion (Whyte, 2017).

Native Americans have some of the highest rates of chronic diseases such as type 2 diabetes, obesity, asthma, coronary heart disease, and depression. Cancer, heart disease, respiratory disease, and other chronic illnesses remain a leading cause of death in Native American populations. Mental health disparities are severe within the Native American population, with high rates of psychological distress, suicide, and

substance use disorders compared to other demographic groups in the U.S.. Suicide rates among Native American youth and young adults are significantly higher than national averages, with suicide being the second leading cause of death for those aged 10-34 (CDC, 2021). This may in part be due to the intergenerational trauma experienced by Native Americans. Intergenerational traumas contribute to elevated rates of depression, mental distress, and PTSD (Gone et al., 2019; Yellow Horse Brave Heart, 2016). High rates of obesity and limited access to healthcare in Native American populations further exacerbate chronic disease prevalence and mortality (Zavala et al., 2021; Lewis et al., 2017; Eberly et al., 2023; CDC, 2020). Both diabetes and obesity rates have been linked to historic shifts in diet, food insecurity, and limited access to preventative healthcare (Obesity and AI/AN populations, 2021; CDC, 2020). Mortality and prevalence of Chronic disease, physical health, and mental health are even further worsened by lifestyle choices such as chronic smoking, drinking, and substance abuse, which are known issues in Native American communities (Legha & Novins, 2012).

Social and economic SDOH factors heavily influence health outcomes in Native American populations. Native Americans have some of the highest poverty rates of any demographic group, limiting access to nutritious food, quality healthcare, and stable housing (Creamer et al., 2022). Native students experience lower high school graduation rates and reduced access to higher education, contributing to economic disadvantages (NCES, 2024). Native Americans face higher unemployment rates and job market discrimination, limiting economic mobility (Sarche & Spicer, 2008).

The health and SDOH disparities faced by Native Americans are deeply rooted in historical injustices and systemic inequities as a result of generations of colonization

and discrimination socially and politically. Ranging from chronic diseases and mental health challenges to limited healthcare access and environmental injustices, Native populations continue to experience worse health outcomes in comparison to other demographic groups in the U.S.. Though improvements have been made in disparate outcomes through the self-determination policy position taken by the federal government in the 1970s, disparate outcomes and conditions still shape the Native American experience.

1.5: Disparate Rural Health outcomes

Rural communities in the United States perform worse in terms of health and SDOH metrics in comparison to their urban counterparts. Their disparate health outcomes are largely driven by a general lack of access to resources. A difficulty in accessing resources in terms of healthcare access but also in terms of adequate food, economic opportunities, and educational opportunities. This is due to the geography of rural communities, where key resources are less densely located due to lower population density. The geographic dispersion of resources in rural areas means that transportation becomes even more important in order to access essential resources, and that also means that those facing transportation barriers lack access to essential resources, shaping worse health outcomes and quality of life. Additionally, as the world becomes increasingly digital, a lack of broadband internet access prevents rural communities from utilizing telehealth services, virtual education, and employment opportunities that are readily available in urban settings (Vogels, 2021).

Limited access to healthcare and the quality of healthcare in rural areas remain large barriers for community health in rural settings. Many rural areas experience

shortages of healthcare professionals, including primary care providers, specialists, and mental health practitioners. The geographic dispersion of healthcare facilities oftentimes makes long distance travel necessary to obtain even basic medical care. Long travel times and distances often result in delay of treatment and exacerbated health conditions (Turrini et al., 2021). The absence of healthcare providers and healthcare facilities leads to higher rates of unmanaged physical and mental distress as well as unmanaged chronic diseases such as obesity, diabetes, heart disease, and cancer, contributing to negative health outcomes and increased mortality rates in the rural population. The absence and dispersion of healthcare facilities and providers also affects preventative care and routine checkup rates (CDC 2024).

Transportation barriers further exacerbate disparities in rural communities. Unlike urban areas with extensive public transit systems, rural residents rely heavily on personal vehicles to access healthcare, employment, and essential services. However, many low-income individuals in rural areas may not own a vehicle, and those who do often face long commutes to reach medical facilities or job opportunities. Poor quality road infrastructure and seasonal weather conditions can make travel dangerous or unreliable. This contributes to missed medical appointments, job instability, and reduced access to other forms of social services (Turrini et al., 2021; Mseke et al., 2024). Transportation barriers significantly impact economic stability and the ability of rural populations to receive routine and timely medical care.

Economic challenges also play a major role in rural health disparities. Rural areas tend to have higher poverty rates and lower median incomes than urban areas, which limits access to nutritious food, stable housing, and quality healthcare (Butler et

al., 2020; Kushel et al., 2006). Areas with lower incomes and higher poverty rates also struggle with obtaining health insurance financially or due to a lack of employer-sponsored health insurance plans. Rural residents are also less likely to seek or afford necessary medical treatments without adequate health insurance, increasing negative health outcome risk. Many rural areas may be considered a food desert, where there is limited access to fresh and affordable groceries, leading to higher rates of obesity and diet-related illnesses and ailments (Byker Shanks et al., 2022).

A growing challenge for rural communities as the world becomes increasingly dependent on digital services is a lack of access to broadband internet. Due to a lack of internet access, rural households may be prevented from accessing telehealth services, digital education sources, economic opportunities, and other digital resources that could improve their overall quality of life. The digital divide between rural and urban residents was highlighted recently during the COVID-19 pandemic, where hybrid or virtual health services were heavily relied upon. Rural communities, particularly in Native lands, experience limited access to broadband internet (FCC, 2024; Cain et al., 2022). Limited access to broadband internet restricts access to economic, educational, and health opportunities, directly impacting or shaping the negative health outcomes seen in rural communities nationwide.

The disparities in health and SDOH outcomes in rural communities are largely driven by a systemic lack of access to essential resources. Geographic isolation, economic hardship, limited healthcare services, inadequate education, transportation challenges, and digital barriers all contribute to poorer health outcomes for rural populations. Addressing these issues in rural communities likely requires target policy

intervention to improve direct measures of health as well as the SDOH factors that shape health outcomes. A prioritization of these efforts in rural communities can begin to create more equitable access to resources and more equitable healthcare systems and outcomes.

1.6: Research Question

It is known that rural communities experience worse health and SDOH outcomes compared to urban communities. Native American communities, which are disproportionately located in rural and remote areas, experience some of the most severe health disparities in the United States when compared to other racial groups. The disproportionately rural Native American population likely influences the mean observed health outcomes in Native American population data. This study seeks to compare Native American health outcomes while controlling for rurality to estimate if mean Native American health and SDOH outcomes are comparatively worse than other similarly rural populations of differing racial makeups. Using GIS and descriptive statistics, this study seeks to answer the following***: do Native American populations exhibit worse mean outcomes in health and SDOH metrics compared to other racial groups in the Southwest while controlling for rurality?*** If, while controlling for rurality, it is observed that Native Americans still perform comparatively worse, that may point to other factors that are contributing to negative Native American health and SDOH outcomes.

Chapter 2: Literature Review

2.1: Race as a construct and Differing Constructs of Race

It is important to recognize the difficulty that racially based studies present. Race is not a fixed, scientific characteristic, but a social construct that varies between societal and historical context. Though genetic diversity among humans certainly exists, it is known that racial categories do not correspond to significant biological differences (Smedley & Smedley, 2005). Instead, race can be considered the product of historic power structures, colonialism, and social stratification, influencing individual experiences and perceptions as well as national policies (Omi & Winant, 2014). Governments around the world categorize race in distinct ways, reflecting national histories, cultural narratives, and political priorities. These classifications impact social policies, identity recognition, and the measurement of racial disparities.

Different constructions of race are reflected in the varying racial categories of a respective country's census or demographic data collection. The ways in which different countries categorize race in their censuses illustrate the fluid and constructed nature of racial identity. The United Kingdom uses an ethnicity-based classification system rather than a strict racial categorization. The census includes broad ethnic groups such as "White", "Mixed or Multiple ethnic groups", "Asian/Asian British", "Black/African/Caribbean/Black British", and "Other ethnic group" (Office for National Statistics, 2021). These categories emphasize cultural heritage and national origin over racial identity, reflecting the UK's approach to multiculturalism. Brazil's census uses a racial classification system based on color (cor or raça), with categories such as "Branco" (White), "Pardo" (Mixed-race), "Preto" (Black), "Amarelo" (Yellow, for

individuals of East Asian descent), and "indigeno" (indigenous). The construction of race in Brazil is much more fluid with classification of the same person depending on status and context much more than other systems (Kay & White, 2015). In the United States, race is recognized as a social category rather than a biological one. The U.S. Census Bureau collects data on race separately from ethnicity with “Hispanic or Latino” being an ethnic rather than racial category. The Census Bureau’s racial categories include "White," "Black or African American," "American Indian or Alaska Native," "Asian," and "Native Hawaiian or Other Pacific Islander," with an option to select multiple races (Jensen, 2021). The classification system has evolved over time, reflecting shifting social attitudes and political movements.

Who does and does not get counted and the categories one is able to identify as is a constructed and political process. For example, It is well known that the population count determines the number of people who represent a state in Congress and in the Electoral College. Undercounting certain populations due to their location, identity, or any other reason can affect large-scale political representation and perceptions about the demographics of a region, state, or the country as a whole (Farley, 2020). In terms of the racial categorization, the recognition of multiracial identity in the 2000 Census is an example of a significant change, allowing individuals to identify with more than one race for the first time (United States Census Bureau, 2024). Although race is a socially constructed concept, it remains useful for studying social disparities and inequity. Racial categorization helps researchers and policymakers monitor trends in health disparities, economic inequality, discrimination, and more. For this reason, this study will make use of the U.S. Census Bureau’s racial categories as of the 2020 census. While race is not

a fixed or inherent characteristic, its societal impact is real, making it essential for research aimed at promoting equity and justice. The categorization of race in the United States will ultimately be important in this study for identifying disparities between communities compared to each other when controlling for rurality.

2.2: Comparing Health Outcomes by Racial Category

The categorization of health and the social determinants of health (SDOH) metrics by racial group has been used to understand and identify disparities and systemic inequalities. Studies have utilized racial classifications to identify and analyze disparities in chronic diseases, healthcare access, economic opportunities, education access and quality, and social determinant metrics (Macias-Konstantopoulos et al., 2023; Carroll et al., 2009; Dressler et al., 2005). Studies utilizing racial classifications have been able to provide valuable insight into how structural inequities and historic injustices continue to shape the health outcomes of differing racial and ethnic groups.

Racial categories have also been used in research related to the determinants of health. Due to the higher rates of chronic disease and poor health outcomes for minority groups in the United States, research on chronic disease and health disparities by race have been a persistent concern of public health research. Black, Hispanic, and Native American populations face higher rates of communicable diseases, viruses, diabetes, hypertension, obesity, respiratory illnesses, heart disease, and mental health ailments (Macias-Konstantopoulos et al., 2023; Ejike, 2021; Dressler, 2005). Disparities in health research are often attributed to contributing factors such as the social determinants of health. Contributing SDOH factors include limited access to healthcare, differences in socioeconomic status, and environmental exposures that increase the risk of disease.

Furthermore, structural inequities, such as residential segregation, employment discrimination, and differential access to quality nutrition and healthcare, further contribute to observed health disparities (Clark et al., 2022). The increasing understanding of the influence that determinants of health have on health outcomes has increased research focus on the subject. Increased research focus includes the role of social determinants of health in explaining health outcomes and health disparities between different communities.

When comparing outcomes by race in health research, one consistent finding is that racial minorities experience significant barriers to healthcare access. Studies have shown that Black and Hispanic populations are more likely to be uninsured or underinsured compared to White populations, affecting their ability to receive preventive and emergency care (Artiga et al., 2020). For the Native American population, similar challenges arise due to the underfunding and limited scope of the Indian Health Service (IHS), which fails to provide comprehensive medical services to many indigenous communities (U.S. Commission on Civil Rights, 2018).

Economic stability and educational attainment are critical social determinants of health that vary significantly across racial groups. Based on the U.S. Census Bureau's data, it is understood that Black, Hispanic, and Native American populations experience significantly higher rates of poverty compared to that of White Americans (Shrider, 2024). Higher rates of poverty limits access to quality housing, healthcare, and nutritious food, directly and indirectly affecting health outcomes. Additionally, it is known that educational attainment correlates with health outcomes. Individuals with lower levels of education tend to have worse health outcomes due to reduced health literacy

and limited job opportunities. Native American communities, in particular, experience lower high school and college graduation rates, which contribute to economic instability and reduced healthcare access (National Center for Education Statistics, 2019).

Geographic facts also play a role in the observed racial health disparities. Geographic isolation of reservation lands and Native American communities worsen healthcare disparities because they lack access to nearby facilities, leading to lower utilization rates and worse health outcomes. Additionally, Native American populations in rural and reservation settings face challenges such as lack of access to clean water, inadequate sanitation, and exposure to environmental contaminants from mining and industrial activities (Lewis et al., 2017). In urban areas, populations may struggle with high pollution levels, leading to increased rates of respiratory diseases such as asthma (Hajat et al., 2015).

2.3: Historic trauma and its effects on Modern Native Americans

Native American disparities are likely largely rooted in a long history of cumulative racial disadvantages socially and politically, intergenerational trauma related to colonization's effect on Native land and culture, and geographic disadvantages shaped by federal policies and rurality. These disadvantages continue to shape the socioeconomic and health outcomes of today's Native American people. Structural inequalities, including systemic underfunding of healthcare services, socioeconomic barriers, and historical oppression, have led to higher rates of chronic diseases, mental health issues, and reduced access to essential resources (Feagin & Bennefield, 2014; Lee, James, & Hunleth, 2020). Understanding these disparities is critical to developing

policies and interventions that address the systemic inequities faced by Native American communities.

Cumulative disadvantage is a measure of the accumulation of social, economic, and person-related stressors due to unequal access to resources and opportunities, which increase one's biological risk for disease (Latham-Mintus et al., 2022). Racial cumulative disadvantage refers to the ways in which systemic racism, historical oppression, and institutional discrimination create and sustain inequalities over time, leading to long-term disparities in economic, health, educational, and social outcomes for marginalized racial groups (Kutateladze et al., 2014). Native Americans have experienced cumulative racial disadvantage for centuries, shaped by colonization, forced displacement, systemic discrimination, and socioeconomic exclusion. Cumulative disadvantages tend to become compound over time, leading to lasting disparities in health as well as in SDOH domains such as economic opportunity, infrastructure, education, and even political representation (Shuey & Wilson, 2008). For Native Americans, these disadvantages have been continually reinforced through federal policies, legal discrimination, environmental injustice, and underinvestment in tribal communities (Gone et al., 2019). The long-term effects of historic policies continue to shape modern disparities, leaving many Native American communities with limited opportunities for advancement.

In addition to cumulative disadvantage, historical trauma shapes contemporary Native American health and SDOH outcomes. In this context, historical trauma is frequent thoughts or rumination of loss of population, land, culture, due to ethnic cleansing and genocides and involves feelings associated with anxiety/depression and

anger/avoidance for the affected (Braveheart & DeBruyn, 1998). The concept of historical trauma is associated with the various atrocities committed against the Native American people during and after colonization of the Americas. For the Native American community, historic traumas include historic loss of land, language and culture. Historic traumas are understood as drivers of contemporary trauma in addition to contemporary stressful life events, conditions, and societal microaggressions (Jolley, 2020). The accumulation of historic trauma and contemporary life traumas driven by poor SDOH conditions result in elevated stress in Native American communities, negatively impacting health outcomes, especially those related to mental health metrics.

The persistent disparities faced by Native American communities are likely at least partially rooted in the cumulative effects of historical trauma and systemic racial disadvantage. The disadvantages seen today have been reinforced over generations through colonization, forced displacement, and discriminatory policies. The disadvantages in the Native American community have compounded to shape inequitable present-day SDOH and health outcomes. Historical trauma and contemporary socioeconomic barriers further compound health disparities leaving Native populations at higher risk for chronic disease, mental health disorders, and limited access to healthcare (Sotero, 2006). By acknowledging the lasting impact of historical oppression and cumulative disadvantage, policymakers and researchers can work toward meaningful interventions that support the long-term well-being of Native American communities.

2.4: An abbreviated history of Native American traumas

One of the most important and foundational drivers of cumulative disadvantage and trauma for Native American communities is land dispossession. For what is now the American Southwest, the dispossession of land began with Spanish colonization in the 1500s as they established missions, presidios, and the encomienda system that subjugated Native Americans for labor, agriculture, and profit. The Pueblo peoples, in particular, were subjected to Catholic missionary efforts that sought to erase indigenous religious practices and force conversion (Knaut, 2015). The Spanish also introduced a system of forced labor known as repartimiento during this time, forcing Native Americans to work in mines and on Spanish estates. This system, along with exposure to European diseases such as smallpox and influenza, led to massive population declines among Southwestern tribes (Reséndez, 2016). The loss of land, population, and autonomy under Spanish rule severely disrupted traditional indigenous society, gravely weakening the indigenous population of the American Southwest long before 'American' settlers from the United States arrived. After Mexico gained independence from Spain in 1821, the newly established Mexican government secularized the previously Spanish missions. This led to a redistribution of land that primarily benefited wealthy Mexicans rather than the indigenous people who had historically inhabited them at this point in time (Reséndez, 2016). Rebellious raids were conducted by several indigenous groups, leading to the Mexican government establishing a bounty system that encouraged the capture and enlistment of Native Americans, further accelerating violence and displacement (DeLay, 2007).

Following the Treaty of Guadalupe Hidalgo in 1848, much of what is now the American Southwest was ceded to the United States and U.S. policy towards

indigenous people began to apply to the people of the Southwest. The reservation system, created through treaties, military force, and federal policies such as the Indian Appropriations Act of 1851, was intended to confine Native Americans to designated lands while opening vast territories for White settlers and westward expansion. These reservations were often located on marginal lands with poor soil, limited natural resources, and harsh environmental conditions, making traditional subsistence activities such as hunting, fishing, and agriculture difficult. The forced relocation to reservations disrupted social structures, weakened tribal governance, and imposed dependence on federal aid, further marginalizing Native communities economically and politically (Fixico, 2013; DeLoria & Lytle, 1983). reservation policies restricted mobility and economic opportunities and limited Tribal sovereignty, as tribes had little power to develop or manage their own lands without government approval.

In 1887, the Dawes Act, also known as the General Allotment Act, was enacted with devastating effects on Native American communities. The act divided tribal lands into allotments to individual tribal members, with the remaining land considered surplus to the federal government to be sold to non-Native Americans (Department of the Interior). The policy aimed to assimilate Native Americans into Euro-American agricultural practices by allotting individual land parcels to Native families while selling "surplus" land to White settlers, greatly affecting Native American land management and access to ancestral lands. This mass land loss also disrupted traditional economic structures, depriving Native communities of vital resources for agriculture, hunting, and self-sufficiency (Miller et al., 2024). The act ultimately led to the loss of over 90 million acres by the policy’s end in 1934 (Department of the Interior). During the time that the

Dawes Act was the driving force behind settler and Native American relations, Native children were also being taken into boarding schools to assimilate them into settler American culture in an attempt to damage tribes and their children's linguistic, cultural, and familial connections. Separation of Native American children from their people, culture, and traditions from an early age further contributed to the historic trauma felt by Native American today (Smith, 2004). The actions sanctioned by the Dawes Act separated tribes and tribal members from valuable and culturally significant lands and practices from an early age. The fragmentation of tribal land weakened communal governance, making it easier for federal and state authorities to exert control over Native affairs. The Dawes Act not only impoverished generations of Native Americans but also set the stage for continued economic marginalization, as land ownership remains a key determinant of wealth accumulation in the United States. This dispossession, coupled with restrictive policies on Native self-governance, created a lasting disadvantage that persists in the form of poverty, economic instability, and legal barriers to reclaiming ancestral lands.

Attempts to begin correcting historical wrongdoings perpetrated by the American government began in the 1930s with the 1934 Indian New Deal, a federal effort to rebuild tribal institutions and tribal culture. This new deal had mixed success and progress for Native Americans was not entirely linear. In the 1950s, the Indian New Deal was replaced by termination policy as the federal government reversed course in an attempt to destroy the very same institutions and cultures it just attempted to rebuild. This era of legislation resulted in about three percent of tribes being terminated, though many have since been reinstated. Tribes by and large held strong and did not accept

deals that threatened further land concessions and tribal recognition, with termination policy managing to terminate very little of Native America (Wunder, 1994).

In 1970, President Nixon denounced termination as morally and legally unacceptable and initiated the Self-Determination Policy that has remained the official legislative and executive objective to this day (Berger, 2008). Under this policy, over half the government services for Native Americans were turned over to tribal control, while other legislation enabled tribes to better protect their cultural and natural resources. Self-Deterministic Policy measures have helped position tribes as true governments rather than doomed minority groups living within US borders (Wilkinson & Biggs, 1977). Today, tribes are no longer limited by their Native American racial status and now position themselves as trading partners with the broader United States people and government while also wielding important negotiating power as governing bodies in their own right. As the United States and tribes turn towards investing in the development of tribal governments and economies in this era of Self-Determination Policy, the gaps seen in health, income, education, and political participation have decreased when comparing Native Americans and other racial groups in the US (Berger, 2008).

Despite the gains that have been made, the effects of the past still color the outcomes that Native Americans face today. The legacy geographic and legislative disadvantages of the lands given to Native Americans continue to impact Native American health disparities, sovereignty, and access to resources. The inclusion of racial data in public health studies allows for a clearer understanding of the unique challenges faced by Native American communities. Furthermore, data indicating that the disadvantages faced by today's Native American populations are not only due to

their rurality but something more may help not only shed light on the Native American experience but assist in future advocacy for legislation that truly addresses the unique conditions that shape the Native American experience.

2.5: Difficulties Defining Rurality

While rural areas are commonly understood as places with lower population densities and fewer urban characteristics, the precise boundaries and characteristics of rurality vary significantly across disciplines, regions, and policy frameworks. Rurality is a multifaceted concept influenced by demographic, economic, social, and spatial factors, making it difficult to establish a universal definition. The differing definitions of rurality are important to researchers and policymakers as they have implications for policy, research, and resource allocation as different classifications can yield different interpretations of rural-urban disparities. The lack of a universally accepted definition can present challenges for researchers and policymakers alike because who is and is not counted as rural is tied to issues of community sustainability, well-being, equity, and access to services and amenities (Nelson, 2021; Brown & Cromartie, 2017).

One of the difficulties in defining rural areas is the variety of metrics that are used to distinguish rural and urban areas. Typically, different definitions of rurality are used to fit different purposes, even for rural metrics within the same country. The U.S. Census Bureau dichotomously classifies rural areas using population density with rural defined as any region outside an urbanized area (50,000 or more people). Core-Based Statistical Areas (CBSAs) are geographic regions defined by the U.S. Office of Management and Budget (OMB) based on population density and economic ties. The CBSA classification system is used primarily for statistical and policy-making purposes,

offering a standardized way to analyze urban and rural areas based on their economic interconnections. The Department of Agriculture uses Rural-Urban Commuting Areas (RUCAs) that categorizes census tracts based on population density, urbanization, and daily commuting patterns. RUCAs differentiate rural and urban areas in a way that considers economic and social linkages between places (Long et al., 2021; Cromartie & Bucholtz, 2008).

In addition, the perception of rurality extends beyond statistical definitions. Social and cultural dimensions play a crucial role in how rural areas are identified and experienced. Communities may self-identify as rural based on historical, lifestyle, or cultural attributes, even if they do not meet formal statistical criteria. Subjectivity exists when constructing a definition of rurality. An individual's or community's rural identity is often shaped by qualitative factors such as social cohesion, traditional values, and community structure that may not be reflected in population metrics alone, further complicating the establishment of a single classification system that reflects community sentiments. To address these challenges, researchers and policymakers have increasingly adopted multidimensional frameworks that account for both quantitative and qualitative aspects of rurality. These approaches acknowledge that rurality exists along a continuum rather than as a fixed category, which may be a more accurate reflection of rural conditions (Long et al., 2021).

Rurality is dynamic and contextually dependent, reflecting the diversity of rural experiences. Some rural areas are characterized by population density alone. Others consider agriculture and natural resource-based industries, while others still are increasingly integrated into broader economic networks through transportation and

telecommunication infrastructure. Depending on the study, the availability of data will guide the choice of rural definition, however, it is important to keep in mind that there is no single best measure of rurality for predicting rural-urban disparities (Long et al., 2021). For this study, using a rural continuum is an effective way to view rurality in comparative health studies because it allows for a more nuanced understanding of rural-urban disparities. Unlike binary classifications that rigidly separate rural and urban areas, a continuum approach acknowledges that rurality exists along a spectrum, capturing the varying degrees of remoteness, economic integration, and healthcare accessibility among different rural communities.

2.6: Origins of the Rural-Urban Gap

The rural-urban gap in America finds its roots in the late 1800s during a period of change for America economically as society shifted from rural farmlands to burgeoning industrial cities. Political leaders and congress wrote legislation and trade policy favorable to industry and manufacturing, creating a labor demand in urban spaces rather than rural geographies (Graham, 2005). Cities and metropolitan areas grew quickly during this period and America's countryside entered a period of decline. In the East, rural labor was supplemented by incoming immigrants while the farthest reaches of the still expanding American West was supplemented by cheap labor from Mexico (Spring, 2001). The first half of the 20th century saw a second wave of migration towards urban areas and away from rural America. Six and a half million black Americans fled violence, poverty, and disenfranchisement experienced in the rural Jim Crow era south between 1910 and 1970, intensifying the allure of urban population centers (Lemann, 1992). The ruling of Brown versus the Board of Education in 1954

desegregated the school system, though desegregation efforts were resisted through methods such as the gerrymandering of district lines, the establishment of racially distinct neighborhoods in urban spaces and within the suburbs for those leaving integrating cities. Rural areas and minority urban areas have been isolated through a combination of zoning restrictions and distance. Urban industrial development and desegregation policy has in part led to the depletion of rural population and a concentration of wealth in urban and suburban spaces (Tieken, 2017). Areas isolated geographically, socially, and economically experience worse outcomes. This isolation may relate to both the rural and Native American experience.

Studies examining the worsening rural disadvantage increasingly point to the role that local taxation plays in the disparities of rural communities. Local tax structures, particularly property taxes, significantly influence the availability and quality of public resources such as schools, healthcare systems, and infrastructure (Tieken, 2017). Property value, which plays a large part in determining tax revenue, is shaped not only by tangible characteristics such as location and amenities but also by perceptions of place. Perceptions, fair or otherwise, impact how property is appraised and, consequently, how well local services are funded. In communities with high property values, schools are better resourced, hospitals are well-equipped, and transportation infrastructure is robust. Conversely, rural areas, where property values tend to be lower, face underfunding of essential services, further reinforcing cycles of disadvantage over time (Van Den Boogaard & Beach, 2023).

When discussing perception, the labels “urban” and “rural” themselves carry implicit biases that affect property valuation and taxation. These spatial descriptors are

often tied to entrenched assumptions about race, class, and moral character, shaping financial investments and disinvestments in communities. For example, the historical association of rural spaces with economic stagnation and “backwardness,” alongside narratives of urban decay and crime, has influenced how financial institutions, policymakers, and potential residents assess property values and resource allocation (Ladson-Billings & Tate, 1995). These perceptions contribute to a feedback loop where undervaluation leads to underfunding, which in turn perpetuates inadequate public services.

This intersection of geography, perception, and taxation has resulted in an inequitable distribution of public goods that disadvantages both rural and racially marginalized communities. The cumulative effects of this systemic disinvestment manifest in disparities in educational attainment, healthcare access, and economic mobility (Thomas et al., 2014). Over time, these gaps in resources have contributed to entrenched inequalities in life outcomes, deepening the divide between rural and urban populations and reinforcing broader patterns of social and economic marginalization. The question remaining that this project seeks to answer is how much does the rurality of Native Americans correlate with the disadvantages they experience. If their disadvantage cannot be completely correlated with their rurality, this may point towards additional factors that must be considered when considering what shapes disadvantages for the Native American people.

2.7: Rural Health and SDOH disparities

Rural communities often face significant disadvantages compared to their urban counterparts in health and SDOH (Social Determinants of Health) metrics due to

geographic isolation, economic constraints, and healthcare shortages (Nelson et al., 2021). Rural populations consistently experience poorer health outcomes than their urban counterparts. Rural residents have higher rates of chronic diseases such as heart disease, diabetes, and obesity. Mental health disparities are also more pronounced in rural areas. Higher rates of depression, suicide, and substance use disorders are common. Additionally, mortality rates are higher in rural areas, with rural residents facing increased risks of preventable deaths due to lower access to emergency and specialized care (CDC, 2024; Nelson et al., 2021).

The poor health outcomes seen in rural communities, both physically and mentally, are largely shaped by their comparatively worse social determinants of health. Rural areas tend to have higher poverty rates, lower wages and fewer job opportunities when compared to urban centers (Creamer et al., 2022). Economic instability limits access to healthcare, nutritious food, and stable housing, all of which are key factors in overall health. The geographic dispersion of resources affects healthcare access and quality for rural residents. Healthcare provider shortages in rural areas contribute to disparities in both preventive and emergency care. Many rural residents must travel long distances to reach hospitals, specialists, or mental health services (Douthit et al., 2015). Education in rural areas also shapes health and life outcomes for rural communities. Lower educational attainment in rural areas correlates with poorer health outcomes. Limited access to higher education and health literacy programs also affects the ability of individuals and communities to navigate healthcare systems and make informed health decisions (Aljassim & Ostini, 2020). Public transportation is often unavailable in rural areas, making it difficult for residents to access healthcare facilities,

jobs, and essential services (Nelson et al., 2021). Poor infrastructure, including limited broadband access, also hampers telehealth services that could mitigate some healthcare access issues.

Lastly, and perhaps most consequently, the geographic isolation of rural communities and the dispersion of resources in rural areas dramatically shapes the rural experience compared to urban areas. The geographic isolation of rural communities means fewer medical professionals, longer travel times to healthcare facilities, and greater difficulty in recruiting healthcare providers. Federally designated Health Professional Shortage Areas (HPSAs) are disproportionately located in rural regions, further emphasizing the gaps in medical service availability (Health Resources and Services Administration, 2025). Geographic isolation also affects access to economic opportunities, social services and amenities. This effect is compounded by transportation options in rural areas. Public transportation is often unavailable. Therefore, many rural residents must rely on personal vehicles and road infrastructure to access healthcare, job opportunities, and other essential services. Without a personal vehicle, accessibility quickly becomes an issue. Lastly, rural residents face higher food insecurity rates due to the scarcity of grocery stores and fresh food markets, often referred to as "food deserts." This contributes to higher rates of diet-related diseases such as diabetes and hypertension (CDC, 2024).

The geographic isolation, economic instability, and healthcare shortages that define many rural areas create substantial barriers to health equity, exacerbating chronic disease prevalence, mental health challenges, and overall mortality rates. Additionally, limited educational opportunities, inadequate infrastructure, and food

insecurity further compound these disparities, reinforcing cycles of poor health outcomes. Recognizing the unique challenges faced by rural populations and implementing tailored solutions can help mitigate these disparities, ultimately fostering healthier and more equitable communities. The issues seen in rural communities are especially present in Native American communities due to their proportionally large rural populations compared to other racial groups. Research is necessary to estimate if poor Native American health and SDOH metrics are due to their rurality or if there are additional factors contributing to their experience.

Chapter 3: Methods

3.1: Determining Rurality Using GIS

There are a diverse set of definitions over what is and is not rural. This study relied on a combination of definitions from the U.S. Census Bureau and National Center for Education Statistics (NCES). Both definitions take an urban centric view on defining rurality by first identifying what is urban and defining what is rural by an absence of urbanity. With an urban centric view, rural encompasses all population, housing, and territory not included within an urban area.

For the 2020 Census, the U.S. Census Bureau defined its urban areas as densely settled cores of census blocks that meet a minimum housing unit density and/or population density per census block. The new addition of a potential housing minimum accounts for the idea that the number of individuals in housing units can change over time, but the presence of housing in the landscape can remain more stable. To qualify as an urban area, the territory identified must contain a minimum population of 5000 or housing unit minimum of 2000. The housing unit minimum approximates the population minimum based on the national average people per housing unit of 2.5. The geographic size of an urban area can vary greatly depending on the household or population density of the area it encompasses. This either/or approach has two key benefits due to its inclusion of areas such as seasonal communities or second home communities that are densely populated but have a lower population on Census Day (April 1st), while still including areas that have a higher than average people per housing unit via the population minimum. The 2020 Census contained three density thresholds in the urban delineation process. First, a 1275 units per square mile ensures each qualifying urban

area contains at least one high density nucleus, second, a 425 housing unit per square mile minimum defines the urban core, and, lastly, a 200 housing unit per square mile minimum fills the remainder of urban areas (Ratcliffe, 2022).

Census blocks that meet these housing unit density minimums form U.S. Census Bureau defined urban areas. The bureau only defines what is considered urban and does not have a strict definition of what is considered rural. Binarily, what is considered rural based on this urban-centric definition are the areas that are not considered urban. This urban delineation provides a handy starting point for this study by providing a dataset congruent with census tracts that define urban. In order to provide a richer

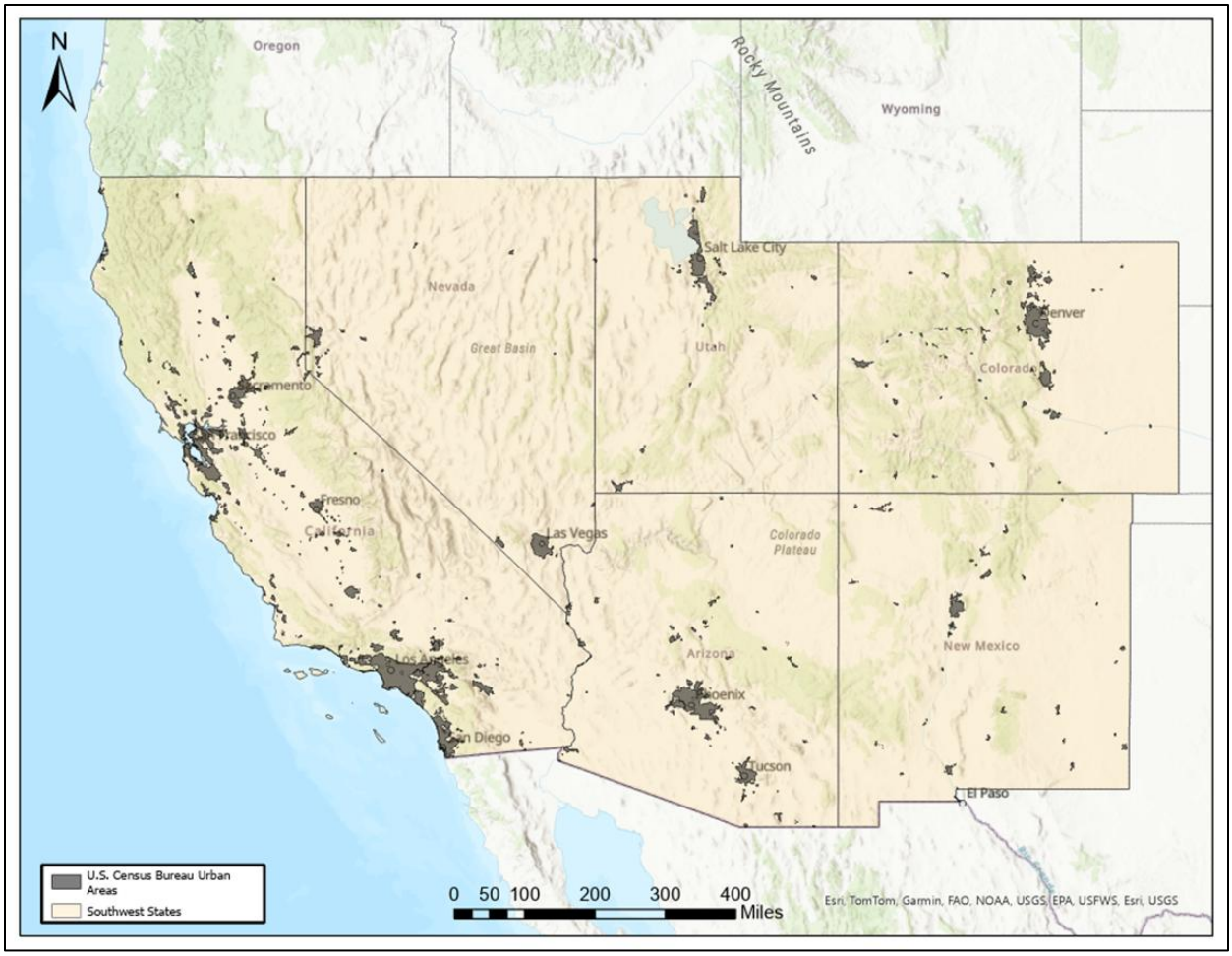

Figure 3: U.S. Census Bureau Designated Urban Areas

understanding of the rural-urban spectrum and rurality, an additional definition that further delineates rural areas must be considered.

The NCES builds upon this definition by adding subcategories of urban and rural to the Census Bureau define urban areas. The NCES' three rural subcategories are defined by proximity to urban areas. Fringe rural areas are defined as Census-defined rural territory that is less than or equal to 5 miles from an urbanized area. Distant rural areas are defined as Census-defined rural territory that is more than 5 miles but less than or equal to 25 miles from an urbanized area. Remote rural areas are defined as Census-defined rural territory that is more than 25 miles from an urbanized area (National Center for Education Statistics, 2022). The NCES definitions also include language defining rurality by distance from urban clusters, but the U.S. Census Bureau no longer distinguishes between urban areas and urban clusters in their 2020 urban area delineation (Ratcliffe, 2022). The NCES' proximity-based subcategorization of rural areas defined three categories of rural for this study.

ArcGIS Pro, a Geographic Information System (GIS) software application, was used to spatially delineate these three categories of rurality based on the aforementioned distance buffers from urban areas. The U.S. Census Bureau provides a feature layer online that contains its delineation of urban areas for 2020 (Esri, 2023). This layer was imported into ArcGIS Pro and used as the input for the Buffer (Analysis) Geoprocessing tool. This tool allows the user to create an output feature class whose geometry is the designated distance buffer (5 mi, 25 mi, 25+ mi) around the input feature (urban areas). The buffers around the urban areas are 'dissolved' together to output overlapping buffers as a single feature with no overlap. The resulting output

feature class contained the three desired subcategories of rurality based on distance from an urban area. Lastly, this rural area buffer layer was joined together with the Census Bureau's urban areas layer using the Spatial Join (Analysis) geoprocessing tool to create one final layer with full geographic coverage with distinctions between urban and rural as well as distinctions between the three subcategories of rurality. Urban areas and each level of rurality was assigned a Rural-Urban (RU) code. Urban as RU0, fringe rural as RU1, distant rural as RU2, remote rural as RU3.

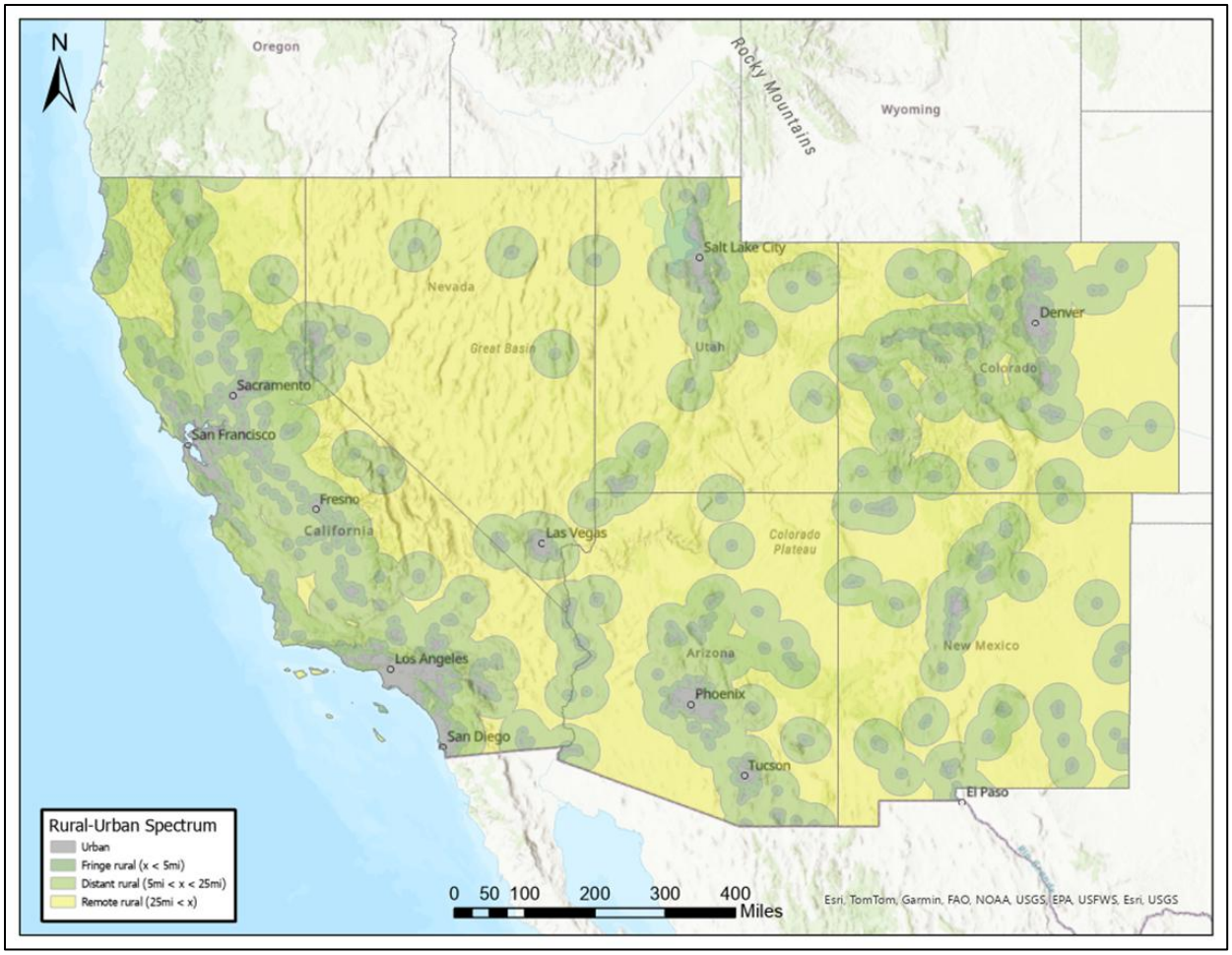

Figure 4: Urban Areas & NCES-Based Rural Buffers

3.2: The U.S. Census Tract

The health and social determinants of health data that used to compare Native Americans with other racial groups is mainly sourced from the Centers for Disease Control and Prevention (CDC), the 2020 U.S. Census, or from the American Community Survey (ACS), an annual demographics survey program that provides an estimate of U.S. demographics. The data available from the Census and ACS are mainly at the census tract level of geographic detail, which is why it will be the main geographic unit for this study. With most of the data already available in this geographic unit, census tracts make it possible to easily compare health and SDOH data between rural and urban census tracts and differing racial groups at a high level of geographic detail. A census tract is a small, relatively permanent geographic area within a county, used to collect and present demographic data from the U.S. Census and American Community Survey, designed to be as homogeneous as possible in terms of population and living conditions (U.S. Census Bureau, 2022). Census tracts are composed of census blocks, meaning the Census Bureau's urban areas fit neatly within the boundaries of the census tracts.

What does not fit neatly into the boundaries of census tracts are the rural buffers in the rural-urban layer created previously. In order to translate the rural-urban continuum created by the buffer layer into the census tract geography, another spatial join was performed on a layer containing all of the census tract for the study area with the rural-urban buffer layer. This spatial join utilized the census tracts as the target feature whose attributes and geometry will be retained and the previously created rural-urban layer will be the join feature in order to join its attributes (specifically the RU code attribute) to the target census tract feature. This spatial join used the 'largest overlap'

matching option to join the rural-urban attributes to census tracts based on the largest overlap between the features. If a census tract is covered by two rural-urban buffers, such as a 40% overlap with RU1 and 60% overlap with RU2, the larger overlapping geometry, RU2, had its features assigned to the census tract. The final result is an output layer of census tracts that contains the attributes of the largest overlapping rural-urban geometry, which allows the output layer to be symbolized like the previous rural-urban layer with the geometry of census tracts. After preparing and processing, all the data used in the study fit within a census tract. Now that census tracts can be selected by their RU Code, it is possible to control for rurality when extracting health and SDOH

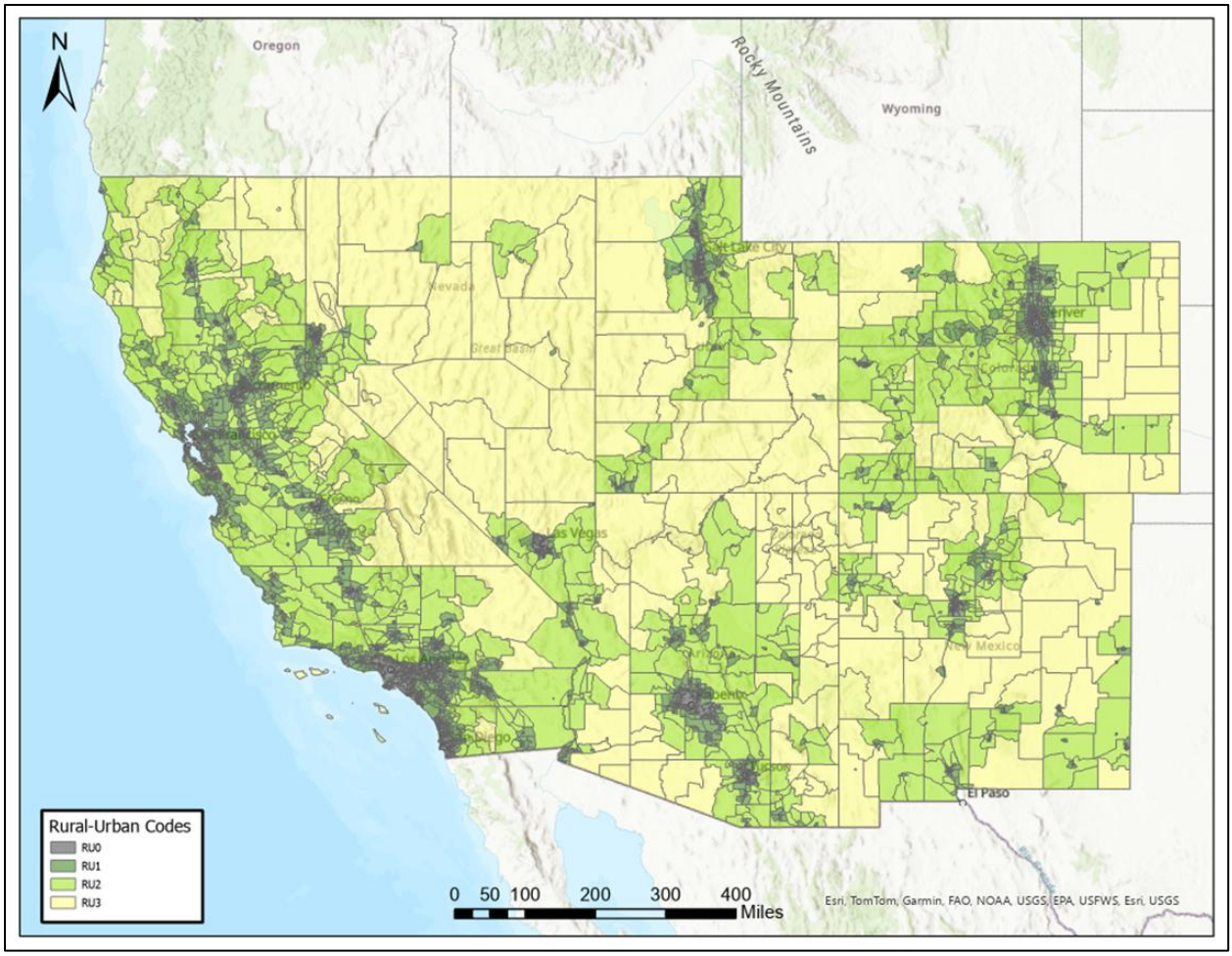

Figure 5: Rural-Urban Codes Assigned to Census Tracts

data. Next, the largest racial group for every census tract will be determined so that census tracts of similar rurality can be compared across racial groups.

3.3: Determining the Largest Racial Group Per Census Tract

Determining the largest racial group for every census tract within the study area is important for this study as an approximation of where these racial groups live and determining what census tract data is representative of a particular racial group. The ACS provides the most recent population estimate based on their 5-year rolling survey estimates as an online Feature Service Layer (ACS Employment Status Variables, 2024). Based on their survey data, the population and racial composition of nearly every census tract can be estimated. The largest racial group, which is not necessarily a group that makes up 50%+ of the population, is considered the plurality demographic group rather than the majority demographic group. The plurality group be obtained by first creating an attribute to house the name of the largest racial group and using the Calculate Field tool and Python to poll the various racial fields and their population estimate and populating the new largest race attribute with the maximum population number. The Calculate Field tool can apply this process to the entire set of census tracts.

There are 7 racial groups considered for the ACS' dataset. Racial identities can vary significantly depending on the individual and the survey, which is important to recognize, as race and identity can be highly complex and individual. For simplicity, this study used the 7 racial groups the ACS data utilizes. The results of calculating the largest race attribute revealed some important insight about the makeup of the

population of the American Southwest. The racial categories of Pacific Islander and Other do not make up the largest population of any singular census tract in the study area by the ACS' estimate. Due to this insight, these two groups will be excluded from the racial demographic comparison.

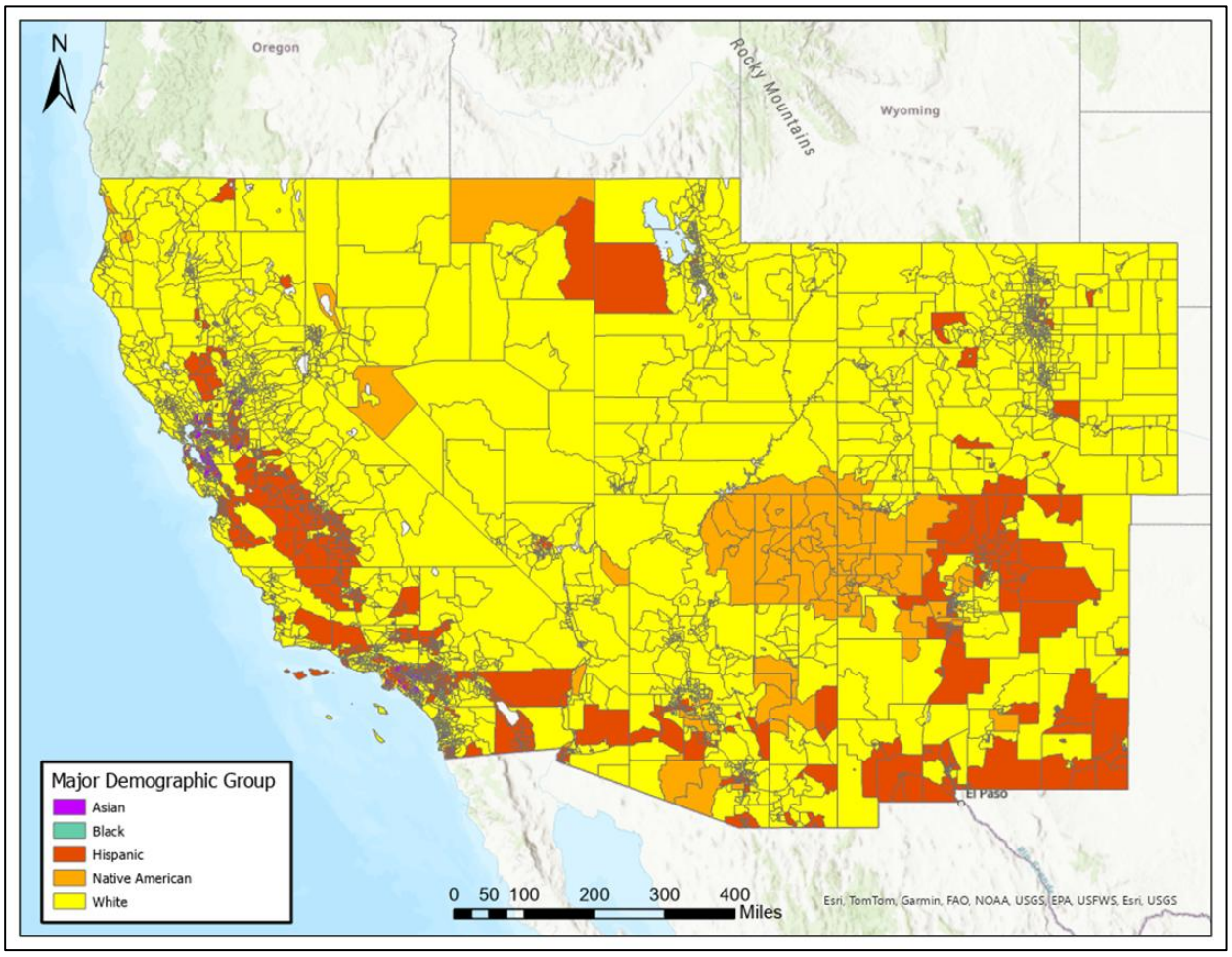

Figure 6: Plurality Racial Demographic Per Census Tract

Now that the plurality racial group for every census tract can be estimated in addition to each census tract's place on the rural-urban spectrum, the two factors can be combined as a single attribute (RaceRU_Code). First, a join was performed using the Add Join geoprocessing tool between the layer of census tracts with rural-urban codes and the layer of census tracts containing the plurality racial group attribute using

the FIPS (Federal Information Processing Series) code as the join field. This allows for a single layer to contain both the rural-urban code attribute as well as the racial plurality attribute. Next, a new attribute was created (RaceRU_Code) so that every census tract can be selected based on race and rurality. This field was calculated using the Calculate Field geoprocessing tool and Python to combine the racial string and the RU code as a string into every existing combination. The resulting field can be visualized as a spectrum of rurality and racial category.

Combining the two fields into one with every combination within the dataset also provided insight about the demographics of the Southwest. Asian and Black people

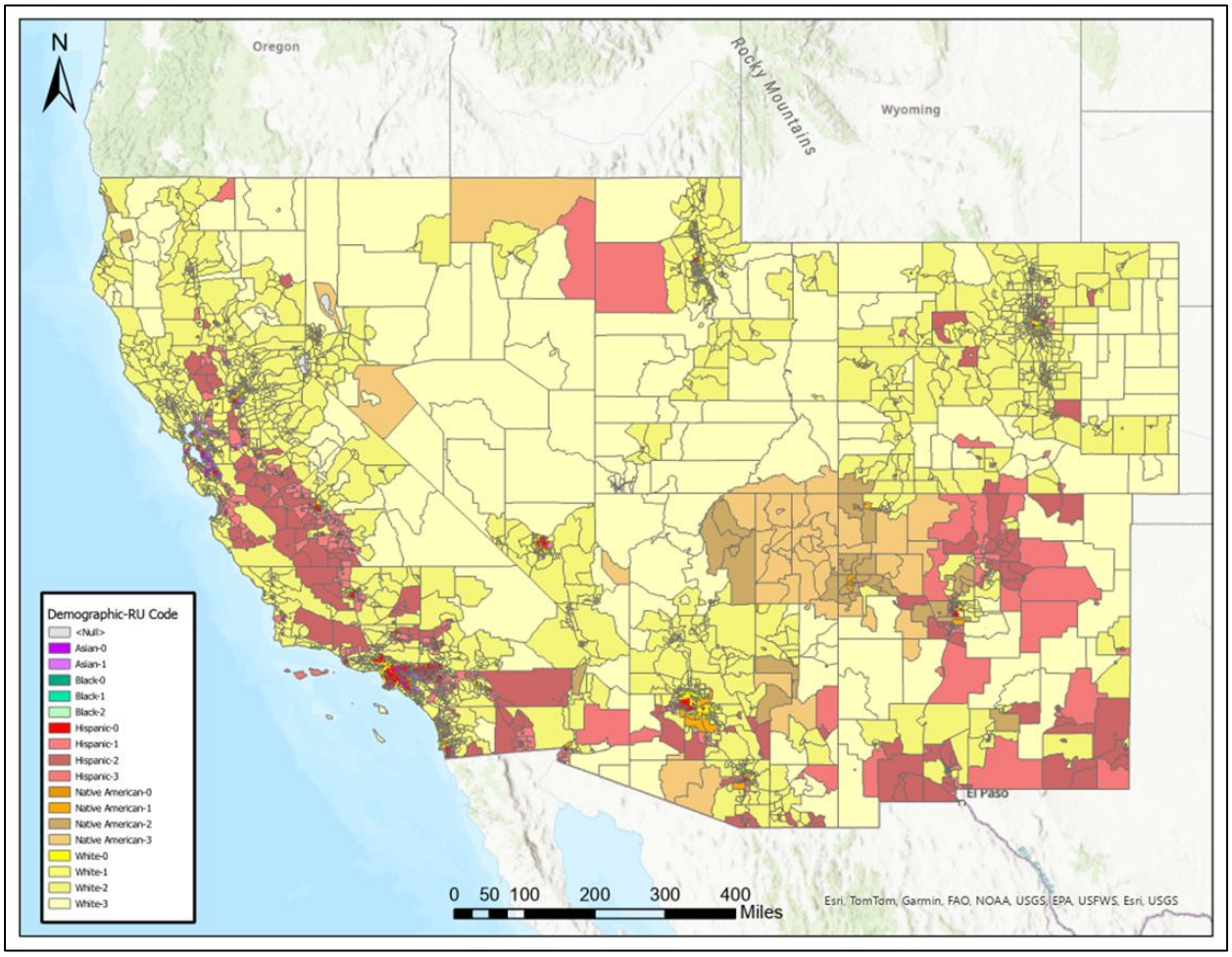

Figure 7: Plurality Demographic Group & Rural-Urban Code Per Census Tract

make up the largest racial groups for several census tracts within urban (RU0) and fringe remote (RU1) rural areas but make up the largest demographic group in few if any census tract in distant (RU2) or Remote (RU3) areas. Due to their lack of plurality prevalence across the entirety of the rural-urban spectrum classification, it was decided not to compare these groups with the remaining three racial categories that can be compared across every rural-urban code. For this study, Native Americans will be statistically compared against the Hispanic and White populations due to each group having a plurality prevalence at every part of the rural-urban spectrum in the study area.

3.4: Health Outcomes Data Considered

Health outcomes can be estimated using a variety of methods, including self-reported surveys, clinical data, mortality rate, and healthcare utilization metrics. These various approaches provide valuable insights into the overall well-being of populations with varying strengths and limitations based on data availability, accuracy and representativeness. This study will focus on key health factors derived from the CDC PLACES: Local Data For Better Health dataset, specifically examining crude prevalence rates of coronary heart disease, obesity, stroke, cancer (excluding skin cancer and melanoma), physical inactivity, frequent physical distress, and fair or poor health. CDC PLACES provides model-based data for a variety of chronic illnesses as well as community health factors for census tracts, the geographic unit for this study, across the country. In their own words, PLACES reflects innovations in generating valid small-area estimates for population health and provides data uniformly across the urban-rural spectrum, which is especially relevant for this study's goals (About PLACES, 2024).

Coronary heart disease (CHD) rates were included as a factor for this study due to its status as a leading cause of mortality and known disparities between racial groups (Williams & Mohammed, 2009). Obesity rates were included due to its status as a significant risk factor for various chronic diseases, including heart disease, stroke, and certain cancers, as well as for its prevalence among minority groups (Williams & Mohammed, 2009). Stroke rates were included due to its high morbidity and due to it leaving as much as 50% of survivors chronically disabled, making it economically and socially consequential for affected groups (Donkor, 2018). Cancer rates were included due to its mortality rates, and rates being influenced by environmental exposures, which may be linkable to specific groups affected by environmental racism (Lewis, Hoover & MacKenzie, 2017). Physical inactivity rates are linked to numerous health issues and disparities among groups can shed light on underlying social and community health (Schootman et al., 2010). Rates of self-reported frequent physical distress was included as a reflection of individuals' perceptions of their own physical health. Higher rates may indicate certain groups have unmet healthcare needs or chronic conditions (Schootman et al., 2010). Lastly, rates of self-rated fair or poor health status were included due it being known as a strong predictor of morbidity and mortality with disparities across racial groups potentially indicating inequities in healthcare access or quality, and broader community health factors (James et al., 2017). Health data was sourced from a feature service layer provided by CDC PLACES (PLACES: Local Data for Better Health, 2024). By analyzing the aforementioned indicators available through the CDC PLACES dataset, this study aims to assess disparities in health outcomes

across racial groups with the dataset's localized perspective on chronic disease burden and overall health status in different communities.

3.5: Social Determinants of Health Data Considered

In addition to comparing health outcomes, this study also wants to compare community factors known as the social determinants of health (SDOH). SDOH encompasses the non-medical factors influencing health outcomes, including the conditions in which individuals in communities are born, grow, work, live, and age (Krause, Schaefer, & Highfield, 2021). SDOH contributes to health disparities and inequities, making them a strong complement to outright health outcome measurements (Healthy People 2030). These determinants provide critical context for understanding the root causes of health disparities beyond exclusively using statistical differences in disease prevalence or mortality rates. The social determinants of health encompass 5 key areas of concern: economic stability, education access and quality, health care access and quality, neighborhood and built environment, and social and community context.

Economic stability is a vital social determinant of health due to the influence that factors such as poverty, unemployment, housing costs, and the cost of living have on health outcomes (Perez et al., 2022). Poverty limits access to basic needs, including food, safe housing, and healthcare. Unemployment increases stress, financial strain, mental health challenges, and risk of chronic illness. High housing costs and costs of living can lead to housing instability, homelessness, and poor health conditions (Center for Disease Control and Prevention, 2023). *Native Americans and rural communities lag behind in these economic stability indicators* (Huyser & Takei, 2010; Singh et. al., 2024).

Economic stability as a domain of the SDOH will be estimated using measures of poverty and unemployment provided by data from the American Community Survey (ACS Employment Status Variables, 2024; ACS Poverty Status Variables, 2024).

Educational access and quality are important due to education factors being linked and related to long term health outcomes. Educational access refers to the ability to obtain and benefit from education. Factors such as geographic location, discrimination, and resources available within the education system affect how accessible education may be considered. Educational quality encompasses academic achievement (degree or diploma conferment) in addition to measures of holistic development socially, emotionally, and cognitively (Barrett et al., 2006; Lewin, 2015). There is nuance to both terms that make up this social determinant of health, but this study chose to make use of two measures of educational achievements, high school diploma attainment rate and bachelor's degree attainment rate. Educational attainment is related to both access and quality and is useful as a proxy but is distinct as a measure of highest formal education completed. Greater high school graduation rates increase opportunities for stable employment, income opportunity, and access to healthcare while college graduation rates further enhance income opportunities in addition to higher rates of health literacy, reduced rates of chronic diseases, and improved life expectancy. Addressing and improving upon education can help reduce individual and community health inequities and promote community well-being (Suiter & Meadows, 2023; Telfair & Shelton, 2012). Rates of high school graduation (or equivalent) as well as rates of undergraduate degree attainment will be used to estimate

this SDOH domain using data sourced from the American Community Survey (ACS Educational Attainment Variables, 2024)

Healthcare access and quality is important as a social determinant of health because it encompasses factors such as timely medical interventions, access to preventative care and promotional health material, and emergency responses. Healthcare access and quality shape health outcomes and health inequities (McGibbon, Etowa, & McPherson, 2008; Tzenios, 2019). Individuals and communities that lack access to healthcare as well as access to quality healthcare experience worse health outcomes due to the differences in emergency, routine, and preventative care. Rates of routine checkups, a lack of health insurance, and transportation barriers will be used to estimate this SDOH domain. Data for these factors will be sourced from the CDC PLACES dataset (PLACES: Local Data for Better Health, 2024).

Neighborhood and built environment as a SDOH domain is a strong social determinant of health because it encompasses infrastructure, housing access, and the stability of housing, all of which directly contribute to health outcomes and access to other resources influencing health outcomes (Nabaweesi et al., 2023). These factors shape access as well as the options that are available to individuals and communities to interact with their natural and built environment. Rates of being cost burdened by rent or mortgages and extreme cost burden from rent and mortgages as well as broadband internet access rates will be used to estimate this SDOH Domain. Data will be sourced from the American Community Survey (ACS Housing Costs Variables, 2024; ACS Internet Connectivity Variables, 2024).

Social and community context is an important social determinant of health due to the way it shapes access to resources, influences health behaviors, and the way it shapes equity and equitable health outcomes. A supportive social and community context can lead to improved mental and physical health while also decreasing health disparities in a community. Social and community context includes mental health measures that could be supported through one's social and community context as well as social and community context in terms of insecurity rates in the community's housing, food, and utilities (Geller et al., 2023). Additionally, voting rates will be considered for social and community context as a lack of civic participation can be indicative of community health or access issues (Brown et al., 2020). Voting rates as well as rates of depression, frequent mental distress, social isolation, food insecurity, housing insecurity, and utility service threats will be considered for this SDOH domain. Data will be sourced from the CDC PLACES dataset as well as from the University of Wisconsin's Country Health Ranking (PLACES: Local Data for Better Health, 2024; County Health Rankings, 2024).

Incorporating Social Determinants of Health into analyses of racial health disparities allows for a more comprehensive understanding of the underlying causes of these inequities. By addressing these health factors, a better understanding of the context surrounding health outcomes can be gained. Additionally, this provides more contextual data to compare racial groups, which shed light on if there are specific factors or domains that a particular racial group may perform worse in compared to other racial groups, even while controlling for the rurality of populations.

3.6: Comparing Racial Groups While Controlling for Rurality

This study seeks to compare Native Americans with Hispanics and White people in the American Southwest while controlling for rurality to estimate if disparate Native American health outcomes and factors social determinants of health are due to their proportionally large rural population. Native Americans, Hispanics, and White people have plurality population census tracts at all levels of the rural-urban spectrum. This means that this study can take subsets of each of these racial groups for each portion of the rural-urban spectrum to compare similarly rural or urban populations of each race. Every health outcome or SDOH factor being considered will have its mean, standard deviation, and sample size recorded for each racial group rurality level combination to use for comparisons.

For example, when considering the percent of the population that is unemployed at rurality code RU3 (remote rural) there are 170 census tracts that are pluraity White, 44 that are plurality Hispanic, and 30 census tracts that are plurality Native American. The mean and standard deviation for unemployment rate for each racial group is calculated and recorded along with the sample size (number of census tracts where each racial group is the largest population). The data will be recorded in groups according to their RU code for comparison between racial groups of the same rurality level, thus controlling for rurality. These groups of data (i.e. unemployment rates at RU3 as a group) will then have an ANOVA (analysis of variance) statistical test applied to them to determine if there is significant difference in outcomes or factors in any racial group considered.

The demographic groups of Pacific Islander and Other were not considered in this study's comparison due to the racial groups not making up a plurality population in

any census tract in the considered study area. Asian and Black populations were not considered in this demographic comparison due to the racial groups lacking a plurality population presence at the more rural end of the rural-urban spectrum. Table 1 Provides a breakdown of the 5 racial demographic groups that had at least 1 plurality population in a census tract in the study area.

This study intends to focus on the Native American population in comparison to the other major demographic groups in the American Southwest. Due to their unique history and relationship with the United States government, many Native American live on federally designated American Indian reservations. These areas are ‘reserved’ for particular tribes and their tribal members to exist as sovereign nations, though even this

Plurality Census Tract Demographic	RU Code	Total
Asian	RU0	926
	RU1	44
	RU2	0
	RU3	0
Black	RU0	99
	RU1	2
	RU2	1
	RU3	0
Hispanic	RU0	4392
	RU1	527
	RU2	163
	RU3	44
Native American	RU0	41
	RU1	39
	RU2	29
	RU3	30
White	RU0	5997
	RU1	1344
	RU2	570
	RU3	176

Table 1: Count of Census Tracts by Plurality Demographic

is debatably somewhat of a misnomer due to the unique relationship that tribal entities have with the U.S. government and the reliance and integration much of tribal infrastructure and economics have with the U.S.. Nonetheless, it is interesting to note how many of the Native American Plurality census tracts exists entirely or partially on reservation lands. Table 2 quickly displays the amount of census tracts in the study area that are at least partially in reservation land in total and broken down by RU code. The majority of census tracts in this study are entirely or at least partially containing reservation lands, and the proportion increases as the rurality increases. This is not entirely surprising due to the rurality of the Native American population and the general rurality of reservation land. This may mean the method of assigning a racial demographic to every census tract based on plurality is at least somewhat successful at capturing Native American rurality and the relation to rural reservation lands.

Plurality Native American Census Tracts	At Least Partially On Reservation Land	Off Reservation Land	Total	Percent of Total (%)
RU0	19	22	41	46.34%
RU1	27	12	39	69.23%
RU2	27	2	29	93.10%
RU3	30	0	30	100.00%
RU0-RU3	103	36	139	74.10%

Table 2: Native American Plurality Census Tracts On and Off Reservation Land

3.7: ACS Census Tract Data, Sample Size Variation, and Normalization

Much of the data utilized in this study is sourced from the American Community Survey (ACS), which is a nationwide survey designed to provide reliable and timely social, economic, housing and demographic every year. This includes much of the health and SDOH data sourced from the CDC PLACES dataset, which itself sources much of its data from ACS or Census datasets. The American Community Survey is

administered by the U.S. Census Bureau as a supplement to the decennial Census. The Census is intended to gather data for the entire population of the United States while the ACS samples the U.S. population to estimate various metrics about American Communities. The ACS has an annual sample size of about 3.5 million addresses that is pooled across a calendar year to reflect that period of time rather than a single point in time as seen in the decennial Census. When ACS data was used in this study, this study utilized ACS 5-year estimates that represent data collected a period of 60 months. Over this 5-year estimate period, the Census Bureau samples approximately one in nine households nationwide.

Due to the ACS being designed as a sample, rather than a true population survey inclusive of all housing units and people, ACS estimates have a degree of uncertainty associated with them, which is noted and provided by the Census Bureau. Additionally, due to the ACS being based on a sample, there may not be an appropriate amount of data available to provide estimates for every metric in every census tract, especially in areas that are less accessible, which often means areas that are more rural or sparsely populated, due to the difficulty in gathering sample data. In 2018, there was a 92 percent response rate to the survey. Question response rates and overall response rates can influence the sample size of data in terms of number of census tracts data is available for in their provided datasets. The variation in sample size per metric can be seen in the tables provided in section 4.1.

Lastly, as is the case with many surveys, the data from the American Community Survey is controlled so that the number of housing units and people agree with the Census Bureau’s official estimates. As such, the ACS uses a weighting system to

ensure consistency between ACS estimates and Census Bureau population estimates by housing units, age, sex, race, and Hispanic origin (Understanding and using American Community Survey Data, 2020). Normalization may introduce some loss of information or precision in the dataset provided through the simplification or removal of data points through the normalization process. Normalization can improve data integrity and reduce redundancies, but it is important to acknowledge that it may also affect the statistical outputs, sample sizes (census tracts with data for a particular metric) and inferences drawn from ACS sample data.

3.8: One-Way ANOVA & the Tukey-Kramer Post-Hoc Test

The use of statistical analysis is crucial in estimating and understanding disparities among population groups. When comparing three or more independent groups to determine if there are significant differences in their means, one-way analysis of variance (ANOVA) is a widely used statistic test. Unlike a t-test, which compares only two groups at a time, ANOVA can evaluate multiple groups simultaneously, reducing the risk of Type 1 errors associated with multiple pairwise comparisons. ANOVA analysis has been extensively used to analyze both health outcomes and racial disparities (Ali, Endut, & Embong, 2017; Gottdeiener et al., 1997; Carroll et al., 2009). In this instance, a one-way ANOVA test will be used to compare similarly rural Native American, Hispanic, and White populations.

The null hypothesis (H_0) of a One-Way ANOVA states that all group mean outcomes are equal, meaning there is no significant difference between the groups. The alternative hypothesis (H_1) posits that at least one group mean outcome differs from the others. The test relies on calculating the F-statistic, which compares the variance

between group mean outcomes to the variance within the groups. A significant F-statistic indicates that at least one group mean outcome is significantly different from the others. If the F-statistic indicates that at least one group mean outcome is significantly different, then a post-hoc test will be applied to determine specific differences between groups.

The Tukey-Kramer Post-Hoc test will be applied to the racial groups when the one-way ANOVA test signals that any one group is significantly different to determine what specific group is different from the others. The Tukey-Kramer post-hoc test is used when sample sizes are unequal as is the case with this study when the sample size of RU3 can range from about 170 for White populations to about 30 for Native American populations. This test controls for Type I errors by adjusting for multiple comparisons and provides confidence intervals for the differences between group mean outcomes. Accounting for multiple comparisons reduces the likelihood of Type 1 errors.

One-Way ANOVA is a powerful statistical tool for comparing the means of three or more independent groups. The Tukey-Kramer Post-Hoc test is extremely useful in identifying what variable or variables are different from the others. In research on racial disparities, it helps determine whether differences exist in key variables across racial groups. By meeting its assumptions and following up with the Tukey-Kramer post-hoc test, this study will gain meaningful insight into what disparities exist between groups, even when controlling for rurality.

Chapter 4: Results

4.1: One-Way ANOVA Results

There are 27 health or SDOH metrics being considered with 4 rural-urban code groups intended to control for level of rurality. This means that each metric has 4 groups to apply statistical tests to, making 108 in total. A one-way ANOVA statistical test was applied to every group. Of the 108 statistic-RU code combinations, only 3 were found to not have any independent variable (racial group) whose mean was significantly different from the other (97.22%). The metrics considered were found to have at least one group mean outcome that was significantly different at RU0 in 27 of 27 (100%) cases, in 27 of 27 (100%) cases at RU1, in 25 of 27 (92.59) cases at RU2, and in 26 of 27 (96.30%) cases at RU3. This was in the case at RU2 owner and renter costs being greater than 50 percent of household income as well as RU3 for crude stroke prevalence. Every other metric at every other rurality level was found to have at least one group being statistically significantly different. This means that the Tukey-Kramer Post-Hoc test needed to be applied for the remaining 105 metric-RU code combinations.

Figure 8: Health and SDOH Domain Color Guide

			Mean Outcome	Standard Deviation	Sample Size
Population in the past 12 months is below poverty level	RU0	White	10.197	8.953	5954
		Hispanic	16.56	10.265	4375
		Native American	12.946	12.906	41
	RU1	White	8.712	7.673	1323
		Hispanic	15.199	11.176	520
		Native American	17.816	12.701	38
	RU2	White	12.337	8.33	566
		Hispanic	18.502	11.519	156
		Native American	32.093	12.874	28
	RU3	White	17.044	10.503	169
		Hispanic	23.673	15.081	44
		Native American	37.327	6.264	30
			Mean Outcome	Standard Deviation	Sample Size
Population in the past 12 months is under 50% poverty level	RU0	White	5.213	5.614	5954
		Hispanic	7.431	6.053	4375
		Native American	6.485	6.417	41
	RU1	White	4.321	4.5	1323
		Hispanic	6.326	5.803	520
		Native American	9.332	8.967	38
	RU2	White	5.755	4.864	566
		Hispanic	7.774	6.363	156
		Native American	17.241	10.758	28
	RU3	White	7.486	5.654	169
		Hispanic	10.978	14.295	44
		Native American	20.73	6.249	30
			Mean Outcome	Standard Deviation	Sample Size
Percent Unemployed	RU0	White	5.364	3.67	5959
		Hispanic	7.274	4.332	4370
		Native American	4.739	3.723	41
	RU1	White	5.073	4.098	1324
		Hispanic	7.357	4.833	515
		Native American	8.514	7.596	37
	RU2	White	6.246	5.786	566
		Hispanic	8.202	5.785	156
		Native American	12.893	4.801	29
	RU3	White	6.436	5.553	170
		Hispanic	8.575	11.116	44
		Native American	14.987	7.121	30

Table 3: Economic Stability Metrics Mean, Standard Deviation, and Sample Size

	RU Code	Demographic	Mean Outcome	Standard Deviation	Sample Size (Tracts)
Population 25+ Highest Education Completed is High School (includes equivalency)	RU0	White	92.515	10.03425	5967
		Hispanic	75.246	8.1	4380
		Native American	90.686	9.5455	41
	RU1	White	92.612	10.18725	1332
		Hispanic	77.43	8.36375	520
		Native American	85.486	9.5505	38
	RU2	White	89.892	9.26625	568
		Hispanic	79.69	8.75125	160
		Native American	78.728	5.748	29
	RU3	White	88.333	7.39375	170
		Hispanic	81.737	8.02675	44
		Native American	78.029	4.36675	30
	RU Code	Demographic	Mean Outcome	Standard Deviation	Sample Size (Tracts)
Population 25+ Highest Education Completed is Bachelors Degree or Higher	RU0	White	44.822	19.455	5967
		Hispanic	21.206	14.364	4380
		Native American	39.449	19.686	41
	RU1	White	39.538	18.838	1332
		Hispanic	20.201	13.384	520
		Native American	20.397	14.469	38
	RU2	White	27.422	14.92	568
		Hispanic	19.75	14.901	160
		Native American	9.059	6.329	29
	RU3	White	20.648	9.042	170
		Hispanic	17.082	10.933	44
		Native American	8.7	2.788	30

Table 4: Education Metrics Mean, Standard Deviation, and Sample Size

	RU Code	Demographic	Mean Outcome	Standard Deviation	Sample Size (Tracts)
Coronary heart disease prevalence	RU0	White	5.885	2.117	5966
		Hispanic	5.913	1.384	4379
		Native American	6.859	2.202	41
	RU1	White	6.741	2.241	1329
		Hispanic	6.646	1.756	516
		Native American	8.157	2.457	37
	RU2	White	8.141	2.263	566
		Hispanic	8.447	2.342	159
		Native American	10.793	1.807	29
	RU3	White	9.271	2.089	169
		Hispanic	9.421	2.084	43
		Native American	11.983	1.757	30

	RU Code	Demographic	Mean Outcome	Standard Deviation	Sample Size (Tracts)
Physical inactivity prevalence	RU0	White	19.367	5.537	5966
		Hispanic	28.617	6.854	4379
		Native American	22.622	6.809	41
	RU1	White	19.536	5.549	1329
		Hispanic	27.836	7.349	516
		Native American	28.254	6.346	37
	RU2	White	22.558	5.978	566
		Hispanic	28.606	6.558	159
		Native American	32.93	5.241	29
	RU3	White	25.624	5.796	169
		Hispanic	29.098	5.846	43
		Native American	24.743	3.317	30

	RU Code	Demographic	Mean Outcome	Standard Deviation	Sample Size (Tracts)
Obesity Crude Prevalance	RU0	White	27.742	5.395	5966
		Hispanic	32.512	5.829	4379
		Native American	32.088	4.776	41
	RU1	White	28.824	5.098	1329
		Hispanic	34.72	5.573	516
		Native American	36.178	4.873	37
	RU2	White	31.205	5.018	566
		Hispanic	35.028	5.265	159
		Native American	38.793	3.437	29
	RU3	White	33.044	4.553	169
		Hispanic	35.537	4.948	43
		Native American	41.393	2.356	30

	RU Code	Demographic	Mean Outcome	Standard Deviation	Sample Size (Tracts)
Frequent physical distress prevalence	RU0	White	12.194	2.803	5966
		Hispanic	15.822	3.408	4379
		Native American	13.488	4.038	41
	RU1	White	12.91	2.902	1329
		Hispanic	15.991	3.694	516
		Native American	17.57	4.341	37
	RU2	White	15.131	3.2	566
		Hispanic	17.555	3.606	159
		Native American	23.952	4.201	29
	RU3	White	16.883	3.726	169
		Hispanic	18.114	4.144	43
		Native American	26.077	2.963	30

	RU Code	Demographic	Mean Outcome	Standard Deviation	Sample Size (Tracts)
Stroke Crude Prevalance	RU0	White	3.037	1.025	5966
		Hispanic	3.484	0.88	4379
		Native American	3.524	1.299	41
	RU1	White	3.372	1.073	1329
		Hispanic	3.673	0.981	516
		Native American	4.722	1.59	37
	RU2	White	4.14	1.17	566
		Hispanic	4.569	1.336	159
		Native American	7.462	1.745	29
	RU3	White	1.472	4.6	169
		Hispanic	1.552	5	43
		Native American	1.345	8.6	30

	RU Code	Demographic	Mean Outcome	Standard Deviation	Sample Size (Tracts)
Fair or poor health prevalence	RU0	White	15.982	5.115	5966
		Hispanic	25.158	7.237	4379
		Native American	18.337	7.528	41
	RU1	White	16.409	5.103	1329
		Hispanic	24.403	7.662	516
		Native American	25.232	7.245	37
	RU2	White	19.769	5.945	566
		Hispanic	25.957	6.975	159
		Native American	34.424	6.939	29
	RU3	White	22.809	5.548	169
		Hispanic	26.233	7.145	43
		Native American	37.96	4.885	30

	RU Code	Demographic	Mean Outcome	Standard Deviation	Sample Size (Tracts)
Cancer (nonskin or melanoma) prevalence	RU0	White	8.203	2.991	5966
		Hispanic	5.437	1.637	4379
		Native American	9.061	3.667	41
	RU1	White	9.366	2.968	1329
		Hispanic	6.507	2.159	516
		Native American	7.551	2.846	37
	RU2	White	9.996	2.636	566
		Hispanic	8.089	2.903	159
		Native American	7.055	1.389	29
	RU3	White	10.08	2.186	169
		Hispanic	8.763	2.756	43
		Native American	7.01	0.762	30

Table 5: Health Metrics Mean, Standard Deviation, and Sample Size

	RU Code	Demographic	Mean Outcome	Standard Deviation	Sample Size (Tracts)
Lack of health insurance prevalence	RU0	White	8.516	4.405	5966
		Hispanic	17.458	7.202	4379
		Native American	10.746	6.551	41
	RU1	White	8.22	4.039	1329
		Hispanic	16.293	7.307	516
		Native American	13.586	5.724	37
	RU2	White	9.912	4.993	566
		Hispanic	15.743	6.677	159
		Native American	13.166	2.904	29
	RU3	White	11.39	4.204	169
		Hispanic	15.191	5.125	43
		Native American	14.527	2.808	30
	RU Code	**Demographic**	**Mean Outcome**	**Standard Deviation**	**Sample Size (Tracts)**
Routine checkup prevalence	RU0	White	71.177	4.267	5966
		Hispanic	68.87	2.963	4379
		Native American	72.427	5.011	41
	RU1	White	71.889	4.297	1329
		Hispanic	68.737	3.329	516
		Native American	69.003	4.33	37
	RU2	White	72.106	4.069	566
		Hispanic	70.031	4.756	159
		Native American	67.328	3.106	29
	RU3	White	72.102	3.371	169
		Hispanic	70.644	3.77	43
		Native American	68.263	1.836	30
	RU Code	**Demographic**	**Mean Outcome**	**Standard Deviation**	**Sample Size (Tracts)**
Transportation barriers prevalence	RU0	White	7.755	3.371	5102
		Hispanic	13.778	4.581	4261
		Native American	9.344	5.485	41
	RU1	White	7.459	3.147	1093
		Hispanic	12.792	4.929	492
		Native American	14.47	6.083	37
	RU2	White	9.02	3.901	427
		Hispanic	13.089	5.668	147
		Native American	23.164	7.108	28
	RU3	White	10.466	5.755	135
		Hispanic	13.568	7.151	37
		Native American	26.2	3.815	30

Table 6: Healthcare Access & Quality Metrics Mean, Standard Deviation, and Sample Size

			Mean Outcome	Standard Deviation	Sample Size
Renter Households: Rent Contract Rent + Utilities > 30.0% Household Income	RU0	White	47.146	16.308	5934
		Hispanic	53.326	13.891	4369
		Native American	41.288	17.089	41
	RU1	White	42.449	21.154	1302
		Hispanic	44.798	18.629	509
		Native American	33.716	2.767	37
	RU2	White	39.151	21.479	561
		Hispanic	33.437	18.851	155
		Native American	26.85	25.226	28
	RU3	White	29.604	15.567	166
		Hispanic	29.724	17.402	43
		Native American	15.007	11.198	29
			Mean Outcome	Standard Deviation	Sample Size
Owner Households: Monthly Owner Costs > 30.0% Household Income	RU0	White	32.348	13.86	5882
		Hispanic	40.002	16.561	4311
		Native American	28.163	11.171	41
	RU1	White	32.571	12.803	1310
		Hispanic	35.045	14.397	510
		Native American	28.37	16.796	37
	RU2	White	35.109	13.926	558
		Hispanic	33.526	17.862	152
		Native American	24.475	17.811	28
	RU3	White	32.179	16.464	164
		Hispanic	27.024	16.569	43
		Native American	31.537	27.492	29
			Mean Outcome	Standard Deviation	Sample Size
Renter Households: Rent Contract Rent + Utilities > 50.0% Household Income	RU0	White	23.241	13.428	5934
		Hispanic	27.345	11.996	4369
		Native American	19.815	11.148	41
	RU1	White	20.494	16.68	1302
		Hispanic	21.737	14.201	509
		Native American	15.248	14.058	37
	RU2	White	18.065	15.802	561
		Hispanic	17.735	15.384	155
		Native American	11.554	13.909	28
	RU3	White	14.704	10.821	166
		Hispanic	13.219	11.166	43
		Native American	7.322	5.56	29
			Mean Outcome	Standard Deviation	Sample Size
Owner Households: Monthly Owner Costs > 50.0% Household Income	RU0	White	13.601	10.358	5882
		Hispanic	17.467	13.289	4311
		Native American	12.888	9.416	41
	RU1	White	13.677	8.832	1310
		Hispanic	14.993	10.214	510
		Native American	9.932	10.08	37
	RU2	White	15.2	10.116	558
		Hispanic	16.032	13.754	152
		Native American	11.474	15.25	28
	RU3	White	14.119	10.421	164
		Hispanic	10.055	8.516	42
		Native American	17.002	23.353	30
			Mean Outcome	Standard Deviation	Sample Size
Broadband Internet Access	RU0	White	93.345	6.073	5952
		Hispanic	89.58	7.387	4368
		Native American	91.254	11.077	41
	RU1	White	93.01	6.197	1323
		Hispanic	88.347	8.624	513
		Native American	80.918	15.638	38
	RU2	White	87.769	8.323	566
		Hispanic	81.258	11.547	156
		Native American	51.372	18.291	29
	RU3	White	81.795	11.274	168
		Hispanic	74.888	14.848	43
		Native American	43.643	13.37	30

Table 7: Neighborhood & Built Environment Metrics Mean, Standard Deviation, and Sample Size

	RU Code	Demographic	Mean Outcome	Standard Deviation	Sample Size (Tracts)
Depression prevalence	RU0	White	22.253	3.126	5966
		Hispanic	21.798	2.287	4379
		Native American	21.107	2.093	41
	RU1	White	22.242	2.583	1329
		Hispanic	21.976	2.083	516
		Native American	22.657	2.436	37
	RU2	White	23.012	2.05	566
		Hispanic	22.46	2.055	159
		Native American	25.441	2.348	29
	RU3	White	23.268	2.224	169
		Hispanic	22.453	2.947	43
		Native American	25.71	1.328	30
Frequent mental distress prevalence	RU Code	Demographic	Mean Outcome	Standard Deviation	Sample Size (Tracts)
	RU0	White	15.958	3.251	5966
		Hispanic	18.736	2.898	4379
		Native American	16.785	4.106	41
	RU1	White	15.68	2.903	1334
		Hispanic	18.28	2.866	516
		Native American	20.216	4.06	37
	RU2	White	16.683	2.696	566
		Hispanic	18.332	3.377	159
		Native American	25.872	4.339	29
	RU3	White	17.725	3.472	169
		Hispanic	18.302	4.497	43
		Native American	27.64	2.361	30
Food insecurity prevalence	RU Code	Demographic	Mean Outcome	Standard Deviation	Sample Size (Tracts)
	RU0	White	11.972	6.233	5102
		Hispanic	24.95	9.91	4261
		Native American	14.673	10.746	41
	RU1	White	11.592	5.928	1093
		Hispanic	22.927	10.056	492
		Native American	24.686	11.084	37
	RU2	White	14.812	7.436	427
		Hispanic	23.563	10.626	147
		Native American	39.1	12.082	28
	RU3	White	17.339	9.671	135
		Hispanic	24.416	11.999	37
		Native American	43.27	5.954	30
Housing insecurity prevalence	RU Code	Demographic	Mean Outcome	Standard Deviation	Sample Size (Tracts)
	RU0	White	11.164	4.694	5966
		Hispanic	21.15	7.118	4261
		Native American	12.719	7.71	41
	RU1	White	10.668	4.46	1329
		Hispanic	19.157	8.864	492
		Native American	19.481	6.941	37
	RU2	White	12.62	5.357	427
		Hispanic	18.817	7.354	147
		Native American	27.093	6.924	28
	RU3	White	13.929	6.203	135
		Hispanic	18.603	7.56	37
		Native American	29.38	3.401	30
Utilities services threat prevalence	RU Code	Demographic	Mean Outcome	Standard Deviation	Sample Size (Tracts)
	RU0	White	6.189	2.862	5102
		Hispanic	10.78	4.187	4261
		Native American	7.827	4.935	41
	RU1	White	6.04	2.674	1093
		Hispanic	10.243	4.147	492
		Native American	12.868	5.475	37
	RU2	White	7.517	3.296	427
		Hispanic	11.069	5	147
		Native American	20.55	6.434	28
	RU3	White	9.07	5.005	135
		Hispanic	12.241	6.425	37
		Native American	22.26	3.019	30
Social isolation prevalence	RU Code	Demographic	Mean Outcome	Standard Deviation	Sample Size (Tracts)
	RU0	White	33.761	3.384	5102
		Hispanic	37.529	2.943	4261
		Native American	34.046	4.481	41
	RU1	White	33.221	3.276	1093
		Hispanic	37.373	3.111	492
		Native American	39.173	4.34	37
	RU2	White	33.848	3.46	427
		Hispanic	37.628	3.987	147
		Native American	43.546	4.972	28
	RU3	White	34.183	3.688	135
		Hispanic	38.349	4.432	37
		Native American	42.013	2.789	30
Citizen population aged 18 or older who voted in the 2020 U.S. Presidential election	RU Code	Demographic	Mean Outcome	Standard Deviation	Sample Size (Tracts)
	RU0	White	70.306	6.066	5997
		Hispanic	66.451	4.921	4392
		Native American	66.42	5.061	41
	RU1	White	70.769	8.46	1344
		Hispanic	62.726	6.904	527
		Native American	61.469	7.39	39
	RU2	White	69.222	9.82	570
		Hispanic	61.705	7.802	163
		Native American	59.251	7.81	29
	RU3	White	68.605	10.005	176
		Hispanic	62.93	10.154	44
		Native American	63.108	6.595	30

Table 8: Social & Community Context Metrics Mean, Standard Deviation, and Sample Size

Metric		RU0	RU1	RU2	RU3
Population in the past 12 months is below poverty level (%)	F-Statistic	635.8174	92.4121	88.2831	44.7453
	P-Value	0	0	0	0
	Significant? (P <.05)	TRUE	TRUE	TRUE	TRUE
Population in the past 12 months is under 50% poverty level (%)	F-Statistic	226.293	31.4756	82.3469	33.2973
	P-Value	0	0	0	0
	Significant? (P <.05)	TRUE	TRUE	TRUE	TRUE
Population Unemployment (%)	F-Statistic	351.5796	47.4235	24.9077	20.0692
	P-Value	0	0	0	0
	Significant? (P <.05)	TRUE	TRUE	TRUE	TRUE
Population 25+ Highest Education Completed is High School (includes equivalency) (%)	F-Statistic	4250.325	481.2495	102.4295	28.9996
	P-Value	0	0	0	0
	Significant? (P <.05)	TRUE	TRUE	TRUE	TRUE
Population 25+ Highest Education Completed is Bachelors Degree or Higher (%)	F-Statistic	2200.048	253.4421	40.1422	21.4602
	P-Value	0	0	0	0
	Significant? (P <.05)	TRUE	TRUE	TRUE	TRUE
Coronary Heart Disease prevalence (%)	F-Statistic	7.3908	6.0081	20.3181	27.5697
	P-Value	0.0006	0.0025	0	0
	Significant? (P <.05)	TRUE	TRUE	TRUE	TRUE
Obesity Crude Prevalence (%)	F-Statistic	1020.026	234.0827	56.7607	51.5247
	P-Value	0	0	0	0
	Significant? (P <.05)	TRUE	TRUE	TRUE	TRUE
Stroke Crude Prevalance (%)	F-Statistic	314.0027	28.7133	111.5256	0.8652
	P-Value	0	0	0	0.4223
	Significant? (P <.05)	TRUE	TRUE	TRUE	FALSE
Cancer (nonskin or melanoma) prevalence (%)	F-Statistic	1463.258	212.1648	49.9964	23.4987
	P-Value	0	0	0	0
	Significant? (P <.05)	TRUE	TRUE	TRUE	TRUE
Physical inactivity prevalence (%)	F-Statistic	3061.777	330.6191	87.05	9.3796
	P-Value	0	0	0	0.0001
	Significant? (P <.05)	TRUE	TRUE	TRUE	TRUE
Frequent physical distress prevalence (%)	F-Statistic	1894.388	175.0465	122.3635	83.3583
	P-Value	0	0	0	0
	Significant? (P <.05)	TRUE	TRUE	TRUE	TRUE
Fair or poor health prevalence (%)	F-Statistic	3049.198	321.1583	123.5775	91.9002
	P-Value	0	0	0	0
	Significant? (P <.05)	TRUE	TRUE	TRUE	TRUE
Lack of health insurance prevalence (%)	F-Statistic	3267.468	417.9	66.1799	21.6957
	P-Value	0	0	0	0
	Significant? (P <.05)	TRUE	TRUE	TRUE	TRUE
Routine checkup prevalence (%)	F-Statistic	431.1776	127.6061	33.2453	14.8171
	P-Value	0	0	0	0
	Significant? (P <.05)	TRUE	TRUE	TRUE	TRUE

Table 9: One-Way ANOVA Results

Metric		RU0	RU1	RU2	RU3
Transportation barriers prevalence (%)	F-Statistic	2792.684	303.3495	178.2791	101.0329
	P-Value	0	0	0	0
	Significant? (P <.05)	TRUE	TRUE	TRUE	TRUE
Renter Households: Rent Contract Rent + Utilities > 30.0% Household Income (%)	F-Statistic	250.6606	6.1941	8.7094	8.8306
	P-Value	0	0.0021	0.0002	0.0002
	Significant? (P <.05)	TRUE	TRUE	TRUE	TRUE
Owner Households: Monthly Owner Costs > 30.0% Household Income (%)	F-Statistic	375.7142	10.0055	5.1684	3.2692
	P-Value	0	0	0.0059	0.0398
	Significant? (P <.05)	TRUE	TRUE	TRUE	TRUE
Renter Households: Rent Contract Rent + Utilities > 50.0% Household Income (%)	F-Statistic	164.9502	5.1977	1.485	4.9815
	P-Value	0	0.0056	0.2272	0.0076
	Significant? (P <.05)	TRUE	TRUE	FALSE	TRUE
Owner Households: Monthly Owner Costs > 50.0% Household Income (%)	F-Statistic	171.0925	8.9556	0.1324	7.4539
	P-Value	0	0.0001	0.876	0.0007
	Significant? (P <.05)	TRUE	TRUE	FALSE	TRUE
Broadband Internet Access (%)	F-Statistic	342.483	134.6906	197.1825	95.2029
	P-Value	0	0	0	0
	Significant? (P <.05)	TRUE	TRUE	TRUE	TRUE
Depression prevalence (%)	F-Statistic	24.3375	3.7328	31.7505	18.1937
	P-Value	0	0.0241	0	0
	Significant? (P <.05)	TRUE	TRUE	TRUE	TRUE
Frequent mental distress prevalence (%)	F-Statistic	1093.303	163.9006	155.9714	98.4788
	P-Value	0	0	0	0
	Significant? (P <.05)	TRUE	TRUE	TRUE	TRUE
Food insecurity prevalence (%)	F-Statistic	3107.399	351.677	168.6436	98.8353
	P-Value	0	0	0	0
	Significant? (P <.05)	TRUE	TRUE	TRUE	TRUE
Housing insecurity prevalence (%)	F-Statistic	3898.211	337.4296	138.4881	87.804
	P-Value	0	0	0	0
	Significant? (P <.05)	TRUE	TRUE	TRUE	TRUE
Utilities services threat prevalence (%)	F-Statistic	2068.512	275.7587	198.4857	94.1812
	P-Value	0	0	0	0
	Significant? (P <.05)	TRUE	TRUE	TRUE	TRUE
Social isolation prevalence (%)	F-Statistic	1685.897	270.6267	149.895	66.9508
	P-Value	0	0	0	0
	Significant? (P <.05)	TRUE	TRUE	TRUE	TRUE
Citizen population aged 18 or older who voted in the 2020 U.S. Presidential election (%)	F-Statistic	544.7676	217.8107	61.4415	5.2467
	P-Value	0	0	0	0.0059
	Significant? (P <.05)	TRUE	TRUE	TRUE	TRUE

Table 10: One-Way ANOVA Results (Cont.)

4.2: Tukey-Kramer Post-Hoc Test Results

At RU0 (urban), Native Americans were statistically found to be significantly different from White people in 12 of 27 (44.44%) metrics while being significantly different from Hispanics in 20 of 27 (74.07%) metrics that were determined have at least one group mean outcome significantly differing in the one-way ANOVA test. At RU1 (fringe rural), Native Americans were statistically found to be significantly different from White people in 26 of 27 (96.30%) metrics while being significantly different from Hispanics in 13 of 27 (48.15%) metrics that were determined have at least one group mean outcome significantly differing in the one-way ANOVA test. At RU2 (distant rural), Native Americans were statistically found to be significantly different from White people in 24 of 27 (88.89%) metrics while being significantly different from Hispanics in 20 of 27 (74.07%) metrics that were determined have at least one group mean outcome significantly differing in the one-way ANOVA test. At RU3 (remote rural), Native Americans were statistically found to be significantly different from White people in 24 of 27 (88.89%) metrics while being significantly different from Hispanics in 22 of 27 (81.48%) metrics that were determined have at least one group mean outcome significantly differing in the one-way ANOVA test.

4.3: Native American Comparison While Controlling for Rurality

While Native Americans differ from White and Hispanic populations in most health and SDOH metrics at all levels of rurality, differing does not necessarily mean worse. Depending on the metric, a lower number could be an indicator of more positive outcomes (e.g., social isolation prevalence) or more negative outcomes (e.g., broadband internet access). Interpreting the metric as well as the signage (+ or -) of the absolute mean difference given in the Tukey-Kramer Post-Hoc test will provide insight on if Native Americans are performing better or worse than Hispanic or White populations for a given health or SDOH metric. Tables 11-14 provide a visualization of how Native Americans compare to White and Hispanic combination after interpreting what was being measured and the signage of the absolute mean difference. 'F' signifies that the Native Americans and the other population group do not have significant differences in means for a particular metric at a particular level of rurality. 'T (+)' signifies that a significant difference in means was found, and that Native Americans were measured as having better outcomes on average for a particular metric at a particular rurality. 'T (-)' indicates that a significant difference in means was found, and that Native Americans were measured as having worse outcomes on average for a particular metric at a particular rurality.

At RU0, Native Americans were statistically found to have worse outcomes in 10 of 27 (37.04%) metrics in comparison to White people and in 2 of 27 (7.41%) metrics. In a breakdown by health outcome or SDOH metrics, Native Americans were statistically found to have worse outcomes than White people in 0 of 3 (0%) economic factors, 2 of 2 (100%) educational factors, 5 of 7 (71.43%) health outcomes, 1 of 3 (33.33%)

healthcare factors, 0 of 5 (0%) neighborhood factors, and 3 of 7 (42.86%) social and community factors.

At RU0, Native Americans were statistically found to have worse outcomes in 2 of 27 (7.41%) metrics in comparison to Hispanic people. Broken down by health or SDOH metric, Native Americans were statistically found to have worse outcomes than Hispanic people in 0 of 3 (0%) economic factors, 0 of 2 (0%) educational factors, 2 of 7 (28.57%) health outcomes, 0 of 3 (0%) healthcare factors, 0 of 5 (0%) neighborhood factors, and 0 of 7 (0%) social and community factors. Statistically significant worse outcomes were only found in rates of coronary heart disease and cancer. Contrary to the trend found at other rurality levels in this study, Hispanic people were found to have worse outcomes than Native Americans in far more metrics (18 of 27) than Native Americans were found to have in comparison to Hispanics (2 of 27). On average, Hispanic people performed worse in the following metrics: rates of high school diploma attainment (or equivalent), rates of bachelor degree attainment, rates of poverty, unemployment, physical inactivity, frequent physical distress, self-reported fair or poor health, lack of health insurance, routine checkups, transportation barriers, renter and homeowner housing burdens (30% household income), extreme renter housing burden (50%) household income, frequent mental distress, food insecurity, utilities service being threatened, and social isolation.

At RU1, Native Americans were statistically found to have worse outcomes in 21 of 27 (77.78%) metrics in comparison to White people. In a breakdown by health outcome or SDOH metric, Native Americans were statistically found to have worse outcomes than White people in 3 of 3 (110%) economic factors, 2 of 2 (100%)

educational factors, 6 of 7 (85.71%) health outcomes, 3 of 3 (100%) healthcare factors, 1 of 5 (20%) neighborhood factors, and 6 of 7 (85.71%) social and community factors. Native Americans were statistically found to have worse outcomes on average in the following metrics: rates of poverty, extreme poverty, unemployment, high school diploma attainment (or equivalent), bachelor degree attainment, coronary heart disease, obesity, stroke, physical inactivity, frequent physical distress, fair or poor self-reported health, lack of health insurance, routine checkups, transportation barriers, broadband internet access, frequent mental distress, food insecurity, housing insecurity, utility service threats, social isolation, and voting rates. Native Americans were only found to have statistically significant better outcomes on average in fringe rural settings compared to White populations in rates of cancer, and rent/mortgages burden rates at both 30 and 50%.

At RU1, Native Americans were statistically found to have worse outcomes in 7 of 27 (25.93%) metrics in comparison to Hispanic people. Broken down by health or SDOH metric, Native Americans were statistically found to have worse outcomes than Hispanic people in 1 of 3 (33.33%) economic factors, 1 of 2 (50%) educational factors, 2 of 7 (28.57%) health outcomes, 0 of 3 (0%) healthcare factors, 1 of 5 (20%) neighborhood factors, and 3 of 7 (42.86%) social and community factors. At fringe rurality, Native Americans were statistically found to do worse in 7 metrics while Hispanics were found to do worse in 6 metrics while performing about the same in the remaining 14 metrics. Native Americans were statistically found to have worse outcomes on average in the following metrics: rates of extreme poverty, coronary heart disease, stroke, broadband internet access, frequent mental distress, utility service

threats, and social isolation. On the other hand, Hispanic people were statistically found to have worse outcomes on average in the following metrics: rates of high school diploma attainment (or equivalent), lack of health insurance, renter and homeowner housing burden (30% household income), and renter and homeowner extreme housing burden (50% household income).

At RU2, Native Americans were statistically found to have worse outcomes in 22 of 27 (81.48%) metrics in comparison to White people. In a breakdown by health outcome or SDOH metric, Native Americans were statistically found to have worse outcomes than White people in 3 of 3 (100%) economic factors, 2 of 2 (100%) educational factors, 6 of 7 (85.71%) health outcomes, 3 of 3 (100%) healthcare factors, 1 of 5 (20%) neighborhood factors, and 7 of 7 (100%) social and community factors. Native Americans were statistically found to have worse outcomes on average in the following metrics: rates of poverty, extreme poverty, unemployment, high school diploma attainment (or equivalent), bachelor degree attainment, coronary heart disease, obesity, stroke, physical inactivity, frequent physical distress, fair or poor self-reported health, lack of health insurance, routine checkups, transportation barriers, broadband internet access, depression, frequent mental distress, food insecurity, housing insecurity, utility service threats, social isolation, and voting rates. Native Americans were only found to have statistically significant better outcomes on average in distant rural settings compared to White populations in rates of cancer and homeowner cost burden in excess of 30% household income.

At RU2, Native Americans were statistically found to have worse outcomes in 19 of 27 (70.37%) metrics in comparison to Hispanic people. Broken down by health or

SDOH metric, Native Americans were statistically found to have worse outcomes than Hispanic people in 3 of 3 (100%) economic factors, 2 of 2 (100%) educational factors, 6 of 7 (85.71%) health outcomes, 2 of 3 (66.67%) healthcare factors, 1 of 5 (20%) neighborhood factors, and 6 of 7 (85.71%) social and community factors. At distant rurality, Native Americans were statistically found to do about the same or worse for every metric. Native Americans were statistically found to have worse outcomes on average in the following metrics: rates of poverty, extreme poverty, unemployment, bachelor degree attainment, coronary heart disease, obesity, stroke, physical inactivity, frequent physical distress, fair or poor self-reported health, routine checkups, transportation barriers, broadband internet access, depression, frequent mental distress, food insecurity, housing insecurity, utility service threats, and social isolation. Similar outcomes only were found in voting rates, renter and homeowner cost burdens, and rates of high school diploma attainment (or equivalent).

At RU3, Native Americans were statistically found to have worse outcomes in 21 of 27 (77.78%). In a breakdown by health outcome or SDOH metric, Native Americans were statistically found to have worse outcomes than White people in 3 of 3 (100%) economic factors, 2 of 2 (100%) educational factors, 4 of 7 (57.14%) health outcomes, 3 of 3 (100%) healthcare factors, 2 of 5 (40%) neighborhood factors, and 7 of 7 (100%) social and community factors. Native Americans were statistically found to have worse outcomes on average in the following metrics: rates of poverty, extreme poverty, unemployment, high school diploma attainment (or equivalent), bachelor degree attainment, coronary heart disease, obesity, frequent physical distress, fair or poor self-reported health, lack of health insurance, routine checkups, transportation barriers,

extreme owner housing burden (50% household income), broadband internet access, depression, frequent mental distress, food insecurity, housing insecurity, utility service threats, social isolation, and voting rates. Native Americans were only found to have statistically significant better outcomes on average in remote rural settings compared to White populations in rates of cancer, renter cost burden in excess of 30% and 50% household income.

At RU3, Native Americans were statistically found to have worse outcomes in 19 of 27 (70.37%) metrics in comparison to Hispanic people. Broken down by health or SDOH metric, Native Americans were statistically found to have worse outcomes than Hispanic people in 3 of 3 (100%) economic factors, 2 of 2 (100%) educational factors, 4 of 7 (57.14%) health outcomes, 2 of 3 (66.67%) healthcare factors, 2 of 5 (40%) neighborhood factors, and 6 of 7 (85.71%) social and community factors. Native Americans were statistically found to have worse outcomes on average in the following metrics: rates of poverty, extreme poverty, unemployment, high school diploma attainment (or equivalent), bachelor degree attainment, coronary heart disease, obesity, stroke, physical inactivity, frequent physical distress, fair or poor self-reported health, routine checkups, transportation barriers, broadband internet access, depression, frequent mental distress, food insecurity, housing insecurity, utility service threats, and social isolation. At distant rurality, Native Americans were statistically found to do about the same or worse for every metric. Similar outcomes only were found in voting rates, renter and homeowner cost burdens, and rates of high school or equivalent educational attainment.

Health Outcome and SDOH comparison (Native American ≠ White?) Including ±					
Health/SDOH Domain	Metric	RU0	RU1	RU2	RU3
Economic Stability	Percent of Population whose income in the past 12 months is below poverty level	F	T (-)	T (-)	T (-)
Economic Stability	Percent of population whose income in the past 12 months is under .50x (under 50% of) the federal poverty level	F	T (-)	T (-)	T (-)
Economic Stability	Percent Unemployed	F	T (-)	T (-)	T (-)
Education	Percent of Population 25 Years and Over whose Highest Education Completed is High School includes equivalency	F	T (-)	T (-)	T (-)
Education	Percent of Population 25 Years and Over whose Highest Education Completed is Bachelors Degree or Higher	T (-)	T (-)	T (-)	T (-)
Health	Coronary heart disease crude prevalence	T (-)	T (-)	T (-)	T (-)
Health	Obesity Crude Prevalence	T (-)	T (-)	T (-)	T (-)
Health	Stroke Crude Prevalance	T (-)	T (-)	T (-)	F
Health	Cancer nonskin or melanoma crude prevalence	F	T (+)	T (+)	T (+)
Health	Physical inactivity crude prevalence	T (-)	T (-)	T (-)	F
Health	Frequent physical distress crude prevalence	T (-)	T (-)	T (-)	T (-)
Health	Fair or poor health crude prevalence	F	T (-)	T (-)	T (-)
Healthcare Access & Quality	Lack of health insurance crude prevalence	F	T (-)	T (-)	T (-)
Healthcare Access & Quality	Routine checkup crude prevalence	F	T (-)	T (-)	T (-)
Healthcare Access & Quality	Transportation barriers crude prevalence	T (-)	T (-)	T (-)	T (-)
Neighborhood & Built Environment	Percent of Renter Households for whom Gross Rent Contract Rent Plus TenantPaid Utilities is 30.0 Percent or More of Household Income	T (+)	T (+)	F	T (+)
Neighborhood & Built Environment	Percent of Owner Households with Mortgages whose Monthly Owner Costs are 30.0 Percent or More of Household Income	F	T (+)	T (+)	F
Neighborhood & Built Environment	Renter Households for whom Gross Rent Contract Rent Plus TenantPaid Utilities is 50.0 Percent or More of Household Income	F	T (+)	F	T (+)
Neighborhood & Built Environment	Owner Households with a Mortgage whose Monthly Owner Costs are 50.0 Percent or More of Household Income	F	T (+)	F	T (-)
Neighborhood & Built Environment	Broadband Internet Access	F	T (-)	T (-)	T (-)
Social & Community Context	Depression crude prevalence	T (+)	F	T (-)	T (-)
Social & Community Context	Frequent mental distress crude prevalence	F	T (-)	T (-)	T (-)
Social & Community Context	Food insecurity crude prevalence	F	T (-)	T (-)	T (-)
Social & Community Context	Housing insecurity crude prevalence	T (-)	T (-)	T (-)	T (-)
Social & Community Context	Utilities services threat crude prevalence	T (-)	T (-)	T (-)	T (-)
Social & Community Context	Social isolation crude prevalence	F	T (-)	T (-)	T (-)
Social & Community Context	Percentage of citizen population aged 18 or older who voted in the 2020 U.S. Presidential election	T (-)	T (-)	T (-)	T (-)
	Total	37.03703704	77.77778	81.48148148	77.77778
	Economic	0	100	100	100
	Education	50	100	100	100
	Health	71.42857143	85.71429	85.71428571	57.14286
	Healthcare	33.33333333	100	100	100
	Neighborhood&Built	0	20	20	40
	SocComCon	42.85714286	85.71429	100	100

Table 11: Native American VS White Mean Outcomes (Tukey-Kramer ±)

Health Outcome and SDOH comparison (Native American ≠ Hispanic?) Including ±					
Health/SDOH Domain	**Metric**	**RU0**	**RU1**	**RU2**	**RU3**
Economic Stability	Percent of Population whose income in the past 12 months is below poverty level	T (+)	F	T (-)	T (-)
Economic Stability	Percent of population whose income in the past 12 months is under .50x (under 50% of) the federal poverty level	F	T (-)	T (-)	T (-)
Economic Stability	Percent Unemployed	T (+)	F	T (-)	T (-)
Education	Percent of Population 25 Years and Over whose Highest Education Completed is High School includes equivalency	T (+)	T (+)	F	T (-)
Education	Percent of Population 25 Years and Over whose Highest Education Completed is Bachelors Degree or Higher	T (+)	F	T (-)	T (-)
Health	Coronary heart disease crude prevalence	T (-)	T (-)	T (-)	T (-)
Health	Obesity Crude Prevalence	F	F	T (-)	T (-)
Health	Stroke Crude Prevalance	F	T (-)	T (-)	F
Health	Cancer nonskin or melanoma crude prevalence	T (-)	F	F	T (+)
Health	Physical inactivity crude prevalence	T (+)	F	T (-)	T (+)
Health	Frequent physical distress crude prevalence	T (+)	F	T (-)	T (-)
Health	Fair or poor health crude prevalence	T (+)	F	T (-)	T (-)
Healthcare Access & Quality	Lack of health insurance crude prevalence	T (+)	T (+)	F	F
Healthcare Access & Quality	Routine checkup crude prevalence	T (+)	F	T (-)	T (-)
Healthcare Access & Quality	Transportation barriers crude prevalence	T (+)	F	T (-)	T (-)
Neighborhood & Built Environment	Percent of Renter Households for whom Gross Rent Contract Rent Plus TenantPaid Utilities is 30.0 Percent or More of Household Income	T (+)	T (+)	F	T (+)
Neighborhood & Built Environment	Percent of Owner Households with Mortgages whose Monthly Owner Costs are 30.0 Percent or More of Household Income	T (+)	T (+)	F	T (+)
Neighborhood & Built Environment	Renter Households for whom Gross Rent Contract Rent Plus TenantPaid Utilities is 50.0 Percent or More of Household Income	T (+)	T (+)	F	F
Neighborhood & Built Environment	Owner Households with a Mortgage whose Monthly Owner Costs are 50.0 Percent or More of Household Income	F	T (+)	F	T (-)
Neighborhood & Built Environment	Broadband Internet Access	F	T (-)	T (-)	T (-)
Social & Community Context	Depression crude prevalence	F	F	T (-)	T (-)
Social & Community Context	Frequent mental distress crude prevalence	T (+)	T (-)	T (-)	T (-)
Social & Community Context	Food insecurity crude prevalence	T (+)	F	T (-)	T (-)
Social & Community Context	Housing insecurity crude prevalence	T (+)	F	T (-)	T (-)
Social & Community Context	Utilities services threat crude prevalence	T (+)	T (-)	T (-)	T (-)
Social & Community Context	Social isolation crude prevalence	T (+)	T (-)	T (-)	T (-)
Social & Community Context	Percentage of citizen population aged 18 or older who voted in the 2020 U.S. Presidential election	F	F	F	F
	Total	7.407407	25.92593	70.37037	70.37037
	Economic	0	33.33333	100	100
	Education	0	0	50	100
	Health	28.57143	28.57143	85.71429	57.14286
	Healthcare	0	0	66.66667	66.66667
	Neighborhood&Built	0	20	20	40
	SocComCon	0	42.85714	85.71429	85.71429

Table 12: Native American VS Hispanic Mean Outcomes (Tukey-Kramer ±)

		Tukey-Kramer Post-Hoc Test					
	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
RU0	Native American	White	-2.5908	0.1911	-6.0851	0.9035	FALSE
	Hispanic	Native American	-4.164	0.0146	-7.6627	-0.6654	TRUE
	Hispanic	White	-6.7548	0	-7.1988	-6.3108	TRUE
RU1	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
	Native American	White	-7.6507	0	-11.0855	-4.216	TRUE
	Hispanic	Native American	1.6783	0.5005	-1.8297	5.1863	FALSE
	Hispanic	White	-5.9724	0	-7.0529	-4.8919	TRUE
RU2	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
	Native American	White	-21.7921	0	-25.9801	-17.6041	TRUE
	Hispanic	Native American	16.4395	0	11.9997	20.8793	TRUE
	Hispanic	White	-5.3526	0	-7.3087	-3.3965	TRUE
RU3	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
	Native American	White	-20.9753	0	-26.4642	-15.4863	TRUE
	Hispanic	Native American	12.1836	0.0001	5.6237	18.7436	TRUE
	Hispanic	White	-8.7916	0	-13.4807	-4.1025	TRUE

Population in the past 12 months is below poverty level

		Tukey-Kramer Post-Hoc Test					
	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
RU0	Native American	White	-1.1992	0.3825	-3.3244	0.9259	FALSE
	Hispanic	Native American	-1.2515	0.3521	-3.3793	0.8763	FALSE
	Hispanic	White	-2.4507	0	-2.7208	-2.1807	TRUE
RU1	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
	Native American	White	-3.9701	0	-5.9087	-2.0316	TRUE
	Hispanic	Native American	2.224	0.0231	0.2441	4.2039	TRUE
	Hispanic	White	-1.7462	0	-2.356	-1.1363	TRUE
RU2	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
	Native American	White	-13.2501	0	-15.7027	-10.7975	TRUE
	Hispanic	Native American	11.6877	0	9.0876	14.2878	TRUE
	Hispanic	White	-1.5624	0.004	-2.708	-0.4168	TRUE
RU3	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
	Native American	White	-14.172	0	-18.4521	-9.8918	TRUE
	Hispanic	Native American	8.4184	0.0004	3.3032	13.5336	TRUE
	Hispanic	White	-5.7536	0.0007	-9.41	-2.0972	TRUE

Population in the past 12 months is under 50% poverty level

		Tukey-Kramer Post-Hoc Test					
	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
RU0	Native American	White	0.6656	0.5285	-0.7833	2.1145	FALSE
	Hispanic	Native American	-2.7394	0	-4.19	-1.2887	TRUE
	Hispanic	White	-2.0738	0	-2.2579	-1.8896	TRUE
RU1	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
	Native American	White	-3.1003	0.0001	-4.8235	-1.3772	TRUE
	Hispanic	Native American	1.0147	0.3662	-0.7448	2.7743	FALSE
	Hispanic	White	-2.0856	0	-2.6225	-1.5487	TRUE
RU2	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
	Native American	White	-7.3214	0	-9.887	-4.7557	TRUE
	Hispanic	Native American	5.8213	0	3.0962	8.5463	TRUE
	Hispanic	White	-1.5001	0.011	-2.7187	-0.2816	TRUE
RU3	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
	Native American	White	-9.3547	0	-13.0013	-5.7081	TRUE
	Hispanic	Native American	5.5056	0.0089	1.1456	9.8656	TRUE
	Hispanic	White	-3.8491	0.0108	-6.9638	-0.7344	TRUE

Percent Unemployed

		Tukey-Kramer Post-Hoc Test					
	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
RU0	Native American	White	2.5939	0.1731	-0.8034	5.9913	FALSE
	Hispanic	Native American	14.363	0	10.9614	17.7646	TRUE
	Hispanic	White	16.9569	0	16.5256	17.3883	TRUE
RU1	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
	Native American	White	6.3777	0.0002	2.621	10.1345	TRUE
	Hispanic	Native American	9.2273	0	5.3901	13.0646	TRUE
	Hispanic	White	15.6051	0	14.4243	16.7858	TRUE
RU2	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
	Native American	White	11.8778	0	7.8372	15.9184	TRUE
	Hispanic	Native American	-1.2128	0.7839	-5.4964	3.0707	FALSE
	Hispanic	White	10.6649	0	8.7653	12.5645	TRUE
RU3	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
	Native American	White	10.0048	0	6.5704	13.4391	TRUE
	Hispanic	Native American	-4.4793	0.0287	-8.5856	-0.3731	TRUE
	Hispanic	White	5.5254	0	2.592	8.4588	TRUE

Population 25+ Highest Education Completed is High School (includes equivalency)

		Tukey-Kramer Post-Hoc Test					
	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
RU0	Native American	White	6.9557	0.0298	0.5382	13.3732	TRUE
	Hispanic	Native American	16.1001	0	9.6746	22.5255	TRUE
	Hispanic	White	23.0557	0	22.2409	23.8706	TRUE
RU1	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
	Native American	White	17.9554	0	11.2095	24.7014	TRUE
	Hispanic	Native American	2.0199	0.7708	-4.8706	8.9104	FALSE
	Hispanic	White	19.9753	0	17.8551	22.0956	TRUE
RU2	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
	Native American	White	19.2891	0	12.7151	25.8631	TRUE
	Hispanic	Native American	-10.8544	0.0008	-17.8236	-3.8851	TRUE
	Hispanic	White	8.4347	0	5.3441	11.5254	TRUE
RU3	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
	Native American	White	11.9667	0	7.6576	16.2758	TRUE
	Hispanic	Native American	-9.9088	0	-15.061	-4.7567	TRUE
	Hispanic	White	2.0579	0.3862	-1.6227	5.7384	FALSE

Population 25+ Highest Education Completed is Bachelors Degree or Higher

Table 13: Tukey-Kramer Post-Hoc Test Results Breakdown (Economic Stability + Education)

		Tukey-Kramer Post-Hoc Test					
		Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
Coronary heart disease prevalence	RU0	Native American	White	-0.9311	0.0036	-1.6084	-0.2538	TRUE
		Hispanic	Native American	0.8479	0.0095	0.1698	1.5261	TRUE
		Hispanic	White	-0.0832	0.0605	-0.1692	0.0028	FALSE
	RU1	Native American	White	-1.0698	0.0074	-1.903	-0.2365	TRUE
		Hispanic	Native American	1.2299	0.0021	0.379	2.0808	TRUE
		Hispanic	White	1.2299	0.3163	-0.0992	0.4195	FALSE
	RU2	Native American	White	-2.7422	0	-3.7525	-1.7319	TRUE
		Hispanic	Native American	2.5901	0	1.5187	3.6616	TRUE
		Hispanic	White	-0.1521	0.7339	-0.6283	0.3242	FALSE
	RU3	Native American	White	-2.9512	0	-3.8897	-2.0128	TRUE
		Hispanic	Native American	2.6101	0	1.4737	3.7466	TRUE
		Hispanic	White	-0.3411	0.5981	-1.1725	0.4903	FALSE
Obesity Crude Prevalence	RU0	Native American	White	-4.2565	0	-6.2978	-2.2152	TRUE
		Hispanic	Native American	-0.7307	0.6794	-6.2978	1.3131	FALSE
		Hispanic	White	-4.9872	0	-5.2464	-4.7279	TRUE
	RU1	Native American	White	-6.678	0	-8.7249	-4.6311	TRUE
		Hispanic	Native American	1.0215	0.4856	-1.0686	3.1117	FALSE
		Hispanic	White	-5.6564	0	-6.2934	-5.0194	TRUE
	RU2	Native American	White	-7.7382	0	-9.982	-5.4944	TRUE
		Hispanic	Native American	4.2592	0.0001	1.8795	6.6389	TRUE
		Hispanic	White	-3.479	0	-4.5368	-2.4212	TRUE
	RU3	Native American	White	-8.5836	0	-10.6228	-6.5444	TRUE
		Hispanic	Native American	5.6168	0	3.1474	8.0863	TRUE
		Hispanic	White	-2.9668	0.0004	-4.7734	-1.1601	TRUE
Stroke Crude Prevalance	RU0	Native American	White	-0.4607	0.0066	-0.8156	-0.1058	TRUE
		Hispanic	Native American	-0.02	0.9905	-0.3753	0.3354	FALSE
		Hispanic	White	-0.4807	0	-0.5258	-0.4356	TRUE
	RU1	Native American	White	-1.1198	0	-1.5363	-0.7033	TRUE
		Hispanic	Native American	0.8581	0	0.4328	1.2834	TRUE
		Hispanic	White	-0.2617	0	-0.3913	-0.1321	TRUE
	RU2	Native American	White	-3.4394	0	-3.9835	-2.8954	TRUE
		Hispanic	Native American	3.0946	0	2.5176	3.6716	TRUE
		Hispanic	White	-0.3448	0.0047	-0.6013	-0.0883	TRUE
	RU3	Native American	White					
		Hispanic	Native American					
		Hispanic	White					

		Tukey-Kramer Post-Hoc Test					
		Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
Cancer (nonskin or melanoma) prevalence	RU0	Native American	White	-0.7843	0.1151	-1.7089	0.1404	FALSE
		Hispanic	Native American	3.4829	0	2.5571	4.4087	TRUE
		Hispanic	White	2.6986	0	2.5812	2.816	TRUE
	RU1	Native American	White	2.21	0	1.1242	3.2957	TRUE
		Hispanic	Native American	0.7256	0.2747	-0.3831	1.8343	FALSE
		Hispanic	White	2.9356	0	2.5977	3.2735	TRUE
	RU2	Native American	White	2.8985	0	1.7074	4.0895	TRUE
		Hispanic	Native American	-0.8057	0.2925	-2.0689	0.4575	FALSE
		Hispanic	White	2.0928	0	1.5313	2.6543	TRUE
	RU3	Native American	White	2.9993	0	1.9407	4.0579	TRUE
		Hispanic	Native American	-1.9634	0.001	-3.2345	-0.6924	TRUE
		Hispanic	White	1.0359	0.0216	0.1233	1.9485	TRUE
Physical inactivity prevalence	RU0	Native American	White	-3.118	0.0032	-5.3596	-0.8764	TRUE
		Hispanic	Native American	-6.3838	0	-8.6282	-4.1394	TRUE
		Hispanic	White	-9.5018	0	-9.7865	-9.2172	TRUE
	RU1	Native American	White	-7.8198	0	-10.2099	-5.4298	TRUE
		Hispanic	Native American	-0.1451	0.9893	-2.5856	2.2954	FALSE
		Hispanic	White	-7.9649	0	-8.7087	-7.2211	TRUE
	RU2	Native American	White	-10.6511	0	-13.3628	-7.9394	TRUE
		Hispanic	Native American	5.0234	0.0001	2.1475	7.8993	TRUE
		Hispanic	White	-5.6277	0	-6.906	-4.3493	TRUE
	RU3	Native American	White	0.3903	0.9343	-2.2305	3.0111	FALSE
		Hispanic	Native American	-4.4036	0.0032	-7.5505	-1.2567	TRUE
		Hispanic	White	-4.0133	0.0001	-6.2727	-1.7538	TRUE
Frequent physical distress prevalence	RU0	Native American	White	-1.2107	0.0315	-2.3364	-0.0849	TRUE
		Hispanic	Native American	-2.5428	0	-3.6699	-1.4156	TRUE
		Hispanic	White	-3.7534	0	-3.8964	-3.6105	TRUE
	RU1	Native American	White	-4.031	0	-5.2728	-2.7893	TRUE
		Hispanic	Native American	1.1166	0.0974	-0.1514	2.3846	FALSE
		Hispanic	White	-2.9144	0	-3.3009	-2.528	TRUE
	RU2	Native American	White	-9.0922	0	-10.5679	-7.6166	TRUE
		Hispanic	Native American	6.8968	0	5.3317	8.4618	TRUE
		Hispanic	White	-2.1955	0	-2.8911	-1.4998	TRUE
	RU3	Native American	White	-9.7037	0	-11.4765	-7.9309	TRUE
		Hispanic	Native American	8.0716	0	5.943	10.2003	TRUE
		Hispanic	White	-1.6321	0.0332	-3.1605	-0.1037	TRUE

Table 14: Tukey-Kramer Post-Hoc Test Results Breakdown (Health)

Fair or poor health prevalence								
RU0	Native American	White	-2.1992	0.0545	-4.431	0.0326	FALSE
	Hispanic	Native American	-7.2395	0	-9.4741	-5.005	TRUE
	Hispanic	White	-9.4387	0	-9.7221	-9.1553	TRUE
RU1	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
	Native American	White	-7.7775	0	-10.1074	-5.4477	TRUE
	Hispanic	Native American	0.144	0.989	-2.2351	2.523	FALSE
	Hispanic	White	-7.6335	0	-8.3586	-6.9085	TRUE
RU2	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
	Native American	White	-15.0833	0	-17.8459	-12.3207	TRUE
	Hispanic	Native American	9.33	0	6.4002	12.2599	TRUE
	Hispanic	White	-5.7533	0	-7.0556	-4.4509	TRUE
RU3	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
	Native American	White	-16.0207	0	-18.8304	-13.2109	TRUE
	Hispanic	Native American	11.862	0	8.4883	15.2357	TRUE
	Hispanic	White	-4.1587	0.0002	-6.581	-1.7363	TRUE

Lack of health insurance prevalence								
RU0	Native American	White	-2.0942	0.051	-4.1958	0.0074	FALSE
	Hispanic	Native American	-7.1063	0	-9.2105	-5.0021	TRUE
	Hispanic	White	-9.2005	0	-9.4674	-8.9336	TRUE
RU1	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
	Native American	White	-4.5401	0	-6.561	-2.5193	TRUE
	Hispanic	Native American	-3.1756	0.0009	-5.2391	-1.1121	TRUE
	Hispanic	White	-7.7157	0	-8.3446	-7.0868	TRUE
RU2	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
	Native American	White	-3.3584	0.003	-5.7536	-0.9632	TRUE
	Hispanic	Native American	-2.0773	0.1336	-4.6175	0.463	FALSE
	Hispanic	White	-5.4357	0	-6.5649	-4.3065	TRUE
RU3	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
	Native American	White	-3.587	0.0001	-5.6329	-1.541	TRUE
	Hispanic	Native American	-0.73	0.7633	-3.1866	1.7267	FALSE
	Hispanic	White	-4.3169	0	-6.0808	-2.553	TRUE

Routine checkup prevalence								
RU0	Native American	White	-1.15	0.1265	-2.5367	0.2366	FALSE
	Hispanic	Native American	3.34	0	1.9517	4.7284	TRUE
	Hispanic	White	2.19	0	2.0139	2.3661	TRUE
RU1	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
	Native American	White	3.4905	0	1.8996	5.0814	TRUE
	Hispanic	Native American	-0.2158	0.9479	-1.8403	1.4087	FALSE
	Hispanic	White	3.2747	0	2.7796	3.7698	TRUE
RU2	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
	Native American	White	4.6283	0	2.7536	6.503	TRUE
	Hispanic	Native American	-2.2565	0.0214	-4.2447	-0.2682	TRUE
	Hispanic	White	2.3719	0	1.4881	3.2557	TRUE
RU3	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
	Native American	White	3.5754	0	2.0009	5.1499	TRUE
	Hispanic	Native American	-2.4832	0.0062	-4.3738	-0.5927	TRUE
	Hispanic	White	1.0922	0.1416	-0.2652	2.4496	FALSE

Transportation barriers prevalence								
RU0	Native American	White	-1.6963	0.0172	-3.1507	-0.2419	TRUE
	Hispanic	Native American	-4.4394	0	-5.895	-2.9838	TRUE
	Hispanic	White	-6.1357	0	-6.3282	-5.9432	TRUE
RU1	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
	Native American	White	-6.1002	0	-7.6057	-4.5947	TRUE
	Hispanic	Native American	1.1883	0.1647	-0.347	2.7236	FALSE
	Hispanic	White	-4.9119	0	-5.4008	-4.4229	TRUE
RU2	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
	Native American	White	-14.6233	0	-16.6452	-12.6013	TRUE
	Hispanic	Native American	10.2768	0	8.1397	12.414	TRUE
	Hispanic	White	-4.3464	0	-5.3376	-3.3553	TRUE
RU3	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
	Native American	White	-15.873	0	-18.5105	-13.2355	TRUE
	Hispanic	Native American	13.3211	0	10.1107	16.5315	TRUE
	Hispanic	White	-2.552	0.0365	-4.9768	-0.1271	TRUE

Table 15: Tukey-Kramer Post-Hoc Test Results Breakdown (Health + Healthcare Access & Quality)

			Tukey-Kramer Post-Hoc Test				
	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
RU0	Native American	White	5.7456	0.0437	0.1268	11.3643	TRUE
	Hispanic	Native American	-12.4843	0	-18.11	-6.8586	TRUE
	Hispanic	White	-6.7387	0	-7.4535	-6.024	TRUE
RU1	**Renter Households: Rent Contract Rent + Utilities > 30.0% Household Income**						
	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
	Native American	White	8.687	0.0282	0.7362	16.6378	TRUE
	Hispanic	Native American	-11.0011	0.0043	-19.1213	-2.881	TRUE
	Hispanic	White	-2.3141	0.0754	-4.8071	0.1789	FALSE
RU2	**Renter Households: Rent Contract Rent + Utilities > 30.0% Household Income**						
	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
	Native American	White	7.916	0.1265	-1.6332	17.4651	FALSE
	Hispanic	Native American	-0.5415	0.9913	-10.6677	9.5847	FALSE
	Hispanic	White	7.3745	0.0003	2.8996	11.8493	TRUE
RU3	**Renter Households: Rent Contract Rent + Utilities > 30.0% Household Income**						
	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
	Native American	White	12.8396	0.0002	5.3514	20.3277	TRUE
	Hispanic	Native American	-13.9659	0.0008	-22.9061	-5.0258	TRUE
	Hispanic	White	-1.1264	0.9085	-7.4928	5.2401	FALSE

			Tukey-Kramer Post-Hoc Test				
	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
RU0	Native American	White	0.8496	0.9302	-4.6452	6.3444	FALSE
	Hispanic	Native American	-9.0518	0.0003	-14.5535	-3.55	TRUE
	Hispanic	White	-8.2022	0	-8.9051	-7.4992	TRUE
RU1	**Owner Households: Monthly Owner Costs > 30.0% Household Income**						
	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
	Native American	White	7.1976	0.0035	1.9863	12.409	TRUE
	Hispanic	Native American	-9.1375	0.0002	-14.46	-3.815	TRUE
	Hispanic	White	-1.9399	0.0148	-3.5715	-0.3082	TRUE
RU2	**Owner Households: Monthly Owner Costs > 30.0% Household Income**						
	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
	Native American	White	7.6083	0.0239	0.8038	14.4128	TRUE
	Hispanic	Native American	-4.7184	0.2758	-11.9441	2.5072	FALSE
	Hispanic	White	2.8899	0.0882	-0.3248	6.1045	FALSE
RU3	**Owner Households: Monthly Owner Costs > 30.0% Household Income**						
	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
	Native American	White	-6.2088	0.2289	-15.1117	2.6941	FALSE
	Hispanic	Native American	11.4612	0.0309	0.8417	22.0807	TRUE
	Hispanic	White	5.2524	0.2325	-2.3194	12.8242	FALSE

			Tukey-Kramer Post-Hoc Test				
	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
RU0	Native American	White	3.3385	0.2187	-1.3611	8.0381	FALSE
	Hispanic	Native American	-7.9217	0.0002	-12.627	-3.2163	TRUE
	Hispanic	White	-4.5832	0	-5.181	-3.9854	TRUE
RU1	**Renter Households: Rent Contract Rent + Utilities > 50.0% Household Income**						
	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
	Native American	White	7.2892	0.0176	1.0249	13.5536	TRUE
	Hispanic	Native American	-8.5195	0.0052	-14.9173	-2.1218	TRUE
	Hispanic	White	-1.2303	0.306	-3.1945	0.7339	FALSE
RU2							
	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
	Native American	White					
	Hispanic	Native American					
	Hispanic	White					
RU3							
	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
	Native American	White	6.6683	0.0051	1.6844	11.6522	TRUE
	Hispanic	Native American	-5.7862	0.0586	-11.7365	0.164	FALSE
	Hispanic	White	0.882	0.8757	-3.3553	5.1193	FALSE

			Tukey-Kramer Post-Hoc Test				
	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
RU0	Native American	White	-2.0941	0.4824	-6.3568	2.1685	FALSE
	Hispanic	Native American	-2.2093	0.4452	-6.4773	2.0587	FALSE
	Hispanic	White	-4.3034	0	-4.8488	-3.7581	TRUE
RU1	**Owner Households: Monthly Owner Costs > 50.0% Household Income**						
	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
	Native American	White	5.5223	0.001	1.9058	9.1388	TRUE
	Hispanic	Native American	-6.4548	0.0001	-10.1483	-2.7612	TRUE
	Hispanic	White	-0.9324	0.1301	-2.0647	0.1998	FALSE
RU2							
	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
	Native American	White					
	Hispanic	Native American					
	Hispanic	White					
RU3							
	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
	Native American	White	-7.9007	0.0071	-13.9994	-1.802	TRUE
	Hispanic	Native American	11.9088	0.0005	4.5671	19.2505	TRUE
	Hispanic	White	4.0081	0.1785	-1.3033	9.3194	FALSE

			Tukey-Kramer Post-Hoc Test				
	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
RU0	Native American	White	2.1071	0.1079	-0.3405	4.5546	FALSE
	Hispanic	Native American	1.3663	0.3913	-1.0843	3.8168	FALSE
	Hispanic	White	3.4733	0	3.1622	3.7845	TRUE
RU1	**Broadband Internet Access**						
	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
	Native American	White	12.3989	0	9.6156	15.1822	TRUE
	Hispanic	Native American	-7.3236	0	-10.1676	-4.4797	TRUE
	Hispanic	White	5.0753	0	4.1954	5.9551	TRUE
RU2							
	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
	Native American	White	33.4178	0	29.2166	37.6189	TRUE
	Hispanic	Native American	-26.0932	0	-30.5553	-21.6311	TRUE
	Hispanic	White	7.3245	0	5.3292	9.3199	TRUE
RU3							
	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
	Native American	White	34.7941	0	28.8462	40.7421	TRUE
	Hispanic	Native American	-28.9882	0	-36.1269	-21.8495	TRUE
	Hispanic	White	5.8059	0.022	0.6773	10.9346	TRUE

Table 16: Tukey-Kramer Post-Hoc Test Results Breakdown (Neighborhood & Built Environment)

		Tukey-Kramer Post-Hoc Test					
	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
RU0	Native American	White	1.1819	0.0191	0.1551	2.2087	TRUE
	Hispanic	Native American	-0.8165	0.15	-1.8446	0.2116	FALSE
	Hispanic	White	0.3654	0	0.235	0.4958	TRUE
RU1	Native American	White	-0.0776	0.9804	-1.0396	0.8844	FALSE
	Hispanic	Native American	0.4221	0.5719	-0.5602	1.4045	FALSE
	Hispanic	White	0.3445	0.0192	0.0451	0.6439	TRUE
RU2	Native American	White	-2.5728	0	-3.4876	-1.658	TRUE
	Hispanic	Native American	3.2618	0	2.2916	4.232	TRUE
	Hispanic	White	0.689	0.0006	0.2577	1.1202	TRUE
RU3	Native American	White	-2.6432	0	-3.7579	-1.5285	TRUE
	Hispanic	Native American	3.152	0	1.8136	4.4905	TRUE
	Hispanic	White	0.5088	0.4258	-0.4522	1.4698	FALSE

Depression prevalence

		Tukey-Kramer Post-Hoc Test					
	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
RU0	Native American	White	-0.744	0.2772	-1.8845	0.3965	FALSE
	Hispanic	Native American	-2.1444	0	-3.2863	-1.0025	TRUE
	Hispanic	White	-2.8884	0	-3.0332	-2.7436	TRUE
RU1	Native American	White	-4.6698	0	-5.814	-3.5257	TRUE
	Hispanic	Native American	2.221	0	1.0527	3.3893	TRUE
	Hispanic	White	-2.4488	0	-2.8047	-2.093	TRUE
RU2	Native American	White	-9.4873	0	-10.7791	-8.1955	TRUE
	Hispanic	Native American	8.0434	0	6.6734	9.4134	TRUE
	Hispanic	White	-1.444	0	-2.053	-0.835	TRUE
RU3	Native American	White	-10.2964	0	-12.0297	-8.5632	TRUE
	Hispanic	Native American	9.2561	0	7.1749	11.3372	TRUE
	Hispanic	White	-1.0404	0.2301	-2.5346	0.4539	FALSE

Frequent mental distress prevalence

		Tukey-Kramer Post-Hoc Test					
	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
RU0	Native American	White	-2.9114	0.0564	-5.8833	0.0605	FALSE
	Hispanic	Native American	-10.3109	0	-13.2851	-7.3366	TRUE
	Hispanic	White	-13.2223	0	-13.6156	-12.8289	TRUE
RU1	Native American	White	-11.4352	0	-14.3791	-8.4913	TRUE
	Hispanic	Native American	0.9611	0.7331	-2.0411	3.9633	FALSE
	Hispanic	White	-10.474	0	-11.4302	-9.5179	TRUE
RU2	Native American	White	-25.0815	0	-28.8796	-21.2835	TRUE
	Hispanic	Native American	15.8137	0	11.7992	19.8282	TRUE
	Hispanic	White	-9.2679	0	-11.1297	-7.4061	TRUE
RU3	Native American	White	-26.1041	0	-30.4963	-21.712	TRUE
	Hispanic	Native American	19.951	0	14.6049	25.2972	TRUE
	Hispanic	White	-6.1531	0.0012	-10.1911	-2.1152	TRUE

Food insecurity prevalence

		Tukey-Kramer Post-Hoc Test					
	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
RU0	Native American	White	-2.3502	0.0259	-4.4757	-0.2246	TRUE
	Hispanic	Native American	-7.8947	0	-10.0231	-5.7663	TRUE
	Hispanic	White	-10.2449	0	-10.5169	-9.9728	TRUE
RU1	Native American	White	-7.6516	0	-9.9888	-5.3144	TRUE
	Hispanic	Native American	-0.3566	0.9347	-2.7471	2.0338	FALSE
	Hispanic	White	-8.0083	0	-8.7483	-7.2682	TRUE
RU2	Native American	White	-14.8991	0	-17.5632	-12.2349	TRUE
	Hispanic	Native American	8.3499	0	5.5339	11.1658	TRUE
	Hispanic	White	-6.5492	0	-7.8551	-5.2432	TRUE
RU3	Native American	White	-15.5067	0	-18.2813	-12.7322	TRUE
	Hispanic	Native American	11.4218	0	8.0447	14.799	TRUE
	Hispanic	White	-4.0849	0.0006	-6.6357	-1.5342	TRUE

Housing insecurity prevalence

		Tukey-Kramer Post-Hoc Test					
	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
RU0	Native American	White	-1.7346	0.0047	-3.0272	-0.442	TRUE
	Hispanic	Native American	-2.9595	0	-4.2531	-1.6658	TRUE
	Hispanic	White	-4.6941	0	-4.8652	-4.523	TRUE
RU1	Native American	White	-6.0077	0	-7.2862	-4.7291	TRUE
	Hispanic	Native American	2.1589	0.0003	0.855	3.4627	TRUE
	Hispanic	White	-3.8488	0	-4.2641	-3.4335	TRUE
RU2	Native American	White	-13.473	0	-15.2175	-11.7284	TRUE
	Hispanic	Native American	9.6724	0	7.8285	11.5164	TRUE
	Hispanic	White	-3.8005	0	-4.6557	-2.9454	TRUE
RU3	Native American	White	-13.2714	0	-15.5554	-10.9873	TRUE
	Hispanic	Native American	10.584	0	7.8039	13.3641	TRUE
	Hispanic	White	-2.6873	0.008	-4.7871	-0.5875	TRUE

Utilities services threat prevalence

		Tukey-Kramer Post-Hoc Test					
	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
RU0	Native American	White	-0.3724	0.737	-1.5449	0.8001	FALSE
	Hispanic	Native American	-3.4675	0	-4.6409	-2.2941	TRUE
	Hispanic	White	-3.8399	0	-3.9951	-3.6847	TRUE
RU1	Native American	White	-5.306	0	-6.5835	-4.0286	TRUE
	Hispanic	Native American	1.415	0.0294	0.1123	2.7177	TRUE
	Hispanic	White	-3.891	0	-4.3059	-3.4762	TRUE
RU2	Native American	White	-10.0141	0	-11.6619	-8.3663	TRUE
	Hispanic	Native American	6.0577	0	4.316	7.7994	TRUE
	Hispanic	White	-3.9564	0	-4.7641	-3.1486	TRUE
RU3	Native American	White	-7.9646	0	-9.6762	-6.2531	TRUE
	Hispanic	Native American	4.1472	0	2.0639	6.2306	TRUE
	Hispanic	White	-3.8174	0	-5.3909	-2.2438	TRUE

Social isolation prevalence

Table 17: Tukey-Kramer Post-Hoc Test Results Breakdown (Social & Community Context)

Citizen population aged 18 or older who voted in the 2020 U.S. Presidential election			Tukey-Kramer Post-Hoc Test				
	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
RU0	Native American	White	3.1928	0.0008	1.1267	5.2389	TRUE
	Hispanic	Native American	0.4808	0.8478	-1.5778	2.5395	FALSE
	Hispanic	White	3.6636	0	3.4031	3.9242	TRUE
RU1	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
	Native American	White	10.7528	0	7.6761	13.8296	TRUE
	Hispanic	Native American	-2.5146	0.1458	-5.6579	0.6287	FALSE
	Hispanic	White	8.2383	0	7.2647	9.2118	TRUE
RU2	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
	Native American	White	10.2139	0	6.0523	14.3754	TRUE
	Hispanic	Native American	-1.9317	0.5584	-6.3377	2.4742	FALSE
	Hispanic	White	8.2821	0	6.3403	10.2239	TRUE
RU3	Group1	Group2	MeanDiff	P-adj	Lower	Upper	Reject h-null?
	Native American	White	5.0217	0.0269	0.4622	9.5813	TRUE
	Hispanic	Native American	-1.1422	0.8748	-6.6078	4.3234	FALSE
	Hispanic	White	3.8795	0.0509	-0.0112	7.7703	FALSE

Table 18: Tukey-Kramer Post-Hoc Test Results Breakdown (Social & Community Context)

Chapter 5: Discussion

5.1: What Drives Poor Native American Outcomes?

While controlling for rurality, Native Americans tend to perform worse than White populations in the American Southwest. The mean outcome of plurality Native American census tracts was worse in comparison to plurality White census tracts in 10 of 27 (37.04%) metrics at RU0, 21 of 27 metrics at RU1 (77.78%), 22 of 27 metrics at RU2 (81.48%), and 21 of 27 (77.78%) metrics at RU3. Native American mean outcomes were worse in more than half the metrics considered at all levels of rurality and in over a third of metrics in urban areas. Still, comparatively Native American mean outcomes were still worse as they performed worse in urban areas in 10 metrics while doing better in only 2 metrics and statistically similarly in the other 15 metrics considered. By categorical breakdown, Native Americans tended to perform worse in health outcomes and all domains of the SDOH except for the metrics considered for the neighborhood and built environment domain. The potential causes of the comparative positive outcomes in this domain and these metrics are explored further in section 5.3.

Additionally, plurality Native American census tracts experienced mean outcomes that were generally worse than Hispanics, but only in the most distantly rural areas. The mean outcome of plurality Native American census tracts was worse in comparison to plurality Hispanic census tracts in 2 of 27 (7.41%) metrics at RU0, 7 of 27 metrics at RU1 (25.93%), 19 of 27 metrics at RU2 (70.37%), and 19 of 27 (70.37%) metrics at RU3. In urban areas, Hispanic communities had the worst mean outcomes compared to both White and Native American people. Compared to Hispanic people, Native Americans had similar mean outcomes in terms of the amount of considered

metrics either group performed worse in compared to the other as Native Americans had worse outcomes in 7 metrics compared to Hispanics having worse outcomes in 6 metrics, with the remaining 14 metrics being statistically similar. Beyond defined fringe rural communities, meaning all rural communities beyond 5 miles of an urban area, Native Americans performed worse than Hispanic people in the majority of metrics considered. By health and SDOH domain categorical breakdown, Hispanic people tend to perform worse in most metrics considered in all domains and in health outcomes in urban settings. In fringe rural areas, where overall results were similar, Native Americans had better mean outcomes in the neighborhood and built environment domain, with Hispanics generally having better mean outcomes in the social and community context domain. Beyond fringe rural areas, Native Americans continued to have better outcomes in the social and community context SDOH domain.

If Native American outcomes remain comparatively poor while controlling for rurality, as is suggested by the results of this study, it begs the question of what is shaping poor Native American outcomes beyond their disproportionately rural population. Additional factors such as historical trauma, cumulative racial disadvantage, and structural inequities are possible factors that shape the poor health and SDOH outcomes seen in Native American communities.

The disparities faced by Native Americans are rooted in a history of colonization, forced displacement, and systemic oppression. Native Americans share a collective sense of loss and social injustice due to centuries of loss. Loss of land, traditional food systems, traditional ceremonies, culture, language, and previously held self-sufficiency (Warne & Wescott, 2019). The effects of historical trauma and its negative effects on

health for Native American individuals has been examined by several researchers and the evidence suggests that historic trauma may lead to transgenerational inheritance of stress, which negatively affects both physical and mental health outcomes. These experiences have led to high rates of PTSD, depression, substance use disorders, and suicide within Native communities (Gone, 2009; Gone et al., 2019; Hartmann & Gone, 2014; Jolley, 2020; Yellow Horse Brave Heart & Chase, 2016). The forced removal from ancestral lands and placement onto reservations disrupted traditional food systems, economic structures, and healthcare practices. Federal policies such as the Indian Removal Act, assimilationist boarding schools, and termination policies have left a lasting impact, contributing to intergenerational trauma and a mistrust of governmental institutions, including healthcare systems, leading to worse healthcare utilization and health outcomes (Yellow Horse Brave Heart & Chase, 2016). Cumulative racial disadvantage compounds these effects. Centuries of systemic exclusion, including racial discrimination in education, housing, healthcare, and employment, have resulted in persistent poverty, lower educational attainment, and limited access to quality healthcare. Over time, these disparities have widened, leading to stark gaps in life expectancy and health outcomes (Findling et al., 2019; Kutateladze et al., 2014; Latham-Mintus et al., 2022).

Another factor to consider that shapes contemporary Native American health outcomes is the funding of Indian Health Services (IHS). The Indian Health Service (IHS) was created to provide health care services to approximately two million Native Americans, mainly those who reside in or near tribal communities. Unfortunately, the funding allocated to achieve this mission is not sufficient. The IHS budget permits

annual health care expenditures of about $4,000 per patient, as compared with the national average of over $9,000. The average IHS hospital is 40 years old, compared to the national average of about 10.6 years. A 2018 government report found that 25% of provider positions were vacant, in part because the IHS is unable to match market salaries and hiring can take more than a year (Leston & Reiley, 2021; US Government Accountability Office, 2018). Although there are valid criticisms about the healthcare quality at IHS facilities, the lack of equitable federal funding is also a prime contributor to the inequitable patient outcomes that are pervasive in Native American communities. Additionally, despite the IHS's federal funding, the funds are not guaranteed. The IHS is classified as a discretionary program, meaning it is not mandated to receive federal funds during annual budgetary allocations. Researchers argue that mandatory IHS funding in the way that Medicaid, Medicare, and social security are funded and additional funding to match national per patient health expenditure would more reliably keep the IHS funded, allow the IHS to keep pace with changes in need and cost, and make the IHS more effective at addressing health disparities (Routbal, 2021; Westmoreland & Watson, 2006). The underfunding of IHS forces many Native individuals to seek care outside the system, but barriers such as cost, insurance gaps, and lack of nearby providers further restrict access.

Furthermore, jurisdictional complexities between tribal, state, and federal governments create barriers to accessing healthcare. Many Native Americans, especially those living in urban areas due to a lack of tribal enrollment or lack of proximity to IHS facilities, are unable to utilize IHS services and must rely on Medicaid, Medicare, or private insurance. Tribal nations often struggle to exercise self-

determination in healthcare administration due to restrictive federal regulations that limit their ability to fully manage healthcare services (Field et al., 2024). Policy limitations also affect funding allocation for public health initiatives, mental health services, and substance use treatment programs in Native communities. Tribal healthcare facilities frequently lack the resources to offer specialized care, forcing many Native patients to travel long distances for medical treatment or forgo care altogether. The inability to access consistent and culturally competent healthcare exacerbates chronic disease burdens, mental health crises, and preventable mortality among Native populations (Warne & Frizzell, 2014).

Lastly, it is important to recognize the intersection of historic dealing with the United States government and/or its settlers and how the disproportionate effect it has had environmentally on Native lands. This can come in the form of infrastructural underinvestment as well as environmental contamination. One of the most significant environmental injustices affecting Native communities, particularly in the Southwest, is radiation exposure from uranium mining. During the mid-20th century, the U.S. government extensively mined uranium for nuclear weapons, with many mines located on or near Native reservations, particularly those of the Navajo Nation. Thousands of Native workers were employed in these mines, often without protective equipment or warnings about the dangers of radiation exposure. Even after many of these mines were abandoned, hazardous waste was left behind, contaminating soil, water sources, and the air (Lewis et al., 2017). The long-term effects of radiation exposure have been devastating, leading to disproportionately high rates of lung cancer, kidney disease, and reproductive health complications among affected tribes (Lewis et al., 2017; Voyles,

2015). Industrial sites, highways, and extractive industries are often located near Native American communities, leading to disproportionate exposure to air pollution. Many reservations have been targeted for hazardous waste disposal sites, landfills, and fossil fuel extraction projects, which release pollutants linked to respiratory diseases, cardiovascular conditions, and cancer (Hoover et al., 2012). Water insecurity and contamination are persistent issues for many Native American reservations. A lack of infrastructure investment and the proximity of reservations to industrial and agricultural pollution sources contribute to unsafe drinking water conditions. A 2019 study found that Native American households are 19 times more likely to lack indoor plumbing compared to White households, exacerbating sanitation-related health risks (US Water Alliance, 2019).

Certainly, due to the intersectional nature of geography and resources, there is an effect that rurality has on these various contributing health and SDOH factors that affect Native American health. However, it is not the only contributing factor and does not account for all the disparities seen when comparing Native Americans to other racial groups as seen in this study's attempt to estimate health outcomes while controlling for rurality. Environmental factors, including radiation exposure, water contamination, climate change, and air pollution, significantly contribute to the health disparities experienced by Native American populations in addition to deeply tied to historical injustices that shape contemporary traumas. Native American do struggle due in part due to their disproportionate rurality, but there are factors outside of rurality and resource dispersion that can be addressed in order to provide more equitable health access and health outcomes for the Native people.

5.2: Hispanic outcomes in urban areas

Although this study has a focus on Native American results compared to the White and Hispanic people in the American Southwest, the disparate outcomes seen in urban areas for the Hispanic population also stood out. In comparison to the White and Native American populations in urban census tracts, they have the worst mean outcomes in 18 of 27 (66.67%) metrics considered and similarly to White or Native American plurality populations in 7 of 27 (25.93%) metrics. This section seeks to provide possible explanations for why Hispanic communities may be experiencing health disparities in urban areas in the southwest.

Disparities in urban Hispanic communities may be due to a combination of legal and policy barriers that have driven poor SDOH environments that have manifested in comparatively poor outcomes across the board. Specifically, documentation status and policies related to documentation status are known to drive factors such as utilization of resources, resource access, stress, and trauma that negatively impact Hispanic health outcomes (Cabral & Cuevas, 2020). Undocumented individuals may avoid healthcare facilities and social services due to fear that their information may be shared with immigration enforcement agencies. Immigration policies significantly impact Hispanic populations, as a large proportion of urban Hispanics are either immigrants or have close ties to immigrant communities, especially within this paper's study area in the Southwest. Restrictive immigration policies, such as limited pathways to citizenship and heightened deportation threats, create an environment of fear and discourage individuals from seeking healthcare, education, or legal protection. This effect can extend to mixed-status families, where U.S. born children of undocumented parents may be hesitant to access healthcare, food assistance, or other forms of public

assistance, producing worse health and SDOH metrics in the community (Garcia et al., 2019).

Access to healthcare is an area where policies can directly create disadvantages for Hispanic populations, especially for undocumented individuals. Undocumented immigrants are excluded from federally funded health insurance programs, including Medicaid and Affordable Care Act (ACA) market subsidies. Exclusion from federally funded healthcare programs reduces access to insurance, preventative care, and routine checkups, leading to an increase in untreated chronic illnesses for undocumented individuals and their families in the Hispanic community (Velasco-Mondragon, 2016). Many Hispanic individuals face language barriers when seeking medical care regardless of documentation status, leading to miscommunication, misdiagnosis, and lower-quality treatment. Title VI of the Civil Rights Act requires healthcare facilities receiving federal funds to provide language services, but enforcement is inconsistent, leaving many hospitals and clinics without adequate Spanish-language interpreters (Al Shamsi, 2020). The lack of culturally or linguistically approachable services further hamper access to the healthcare system.

Educational achievement metrics are a specific area where Hispanic populations in this study significantly lagged compared to their contemporaries. In urban settings for plurality Hispanic census tracts, high school graduation rates (or equivalent) are only at around 75% compared to the 90+% for the White and Native American populations. Education, a social determinant of health, can have policies created that produce systemic barriers for Hispanic populations. Research suggests that bilingual and dual-language immersion programs improve literacy and overall academic performance, yet

these programs remain underfunded or inaccessible to many Hispanic students (Flores, 2020; Marrero, 2016). Limited English proficiency is a major problem for affected Hispanic populations as greater English proficiency is associated with greater educational attainment among immigrant populations. A lack of access to English socially or in school settings sets up young English Language Learners (ELLs) for less academic success and opportunity in their lives. In addition to difficulties with accessible English learning, undocumented Hispanic students face significant financial and legal obstacles in pursuing higher education, as they are often denied in-state tuition and state financial aid. These barriers discourage college enrollment, limiting economic mobility for many Hispanic families. Education, especially postsecondary education, is increasingly tied to success in the labor market in the United States. Higher levels of educational attainment is tied to higher wages but there are also benefits in terms of career choices, which opens up lifestyle opportunities that can benefit both quality and quantity of life for higher educational attainers (Baum & Flores, 2011).

As a domain of the social determinants of health, education is understood to affect health outcomes either directly or indirectly. In addition, SDOH domains are understood to be intersectional in their causes and effects, meaning that barriers in education can also affect outcomes such as economic stability, community context, and the neighborhood and built environment, which may have led to the variety of metrics that the Hispanic population compared poorly against the urban White and Native American populations. There are a multitude of ways that the Hispanic population are affected by barriers to education, leading to worse health outcomes. The issue of documentation, familiarity with U.S. social institutions, and barriers for ELLs is

especially relevant to the outcomes seen in the Southwestern U.S. study area (Kolak et al., 2020). Immigrants from Latin American countries and their descendants constitute a rapidly growing portion of the population of the United States, especially in the Southwest, and the issues they face, particularly in urban areas, were highlighted by the results of this study. Though this population group was not the focus of this study, it is important to recognize and attempt to explain the struggles they may experience that is supported by the results of this study.

5.3: Native American Housing Outcomes

In terms of the housing cost burden for both renters and homeowners, Native Americans perform similarly or better than White and Hispanic people at both 30% and 50% household income thresholds at every level of the rural-urban spectrum except for homeowner cost burden at the 50% threshold at RU3 (remote rural). Compared to the other considered metrics of health and SDOH, this set of metrics stands out as an area that Native Americans have an advantage in across the rural-urban spectrum.

A major reason for the lower rent burden among the Native American population in rural areas is the availability and distribution of tribal and federal housing assistance. This is an advantage Native Americans have compared to other racial groups in the neighborhood and built environment domain of the social determinants of health. The Indian Housing Block Grant (IHBG) and Indian Community Development Block Grant (ICDBG) programs, which are administered by the U.S. Department of Housing and Urban Development (HUD), provides funding for affordable housing on Tribal lands which are oftentimes located in a rural context. Further IHBG funding can be gained through the competitive grant program that prioritizes funding for new construction,

rehabilitation projects, and necessary infrastructure to increase housing lifespan and alleviate substandard housing conditions as well as Native American veteran specific programs (Department of Housing and Urban Development, 2024). Many tribal governments allocate these funds to offer affordable housing at a reduced cost of even rent-free housing to their members, which can significantly reduce the burden that the cost of housing can put on Native American families. Furthermore, the HUD's Section 184 Indian Home Loan Guarantee Program assists in facilitating Native American homeownership by providing favorable loan terms, reducing the burden of mortgages while also increasing overall homeownership (Department of Housing and Urban Development, 2024). Native Americans are also more likely to participate in multigenerational housing and communal living (Lofquist, 2013). This housing style allows for multiple wage earners to contribute to housing costs, reducing individual rent burden. Such living arrangements may alleviate the burden of housing costs.

The rural areas that Native Americans reside in, including reservation lands, have lower housing costs compared to other regions of the United States, which also results in a lower rent burden. This may be in part due to the history of colonization and relocation of Native Americans. Oftentimes, whether through treaty or by force, Native Americans were given land that was poor land that was separated from their ancestral homes. The lands given to Native Americans were lands that were not valued agriculturally or locationally through their proximity to waterways, travel and trade networks, or other established colonizer settlements. Similar outlooks on the lands that rural Native Americans inhabit since then are still influenced by negative perceptions of proximity to resources and agricultural value, driving down the price of housing for rural

Native Americans on and off the reservation (Ge et al., 2018). Perceptions of land value in areas that rural Native Americans live as well as homeownership assistance and development programs are likely major contributors in the positive renter and homeowner burden metrics for Native Americans in comparison to other rural communities.

Although Native Americans in urban settings do not benefit from tribal land specific housing assistance programs, there are other programs that can assist in securing affordable housing in urban areas. Organizations such as the American Indian Community Development Corporation in Minneapolis and Native American Connections in the Phoenix area offer low-income housing specifically for Native American populations (About NAC; AICDC). The latter is especially relevant to this study and its study area because the majority of RU0 (urban) Native American census tracts are in the Phoenix area, which may have influenced the results displayed for urban Native Americans. Additionally, multigenerational or multifamily housing practices carry over to urban settings, which may also alleviate individual housing cost burdens (Pindus, 2017).

The lower rent burden among Native Americans in both rural and urban areas is largely a result of targeted housing assistance programs, homeownership opportunities, and communal living arrangements. However, this seemingly has not equated to economic security or improved health outcomes. Persistent disparities in health and other domains of SDOH continue to hinder Native Americans. Addressing these broader disparities likely requires a multifaceted approach that goes beyond housing assistance to include healthcare and other SDOH metrics. Lastly, the presence of housing and homeownership does not necessarily equate to quality housing.

5.4: Native American Culture and Community Health

The comparatively poor health outcomes and resource access for Native Americans have been shaped by a unique combination of historic injustices and systemic inequities. Despite the disadvantages Native Americans face, there are factors that strengthen their community health. Many indigenous communities demonstrate resilience that enables better health outcomes than what may be experienced otherwise due to cultural strengths, social cohesion, and spiritual tradition. Understanding the positive influences on Native American health is essential for a more culturally competent comprehension of the unique circumstances of their social determinants of health, healthcare outcomes, and healthcare systems. This understanding is necessary to develop healthcare interventions and community health strategies that build upon the positive traits in Native American communities.

Native Americans often have strong social ties, especially in reservation settings. Extended families are a central organizing unit in many Native American cultures and communities that emphasizes communal responsibility, interdependence, reciprocity and an obligation to care for one another. Community relationships extend beyond blood relatives to include important others as part of a family. An extensive network of familial and traditional relationships strengthens Native American communities and helps ensure members have a multitude of figures to look towards as grandparents, aunts and uncles, cousins, siblings, and more. Additionally, Native Americans are more likely to live in multigenerational households, which have been linked to reduced stress and improved mental health outcomes (Sarche & Spicer, 2008). Although Native Americans perform worse in aspects of mental health compared to similarly rural communities, factors outside of community and social ties may be at play. Close-knit

communities and social networks provide emotional and material support during health crises.

Studies have shown that social cohesion and cultural engagement also act as protective factors against mental health issues (Gone & Tremble, 2012; Pindus, 2017). Many Native American communities also engage in traditional cultural and spiritual practices and rituals that help create a strong sense of community through a shared identity and sense of belonging, which is crucial for mental resilience. Engaging with one's traditional belief systems in the community has been shown to have a positive effect on the rates of high self-esteem as well as rates of psychological distress, depression, and substance abuse rates. Participating in traditional indigenous spiritual and religious practices contributes to individual holistic well-being. Healing practices within this context can help improve one therapeutically in addition to physically, mentally, and holistically. These practices in turn also serve to strengthen intergenerational ties, reinforcing social support systems that buffer against adversity and traumas (Yellow Horse Brave Heart & Chase, 2016). Lastly, language revitalization programs and cultural education initiatives have been identified as protective factors similar to the positive effects of strong social ties, and cultural engagement. Language revitalization and participation can help strengthen one's sense of cultural and community identity, improving mental health and self-confidence (Sarche & Spicer, 2008).

Despite the historical and systemic challenges faced by Native American communities, their numerous cultural and social strengths contribute to positive health outcomes. Even in areas where this study has shown that Native Americans lag behind

other similarly rural communities of differing racial compositions, these strengthening and resilient aspects of Native American cultures may help reduce worse outcomes in these areas. Tight-knit communities provide essential social support, indigenous spiritual practices enhance mental and emotional well-being, and traditional healing methods offer valuable medical insights. By acknowledging and building upon these strengths, public health professionals and policymakers can create more effective and culturally relevant interventions that empower Native populations. Native American communities may be more apt to embrace a collectivist approach to health and well-being, encouraging collective problem solving and decision making to support enhancing health outcomes (Hossain et al., 2011). Tribal run wellness centers, nutritional programs, and mutual aid networks have been successfully launched in Native American communities, helping bolster health outcomes and resilience (Mihesuah & Hoover, 2019). Despite the numerous metrics detailing the struggles of Native American communities, there are positive pillars to point to in Native American lifestyles that serve to uplift the community in the face of historic injustices and systemic inequities. Understanding these insulating factors is key to promoting health equity and resilience among indigenous communities.

5.5: Methodological Limits and Complexities of Health, Race, and Rurality

Although this study attempted to be inclusive in its metrics of health outcomes, there are many more ways to measure health and each domain of the social determinants of health. Health is a broad concept that encompasses physical, mental and social well-being, which can be measured or estimated in a variety of ways. Additional health metrics may include illness frequency and duration, physical and

mental disability rates, life expectancy, days hospitalized, incidence of low birth weight, stillbirth rate, teen birth rates, estimates of years of potential life lost, and more. Additionally, health outcomes could be further divided by sex or age in addition to racial group (Ashraf et al., 2019). Although it would be great to include each of these metrics of health, data on these metrics may not be available at the scope this study encompasses. Additionally, metrics may be reflective of disparities in healthcare access rather than actual health status with undiagnosed conditions in populations with limited healthcare access resulting in potential underestimation of disease burdens, complicating estimating community health outcomes (Penman-Aguilar et al., 2016).

SDOH metrics were included to provide a larger picture of community health due to its known role in shaping the health of populations (Magnan, 2017; World Health Organization). Similar to health metrics, there are a variety of metrics for the social determinants of health. The U.S. Department of Health and Human Services enumerates the 5 domains of the social determinants of health while also providing a list of metrics for each domain that can be used to estimate health in a particular domain. Some metrics not considered in this study include measures of arthritis, workplace injury incidents, reading writing and math proficiency, emergency care wait times, cancer specific screenings, developmental delays in children, drug and alcohol use, oral condition incidence, health communications, STD/STI rates, water and air quality, motor vehicle deaths, rates of bullying based on race or LGBTQ+ status, and more (Healthy People 2030). Again, inclusion of every possible metric could possibly paint a better picture of community health, but by the department's own measure, some of these metrics are still developmental and may not be available in such a large regional

comparison. Additionally, many metrics are directly related to each other in the domains of SDOH or may be included in multiple domains as is the case with household rent or mortgage burden in regard to economic and built environment considerations.

Additionally, race can be a complicated way of classifying people as people can hold a multitude of racial and ethnic identities. Different governments and societies have different conceptions and measures of race within their own methodology that can fundamentally shape who is and is not considered and shape what category that are placed within, appropriately or not. Varying methodology may influence demographic data and its interpretations (Morning, 2008; Morning, 2015). For simplicity, this study followed the 2020 census' racial categorizations, though it is still important to recognize the complexities of race. Additionally, most likely due to the study area chosen, there was difficulty in finding representative population groups at every level of rurality (RU0-RU3) for every racial category, leading to the choice to compare Native Americans with only Hispanic and White people. There are likely, for example, a large enough sample of Black populations in the Southeast United States that could have been compared to the other groups if the study area was larger or if there was a focus on the Eastern U.S..

Lastly, rurality is a complex idea that can be defined and approached in a multitude of ways. Specific definitions serve different purposes and have different geographic units as their base. Different definitions of rural largely stem from differing conceptions of what it means to be rural, including proximity to an urban core, 'connectedness' to a core often based on commute, population density or size, and the sharing of a political border (County, legislative district, etc.) with an urban area. Some definitions focus on populations, commuting areas, influence, healthcare, education, or

even agriculture due to a connection to rurality. Many definitions are urban based, defined by delineating what is urban first and labelling that which is not urban as rural. For dichotomous and non-dichotomous definitions, continuums of rurality may be established where two areas may be considered rural, but one rural area may be 'more' rural than another (Long et al., 2021). This study utilized the U.S. Census Bureau's urban areas dichotomous methodology to separate rural and urban and then applied the NCES' continuum to these rural areas to provide different intensities of rurality as comparison points for different populations.

Future rural research may seek to build upon this study by using different definitions of rurality, additional or different metrics of health or the SDOH, different statistical approaches, or by including additional or different racial demographics into future comparisons. In addition, expanded, tightened, or differing regional focus geographically can influence all the data fed into future studies and statistical analysis while also affecting potential explanatory factors due to differing historical contexts, political history, or determinants of health. This study touches upon a variety of contested and complex subjects, making future research or iterations ripe for expansions on the same core principles. Native American and Rural populations both perform worse than their respective counterparts, and additional research can help fuel targeted policy intervention to mitigate the disparities in these communities in the pursuit of equitable outcomes.

Chapter 6: Conclusion

6.1: Final Thoughts

Based on the results of this study, it can be concluded that Native Americans tend to perform worse than White and Hispanic populations in the Southwest while controlling for rurality. This question was important to address because Native Americans are a disproportionately rural population compared to other racial groups in the United States, and it is known that people in rural communities also face disparate challenges due to the unique circumstances of rural life. Native American populations still doing worse in comparison to other similarly rural communities of differing racial compositions points to other factors influencing their poor health and SHOH metrics. While some explanatory factors were put forth here, further research is necessary to accurately assess the conditions of Native American communities. Additionally, there are several other ways to approach racial and rural health comparisons. Modifications of the methods used include utilizing a different study area, different racial group comparisons, different conceptions of rurality, and even different or additional health and SDOH metrics. Future research could even eschew the racial or rural-urban portion entirely to singularly focus on racial or rural-urban comparisons. The nature of the topics touched in this study, ranging from race, to rurality, to health, and to the determinants of health, mean that there is a diverse array of theoretical and methodological approaches that can be considered.

Regardless of the approach taken it is hard to deny that there are struggles in the Native American community. The fact remains that this population is one of the worst performing in the country in a large variety of metrics. Native American populations

struggle with chronic health conditions and diseases, mental health issues, access to care, access to economic opportunities, and more. This is in part a product of their rurality, but, as this study has shown, the hardships faced in this community go beyond their rural circumstances. Native American communities need additional resources in order to attain more equitable outcomes, but there are barriers physically and legislatively to obtaining these outcomes.

Much of the legislative barriers are due to the relationship between tribal entities as sovereign states and the United States as an overarching federal presence. The U.S. recognizes Native American tribes as domestic dependent nations, meaning they have a degree of self-governance but remain subject to federal oversight. This unique legal and political status has created a complex, sometimes adversarial, relationship between tribal nations and the federal government. Tribes have the right to self-governance, which predates the formation of the United States and its settlers' westward expansion. Tribal sovereignty and self-governance mean that tribes can govern their own lands, create laws, manage resources, and operate judicial systems, at least in theory. In practice, tribal sovereignty is not absolute (Cornell, 2015). Congress has the power to modify or limit tribal authority, and federal agencies (such as the Bureau of Indian Affairs) oversee many aspects of Native governance. This oversight and responsibility held by the federal government stems from historic treaty terms, supreme court rulings, and federal laws that require the U.S. to protect tribal lands, resources, and rights while providing essential services such as healthcare, education, and infrastructure. However, the fulfillment of these obligations is questionable, as can be highlighted by the underfunding of Indian Health Services. This oversight can be beneficial in terms of

federal funding and government assistance, but funding is often not fully sufficient and federal oversight oftentimes obstructs the self-determination of Tribal governments while muddying what it means for tribes to be truly sovereign (Brouwer & Provins, 2024; Evans, 2011).

It is difficult to project a future where Native American can reclaim ownership of the entirety of their ancestral lands and are given true sovereignty over said ancestral lands. Short of that, the Native American people will likely have to navigate their relationship with the federal government to advance their interests from where they are now. Native Americans should not resign themselves to systemic neglect in health, infrastructure, education, and economic opportunities. Instead, research is needed to identify where there are funding and systemic shortcomings, and political action is needed to lobby for legislation that truly addresses the gaps in health, education, and economic opportunity faced by the Native American people.

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