Journal of Economics, Race, and Policy (2022) 5:194–209
https://doi.org/10.1007/s41996-021-00095-0

ORIGINAL ARTICLE

# Native American Age at Death in the USA

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Received: 2 June 2021 / Revised: 4 November 2021 / Accepted: 17 December 2021 /Published online: 4 March 2022
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## Abstract

There are persistent disparities in mortality rates between Native Americans and other groups in the USA. Public-use mortality data severely limits the ability of researchers to examine contextual factors that might explain these disparities. Using restricted-use mortality microdata, we examine the relationship between geographic location, specific causes of death, and age at death. We show that Native American women, on average, die 13 years earlier than White women; Native American men, on average, die 12 years earlier than White men. These disparities are largest in the northern Great Plains and Rocky Mountain states. The disparity in age at death is in part due to Native Americans dying from diseases at younger ages than White Americans. Native American women and men die younger and more often from homicide in counties with persistently higher White male to female ratios. Native American men also die younger and more often from homicide when White male to female ratios increase within their county over time.

**Keywords** Health · Native American · Gender · Sex · Age at death · Cause of death · Homicides · Mortality disparities

## Introduction

There are well-documented historical disparities in health outcomes and mortality rates between Native Americans and other groups in the USA (Barnes et al. 2010; Gracey and King 2009; Indian Health Service 2019; Jones 2006; Sequist 2017). For example, age-adjusted mortality rates are 40% higher for American Indian and Alaska Native (AIAN) populations than all other racial groups (Sarche and Spicer 2008). In the era of COVD-19, Native American mortality from COVID-19 were estimated to be approximately 2.5 times that of non-Hispanic Whites (Akee and Reber 2021) in part due to systemic differences in health care access and basic housing resources (Rodriguez-Lonebear et al. 2020).

Despite the evidence of health disparities facing Native Americans, existing data sets for American Indian, Alaska Native, and Native Hawaiian (AIANNH) mortality often are quite limited in their subnational geography, time series dimensions and/or lack a consistent race definition over time. This makes it difficult to conduct detailed analysis of the factors associated with mortality outcomes for Native Americans and assess regional variation using standard data sets. In this paper, we use restricted-use National Center for Health Statistics (NCHS) data to document Native American mortality trends over time and by geography which are not often provided in public use data or reports. This data allows us to document and control for geographic variation in Native American causes of death and average age at death by genders in the USA. We include White Americans in this analysis as a illustrative comparison group.[1]

These data also allow us to speak to how regional variation in local conditions impact the average age of death of Native peoples. In recent years, advocacy groups have highlighted that homicide is a disproportionately high cause of death among Native American women and girls (Lucchesi and Echo-Hawk 2018). Native American men are also more likely to die from homicide than their non-Native counterparts. There is specific evidence that extraction industries are associated with increased violence against men; the oil boom in the Bakken region of North Dakota and Montana was associated with 30% increase in violent crimes where both the perpetrator and victims were

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[1] In our analysis that follows we include all AIANNH people as a single group and White Americans as a single group and do not separate out either of these race categories by Hispanic ethnicity.

male (Martin et al. 2019). The local gender imbalances that result from occupational segregation in the extraction industries near tribal lands have been a proposed cause of the disproportionate violent deaths of Indigenous people (Honor the Earth 2018). Our data allow us to explore how the local, White American male to female ratio[2] is associated with the average age of death, and the proportion of deaths due to homicide, of Native peoples. Although the White male to female ratio is an imperfect proxy for the measurement of extraction industries, the male to female ratio has been shown to be directly correlated with violence. For example, see Hesketh and Xing (2006) for a summary of early literature. More recent papers that empirically establish the correlation between the male to female ratio and violence include D'Alessio and Stolzenberg (2010), Diamond-Smith and Rudolph (2018), and La (2017).

In this paper, we start by confirming the findings of previous research that Native Americans die at younger ages than White Americans (Abbasi 2018). This finding holds across all years in our data and for both genders. We then investigate what factors may be driving these disparities in age at death. We implement a counterfactual analysis showing that Native Americans die at younger ages even when dying from the same cause of death as White Americans. We also show that Native American men tend to die from different causes of death than White Americans; these causes are more prevalent among people who die young.

We then examine the concern that deaths for Native Americans are related to the expansion of extraction industries (for example, fossil fuels) and the corresponding influx of men to an area. We specifically analyze the relationships between the White male to female (M/F) ratios on average age at death and the proportion of deaths attributed to homicide. We use county fixed effects to compare how age at death is related to both within-county and between-county variation in the White American M/F ratio. We find that Native American men and women die at younger ages and more often from homicide in counties with higher White American M/F ratios. For women, this relationship only appears for long-term changes, whereas men die younger and more often from homicide even with short-term changes in the White M/F ratio.

[2]Throughout this paper, we use the term "male to female ratio." The term reflects the underlying data we use to estimate this ratio, where individuals are identified as either "male" or "female." Because the underlying data does not collect gender and sex separately and relies on a binary outcome, the data likely reflects a combination of gender (social identity) and sex (biological traits). We therefore do not use the term "sex ratio" or "gender ratio."

This analysis contributes to the literature on disproportionately high death rates for certain racial and ethnic groups in the USA. Our work is perhaps closest to that of Espey et al. (2014) because of its temporal nature and its focus on mortality among Native peoples although we focus specifically on just American Indians and Alaska Natives. Espey et al. (2014) use US National Death Index records linked with Indian Health Service (IHS) data and focus on IHS Contract Health Service Delivery Area counties (in which less race misclassification occurs) to examine American Indian mortality relative to Whites from 1990 to 2009. The authors found that the death rate for American Indians was 46 percent higher than that of Whites. While Whites saw decreases in all-cause mortality over this time period, American Indians did not. We extend the work of Espey et al. (2014) in several ways. First, we examine whether the disparities in expected years of life are driven by differences in causes of death or the age at death for the given cause. Second, we cover a more recent time period (up to 2017), include all Native peoples, and have a more expansive geographic coverage. Finally, we examine whether age at death is correlated with local M/F imbalances.

Our work is also similar to Feir and Akee (2019) given our use of administrative data. However, they focus on Indigenous mortality in Canada and we focus on Indigenous mortality in the USA. Our research is able to address which causes of death show the largest differences across race groups and we have the county of death which Feir and Akee (2019) did not have access to in their data.

## Background

Many American Indian reservations, Alaska Native villages and Native Hawaiian Homelands are disproportionately rural. While a large proportion of the overall Native American population currently resides in urban settings, as does the rest of the country, Native American trust lands are still important culturally, economically and politically. However, the rural location of these lands can pose several significant issues for the health and safety of Native Americans.

First, there is a lack of access to adequate healthcare facilities and services in many of these locations. While there has been significant improvements in the past twenty years, there are still significant deficiencies in the availability of hospitals and clinics on or near these homelands. In particular, reservation or village residents typically have to travel much longer distances to access healthcare and preventative services than their non-rural counterparts (Indian Health Service 2019; Quintero et al. 2021). As a result, there may be an important link between

residing in these remote, rural locations and shortened lifespans of Native American people.

Second, given the overlapping jurisdictions of federal and tribal governments in criminal and civil cases, it is often difficult or impossible to arrest, evict or prosecute non-Natives residing on reservations, villages or other homelands. In cases where there is known domestic violence and/or drug and alcohol abuse it is often quite difficult for tribal governments to discipline these non-Native community members as they lack the authority to do so. As a result, repeat offenders are often able to remain in close proximity to their victims and allowed to continue to offend. This creates an on-going problem of high rates of violence, murder and homicide for Native American women and girls. Often these individuals go missing and there is little to no follow-up or investigation in these matters. Native Women's Wilderness, a human rights organization devoted to solving the problem of Missing and Murdered Indigenous Women (MMIW) writes:

> Our women and girls are being taken from us in an alarming way. As of 2016, the National Crime Information Center has reported 5,712 cases of missing American Indian and Alaska Native women and girls. Strikingly, the U.S. Department of Justice missing persons database has only reported 116 cases. The majority of these murders are committed by non-Native people on Native-owned land. The lack of communication combined with jurisdictional issues between state, local, and tribal law enforcement, make it nearly impossible to begin the investigative process (Native Women's Wilderness 2021).

Likewise, New Mexico-based Coalition to Stop Violence Against Native Women notes the importance of location in violence against Indigenous people when they explain "Many times Native people are targeted in bordertowns for the color of a person's skin, anti-Indianism, and the influences of settler colonialism" (Coalition to Stop Violence Against Native Women 2021). Extraction industries, like natural gas mining or pipeline construction, create short-term housing for workers known as "man camps" that have been linked to increases in violent crime against men (Martin et al. 2019) and against Native American women (Honor the Earth 2018).

Despite the important role of location, it is surprisingly difficult to document local or state-level variation in mortality among Indigenous people because publicly available data do not report subnational mortality statistics if there are fewer than 10 deaths due to privacy and confidentiality reasons. While this is an important restriction that protects individual's privacy, we show that this restriction makes it impossible to disaggregate annual Native American mortality rates to identify the geographical patterns, age groups, or causes of death among Indigenous people using public data. To address this barrier, we use restricted-use National Center for Health Statistics (NCHS) data to examine the causes of death that drive disparities in age at death, document mortality trends over time, and examine geographic patterns in mortality.

## Data

### Mortality Data

The NCHS publicly available data provide mortality rates (deaths per 100,000) for different causes of death by race, gender and age group. Any subnational (state, county) level mortality rates are suppressed when the number of deaths is below 10 in public-use data. This data suppression practice has a unique impact on documenting and explaining deaths of Indigenous people. Local geographic information may be an important characteristic in helping us understand Native American deaths due to violence. Analysis that fails to take account of the geographical dispersion of the Native American population and the concentration of rural deaths of the Indigenous populations will fail to uncover important trends or explanatory patterns. The history of systematic genocide, furthermore, means that the population of Indigenous people is relatively small in many counties. Therefore, publicly available data will, by default, suppress specific Native American causes of death or specific age groups for many counties in the USA.

We illustrate this issue in the first panel of Table 1. There are 3,143 counties and county-equivalents in the 50 states and the District of Columbia in 2017. However, Native American mortality rates are only reported for less than 10% of all counties in the USA (6.59% of counties for Native American women and girls and 7.54% of counties for Native American men and boys). This contrasts with more than 96% of all counties in the USA for both White male and females. Thus, even a simple analysis of overall county-level Native American mortality using public data will be restricted to only 6–7% of all counties.

Public-use data is even more restricted when researchers are interested in examining causes of death at the county level. For example, death certificates in the USA contain a code which indicates the cause of death; the code is a standardized set of causes of death that are known as the International Classification of Diseases (ICD). If every county listed the mortality rate for each ICD-10[3]

[3]The ICD version 10 (ICD-10) coding structure includes 20 broad chapters that describe general cause as well as detailed causes of death.

**Table 1** Percent of US counties that provide mortality rates by race and gender in 2017

| | AIANNH | | White | |
|---|---|---|---|---|
| | Females | Males | Females | Males |
| County mortality rate | 6.59% | 7.54% | 96.34% | 97.07% |
| County mortality rate in combination with other variables | | | | |
| Cause of death — ICD chapter | 0.22% | 0.31% | 24.74% | 25.01% |
| Five year age groups | 0.12% | 0.20% | 17.76% | 22.84% |
| One year age groups | 0.00% | 0.00% | 4.92% | 6.73% |

Note: Authors' extractions from CDC Wonder (https://wonder.cdc.gov/ucd-icd10.html). There are 3,143 total counties in the US county × ICD chapter = 62,860 total observations; County × 5-year age groups = 69,146 total observations; County × 1-year age groups = 317,443 total observations

chapter, there would be 62,860 total observations (3,143 counties × 20 ICD-10 chapters = 62,860 total observations). As shown in the second panel of Table 1, only 0.22% of those total observations are available for Native American women and girls and only 0.31% for Native American men and boys. In contrast, 24.74% of observations are available for White women and girls and 25.01% for White men and boys.

If, instead, researchers were interested in examining the incidence of death at the county level by 5-year age groups, then there would be a total of 69,146 total observations (3,143 counties × 22 age groups = 69,146 total observations). This is shown in the third row of Table 1. Only 0.12% of those total observations are available for Native American women and girls compared to 17.76% for White American women and girls. Similarly low rates exist for Native American men and boys as compared to White men and boys in the USA. The results are even more dire for one year age groups and county of death as shown in the final row of Table 1.

In short, there are far fewer observations for Indigenous mortality rates at subnational geography than White American mortality rates. Moreover, the number of observations available for an analysis of Indigenous peoples' deaths by gender decreases dramatically when one wishes to examine fine-grained aspects of mortality rates like broad cause of death or age at death. This lack of public data, while important to protect confidentiality, is a serious barrier to explaining the patterns of death among of Indigenous men and women.

To overcome this barrier, we analyze restricted-use microdata on individual deaths in the USA from the National Center for Health Statistics (NCHS) that contains geographic and demographic information. This data includes all death certificates issued in the USA from 2005 to 2017. This data includes the county where the death was recorded, race and age of the person who died, education of the person who died, ICD-10 codes for all recorded causes of death, whether the person was autopsied, who signed the death certificate, and other information on the death. The main outcomes we analyze are average age at death and the proportion of deaths from homicide.

It is important to note a serious weakness of the restricted-use NCHS data. All official mortality data, including the restricted-use NCHS data, relies on the information recorded on the death certificate. There is systematic bias in how medical examiners and coroners record information on race and cause of death on death certificates. For example, 15% of American Indians and Alaska Natives on the Northwest Tribal Registry who died in Washington State were misclassified as non-AIAN on their death certificate (Stehr-Green et al. 2002). Similarly, 22% of American Indians and Alaska Natives who received care from the Indian Health Services and died in Oklahoma were racially misclassified (Dougherty et al. 2019). The NCHS linked death certificate data to the Current Population Survey and found that over 40% of people who self-reported being American Indian or Alaska Native in the CPS were recorded as White on their death certificate; this high level of racial misclassification was found in data from 1979 to 2011 (Arias et al. 2016). Racial

For example, "External causes" is an ICD-10 chapter that includes deaths from all external factors, including traffic collisions, drug overdoses, murder, and all other non-medical or disease-related causes of death.

misclassification for the AIAN population is less likely to occur in rural areas (Stehr-Green et al. 2002) and in Contract Health Service Delivery Areas (Jim et al. 2014). Nevertheless, this is the best available data to conduct this analysis.

### Data on Male to Female Ratios

In rural areas, extraction industries bring a wide range of changes to a local community, including changes in income, increased housing prices, and a sudden increase in population without a corresponding increase in local government resources (Ruddell et al. 2014). During the fossil fuel boom in the Bakken region, crime increased — particularly violent assaults against men. Similarly, a key concern for the Missing and Murdered Indigenous Women epidemic is the role of non-Native men who attack Native American women, particularly temporary workers in extraction industries living in "man camps" (Honor the Earth 2018) near and around Native American homelands. These crimes are difficult to investigate or prosecute because of jurisdictional barriers; in particular, the Oliphant Supreme Court decision (1978) established that local or tribal officials did not have the jurisdiction to charge non-Indians with many offenses on reservation lands.[4]

However, even outside of tribal lands, such as in border towns or other rural areas, a disproportionately high number of men may increase Native mortality. Specifically the male to female ratio (M/F) has been linked with violence more broadly (Diamond-Smith and Rudolph 2018; D'Alessio and Stolzenberg 2010; Hesketh and Xing 2006; La 2017). As a proxy for measuring exposure to transient workers in extraction industries and as an object of interest in and of itself, we construct the male to female (M/F) ratio from the intercensal county population estimates published by the U.S. Census Bureau. We use the male to female ratios for specific races (White and American Indian/Alaska Native/Native Hawaiian) for 2005 to 2017 by county and year. Because the M/F ratio is based on intercensal county population estimates, this measure is more prone to error for smaller populations than larger ones.

## Methods

### Counterfactual Distribution of Age at Death Estimates

We first document mortality differences between Native Americans and White Americans by gender and examine differences in the average age at death. We tabulate the causes of death for Native and White Americans and calculate the average age at death from each of these causes of death for each race group. We use this information to weight the average age at death for Native Americans so that they match the proportion of White Americans who died from each cause of death. This produces a counterfactual cause of death distribution for Native Americans based on the White causes of death.

In Eq. 1 the outcome variable is the counterfactual Native American age at death, denoted $\tilde{Age}_{AIAN}$. The variable $\hat{p}_{w,c}$ measures the proportion of White Americans, $w$, who died from cause of death $c$ and $\bar{age}_{AIAN,c}$ is the average age at death for Native Americans from cause $c$.

$$\tilde{Age}_{AIAN} = \Sigma_c \hat{p}_{w,c} \times \bar{age}_{AIAN,c} \quad (1)$$

For the second analysis, we use the proportion of Native Americans, $AIAN$, who died from cause of death $c$ denoted as $\hat{p}_{AIAN,c}$ weighted by the average age at death for each of these causes for White Americans, $\bar{age}_{w,c}$. This relationship is shown in Eq. 2 below.

$$\tilde{Age}_{AIAN} = \Sigma_c \hat{p}_{AIAN,c} \times \bar{age}_{w,c} \quad (2)$$

These two different weighting schemes provide counterfactual information on what the distribution of deaths would look like if they occurred for the same causes of death (Eq. 1) or the same average age at death (Eq. 2) as for White people. Our analysis will produce two counterfactual estimates for the AIAN average age at death that we plot using kernel density estimation.

### Male to Female Ratio Analysis and Age at Death

One of our contributions is to investigate the relationship between Native American mortality and the M/F ratios in the counties where the death occurred. In this next set of analyses, we focus on two outcome variables: age at death and death by homicide.

We run the following regression in Eq. 3 to establish the relationship between the M/F ratios across counties and the average age at death for Native Americans. We do not take these relationships to be causal, merely associative.

In the following equation, $Age\text{-}at\text{-}death_{i,c,y,r}$ denotes person $i$ from race group $r$ died in county $c$ in year $y$. We denote the male to female ratio, $mfr$, of the other race (e.g., if person i is Native American, we examine the relationship to the White male to female ratio) by $mfr_{c,y,-r}$. We do not examine the relationship between age at death and a person's own race group, because this may simply represent a mechanical relationship (e.g., when White woman die younger, it increases the White American M/F ratio in the county). The variables $\tau_y$ and $\mu_c$ represent time and county fixed effects, respectively. We report results including and

[4] Oliphant v. Suquamish Indian Tribe, 435 U.S. 191 (1978).

excluding county fixed effects so that we can examine the relationship both within and between counties.

$$Age\text{-}at\text{-}death_{i,c,y,r} = \beta_0 + \beta_1 \times mfr_{c,y,-r} + \tau_y + \mu_c + \epsilon_{i,c,y,r} \quad (3)$$

We use the same framework to examine the proportion of people who died by homicide. Here we examine the relationship between an indicator variable if person i died by homicide ($Homicide_{i,c,y,r}$) and the male to female ratio. We consider the White American and Native American M/F ratios in separate regressions.

## Counterfactual Distribution of Deaths and Ages at Death Results

### Differences in Average Age at Death

Table 2 shows the average age at death for Native Americans and White Americans from 2005 to 2017 based on the restricted-use NCHS data. In 2017, Native American women and girls died 12.5 years earlier than White women and Native American men died almost 12 years earlier than White men. The average age at death has increased slightly for all women and men of all races from 2005 to 2017. However, the difference in the average age at death between White Americans and Native Americans has decreased slightly over time for both men and women. Appendix Table A1 shows this disparity starts in early childhood. Among Native Americans, 2.86% of deaths occur at age 5 or younger. In contrast, among White Americans less than 1% of deaths occur at age 5 or younger. Appendix Tables A2 and A3 show the most common causes of death for deaths that occur at age 5 or younger for Native Americans and White Americans.

While there are differences across race and gender groups in the average age at death, we show in Fig. 1 that there are also differences across US states in the average age at death. Panels A and B show the state-level variation in average age at death for Native American females and males, respectively. Darker colors indicate younger ages at death. The figures indicate a clear pattern of younger deaths for Native Americans in the northern Great Plains states (North and South Dakota, Minnesota, Nebraska) and northern Rocky Mountain states (Montana, Wyoming, Nebraska, and Utah).

In contrast, Panels C and D of Fig. 1 indicate that White Americans live longer in the northern Great Plains and northern Rocky Mountain states. This is an important and striking difference: states where White Americans are dying at older ages are places where Native Americans are dying at younger ages. The observed differences in average age at death shown in Fig. 1 are not driven by Native Americans living in states where all people die younger on average. Instead, the divergence in average age at death is for people residing in the same US states.[5]

### Differences in Causes of Death

The strikingly persistent disparity in average age at death between Native Americans and White Americans shown in Table 2 could be due to dying of different causes or due to dying earlier of the same causes. In the first case, it might be that Native Americans die from causes that typically occur at younger ages and are less common among White Americans. For example, deaths from auto-collisions occur more often at a young age and accounts for 1.13% of Native American women and girl deaths, while it only accounts for 0.27% of White women and girl deaths. In the second case, even when Native Americans have similar medical conditions, they may lack the proper healthcare to deal with the conditions and consequently die at younger ages than other groups with more resources. Typical examples are the rate of cancer diagnoses, treatment and survival rates across race and ethnic groups in the USA (Indian Health Service 2019; Jones 2006; Unal 2018).

In order to begin to assess which dimension explains a larger proportion of the age at death disparity, we tabulate the NCHS data to identify the top 22 causes of death for Native American and White females in Table 3 and for Native American and White males in Table 4. The first set of three columns show the percent of all female deaths for each cause of death for Native American and White Americans. The third column in that section indicates whether the proportion is larger or smaller than for White Americans. The data indicate that Native American women and girls die at a higher rate from diabetes, liver disease, vehicle accidents and accidental overdoses than White Americans in Table 3. On the other hand, White females tend to die more frequently from chronic heart disease, Alzheimer's disease and dementia — which are diseases that tend to start at older ages in general.

The second set of three columns indicates the average age at death from those causes by race. The third column shows the difference in age at death across the two race groups; in all cases shown, we find differences that are negative in sign indicating that Native Americans die at younger ages than

[5] It is also worth noting that these stark geographic differences in age of death for Native American and Whites occur in the states that entered the Union after the Civil War and whose land was more likely to be transferred to the USA without formal treaties were the source of brutal land-acquisition policies resulting in massive dislocation of Indigenous populations. See Carlos et al. (2021) for maps of this dispossession and a discussion of this process.

**Table 2** Average age at death for women and girls (left panel) and men and boys (right panel) by the race reported on the death certificate

| | Average age at death for women and girls | | | Average age at death for men and boys | | |
|---|---|---|---|---|---|---|
| | Native American | White American | Difference | Native American | White American | Difference |
| 2005 | 63.8 | 77.3 | −13.5 | 56.4 | 69.9 | −13.5 |
| 2006 | 64.2 | 77.2 | −13 | 55.9 | 69.8 | −13.9 |
| 2007 | 63.7 | 77.2 | −13.5 | 56.6 | 70 | −13.3 |
| 2008 | 63.7 | 77.4 | −13.7 | 56.8 | 70.2 | −13.4 |
| 2009 | 63.3 | 77.2 | −13.9 | 56.8 | 70.3 | −13.5 |
| 2010 | 64.9 | 77.5 | −12.7 | 57.4 | 70.7 | −13.2 |
| 2011 | 64.4 | 77.6 | −13.3 | 58 | 70.8 | −12.8 |
| 2012 | 64.3 | 77.6 | −13.3 | 58 | 70.9 | −13 |
| 2013 | 65.1 | 77.7 | −12.6 | 58.8 | 71.1 | −12.3 |
| 2014 | 65 | 77.5 | −12.5 | 58.8 | 71.1 | −12.3 |
| 2015 | 65 | 77.6 | −12.7 | 59 | 71.2 | −12.1 |
| 2016 | 64.8 | 77.4 | −12.6 | 59 | 70.9 | −12 |
| 2017 | 65 | 77.5 | −12.5 | 59.3 | 71.1 | −11.9 |

Source: Authors' calculations from the restricted-use NCHS mortality data

their White counterparts from these causes of death. Similar results hold for Native American men and boys.

Given longstanding disparate access to healthcare, high rates of poverty and systemic racism, it is instructive to investigate the extent to which average ages at death differ for Native Americans relative to Whites by the cause of death. Differences in causes of death can reflect different environments — for example Native Americans dying from lung cancer could reflect higher exposure to cigarette smoke or other toxins. However, to the extent Native Americans who die from lung cancer do so, on average, three years earlier than White Americans, may reflect less access to preventative care, diagnosis and treatment.

We consider two counterfactual scenarios in Table 5 in order to show what the average age at death would be for Native Americans if they died from the same causes as Whites. For this counterfactual exercise, we consider only causes of death where we have observations for both Native Americans and White Americans — this overlap allows us to compute Eq. 1 and Eq. 2. There are 893 ICD-10 codes for men and boys and 888 for women and girls with the needed overlap.

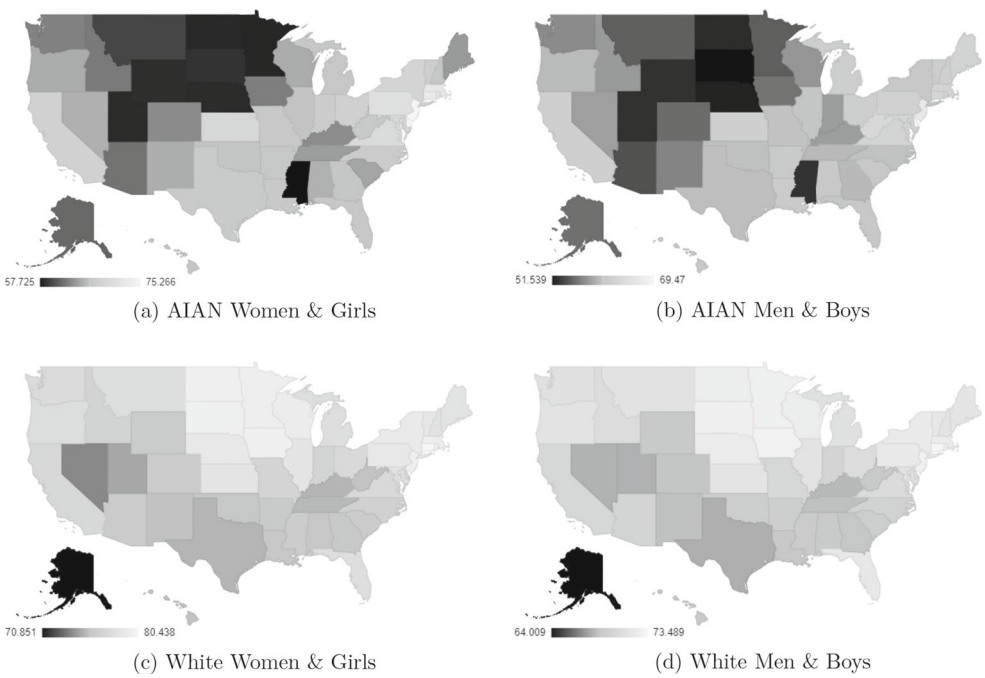


**Fig. 1** Average age at death by state, sex, and race from 2005 to 2017. Source: Authors calculations from restricted-use NCHS data. Note: Darker shaded states have younger average ages at death. Because the average age at death varies significantly between race by gender groups, each map has a different scale to highlight within group variation in average age at death

**Table 3** Top 22 causes of death for Native American women and girls (all causes with more than 1% of deaths)

| Cause of death | | Percent of all deaths | | | Average age at death | | |
|---|---|---|---|---|---|---|---|
| | | Native American | White American | Difference | Native American | White American | Difference |
| I25 | Chronic heart disease | 6.81 | 9.23 | −2.42 | 74.5 | 83.12 | −8.62 |
| C34 | Lung cancer | 4.58 | 5.6 | −1.02 | 68.66 | 72.02 | −3.37 |
| J44 | COPD | 4.33 | 5.72 | −1.39 | 72.84 | 78.19 | −5.35 |
| E14 | Diabetes (unspecified) | 3.84 | 1.64 | 2.2 | 68.11 | 75.11 | −7 |
| K70 | Alcoholic liver disease | 3.5 | 0.38 | 3.12 | 49.38 | 55.07 | −5.69 |
| I21 | Myocardial infarction | 3.26 | 4.33 | −1.07 | 72.78 | 80.17 | −7.39 |
| C50 | Breast cancer | 2.42 | 3.1 | −0.68 | 64.06 | 69.38 | −5.32 |
| G30 | Alzheimer's disease | 2.34 | 5.2 | −2.86 | 85.22 | 87.4 | −2.18 |
| F03 | Dementia | 2.32 | 5.45 | −3.13 | 86.34 | 88.23 | −1.89 |
| I64 | Stroke | 2.09 | 3.25 | −1.16 | 78.13 | 84.47 | −6.34 |
| E11 | Diabetes Mellitus | 1.95 | 0.72 | 1.23 | 71.11 | 77.77 | −6.66 |
| J18 | Pneumonia | 1.89 | 2.06 | −0.17 | 73.23 | 82.9 | −9.67 |
| A41 | Other septicaemia | 1.88 | 1.43 | 0.45 | 65.99 | 76.6 | −10.61 |
| I50 | Heart failure | 1.79 | 2.98 | −1.19 | 79.58 | 86.1 | −6.52 |
| K74 | Fibrosis and cirrhosis of liver | 1.62 | 0.57 | 1.05 | 60.26 | 67.75 | −7.49 |
| C18 | Colon cancer | 1.54 | 1.59 | −0.05 | 68.13 | 75.22 | −7.09 |
| N18 | Chronic renal failure | 1.36 | 0.79 | 0.57 | 69.92 | 78.93 | −9.02 |
| I11 | Hypertensive heart disease | 1.16 | 1.29 | −0.13 | 69.72 | 81.19 | −11.48 |
| V89 | Vehicle accident | 1.13 | 0.27 | 0.86 | 34.26 | 44.7 | −10.44 |
| C25 | Pancreatic cancer | 1.13 | 1.43 | −0.3 | 69.46 | 74.09 | −4.63 |
| X44 | Accidental drug overdose | 1.09 | 0.57 | 0.52 | 42.48 | 45.15 | −2.67 |
| C80 | Cancer (unspecified) | 1.01 | 1.01 | 0 | 68.9 | 73.98 | −5.08 |

Source: Authors' calculations from the restricted-use NCHS mortality data

If Native Americans died from the same causes of death as White Americans, the average age at death increases by six years for both women and men from their actual rates. Native American women's average age at death would be 70.7 years and it would be 64.1 years for Native American men; these increases are significant, however, they still do not reach parity with Whites.

In the bottom row of Table 5 we show the average age at death for Native Americans if they died at the same average age as White Americans for a given cause of death. We find that the average age at death would increase by about seven years for both Native American women and men. This suggests that both the different distribution of cause of death and the different age at which a person dies for a given cause play a role in the large difference in average age at death between these two race groups.

An alternative way to show these differences is to graph the kernel density of these age at death distributions. In Fig. 2, we plot the actual distribution for Native Americans and the two counterfactual distributions. The solid line in each figure shows the actual distribution of age at death for Native Americans; the dashed line shows the hypothetical distribution of age at death for Native Americans weighted by the White cause of death. The dotted line shows the hypothetical age at death with White age at death weighted by the Native American cause of death. The top panel presents the average age at death for Native American women and girls and the bottom panel displays the same results for men and boys. The vertical difference between the solid line and the dashed and dotted lines at ages 20–40 indicate that Native Americans are dying at higher rates than Whites. This is particularly large for Native American men and boys.

For both men and women, if Native Americans died from the same causes as White Americans, then the distribution of age at death would be notably shifted towards the right (as indicated by the dashed line). This indicates that the average age at death for Native Americans would increase

**Table 4** Top 22 causes of death for Native American men and boys (all causes with more than 1% of deaths)

| Cause of death | | Percent of all deaths | | | Average age at death | | |
|---|---|---|---|---|---|---|---|
| | | Native American | White American | Difference | Native American | White American | Difference |
| I25 | Chronic heart disease | 8.65 | 11.33 | −2.68 | 67.99 | 75.59 | −7.6 |
| C34 | Lung cancer | 4.53 | 6.79 | −2.26 | 68.2 | 71.1 | −2.9 |
| I21 | Myocardial infarction | 4.19 | 5.53 | −1.33 | 66.24 | 72.56 | −6.32 |
| K70 | Alcoholic liver disease | 3.99 | 0.99 | 3 | 50.56 | 56.78 | −6.22 |
| E14 | Diabetes (unspecified) | 3.43 | 1.91 | 1.53 | 63.48 | 70.48 | −7 |
| J44 | COPD | 3.37 | 5.07 | −1.7 | 72.46 | 76.59 | −4.13 |
| X70 | Intentional self-harm | 1.78 | 0.63 | 1.15 | 30.81 | 40.42 | −9.61 |
| V89 | Vehicle accident | 1.72 | 0.57 | 1.14 | 34.34 | 41.84 | −7.5 |
| F10 | Alcohol Related disorders | 1.66 | 0.45 | 1.21 | 51.12 | 56.54 | −5.42 |
| E11 | Diabetes Mellitus | 1.62 | 0.77 | 0.84 | 66.9 | 73.76 | −6.86 |
| J18 | Pneumonia | 1.56 | 1.78 | −0.22 | 68.43 | 78.76 | −10.33 |
| C22 | Liver cancer | 1.46 | 1.04 | 0.42 | 63.67 | 67.09 | −3.42 |
| C61 | Prostate cancer | 1.41 | 2.13 | −0.72 | 75.67 | 79.36 | −3.69 |
| C18 | Colon cancer | 1.37 | 1.64 | −0.27 | 66.12 | 71.38 | −5.26 |
| I11 | Hypertensive heart disease | 1.32 | 1.18 | 0.15 | 60.55 | 69.13 | −8.58 |
| I64 | Stroke | 1.32 | 1.99 | −0.67 | 72.55 | 79.22 | −6.67 |
| A41 | Other septicaemia | 1.27 | 1.26 | 0.02 | 63.37 | 73.18 | −9.81 |
| I50 | Heart failure | 1.25 | 2.21 | −0.96 | 72.86 | 81.5 | −8.64 |
| X42 | Accidental narcotic overdose | 1.24 | 0.89 | 0.34 | 38.88 | 39.15 | −0.27 |
| K74 | Fibrosis and cirrhosis of liver | 1.17 | 0.78 | 0.39 | 56.68 | 63.36 | −6.68 |
| X44 | Accidental drug overdose | 1.14 | 0.83 | 0.32 | 39.63 | 40.74 | −1.11 |
| F03 | Dementia | 1.1 | 2.49 | −1.39 | 82.58 | 85.22 | −2.64 |

Source: Authors' calculations from the restricted-use NCHS mortality data

if they experienced the same distribution for causes of death as Whites. However, the shift of the distribution to the right (i.e., more people living longer) is more dramatic for both men and women if Native Americans died at the same age as White Americans for a *given cause of death*. This suggests that while Native Americans are dying from causes of death that are less common among White Americans, they are also more likely to die younger for a given cause. As suggested above, this implies that differences in access to care may be an important explanatory factor in Native White mortality differences.

## Age at Death, Homicide, and the Male to Female Ratio Regression Results

We now shift our analysis to examining the relationship between age at death and having died by homicide and

**Table 5** Counterfactual average age at death for Native Americans using the White American distribution of cause of death and White American average age at death for each cause of death

| | Women and girls | Men and boys |
|---|---|---|
| Counterfactual average age at death using White distribution of cause of death | 70.65 | 64.09 |
| Counterfactual average age at death using White age at death for each cause | 71.76 | 64.61 |
| Actual Native American average age at death | 64.4 | 57.9 |

Source: Authors' calculations from the restricted-use NCHS mortality data. Includes deaths from ICD-10 codes with observations for both White American and Native American (888 causes of deaths for women and girls, 893 for men and boys) Average age at death for White women and girls from these causes is 77.5 and 70.7 for men and boys. Average age at death for Native American women and girls is 64.4 and 57.9 for men and boys

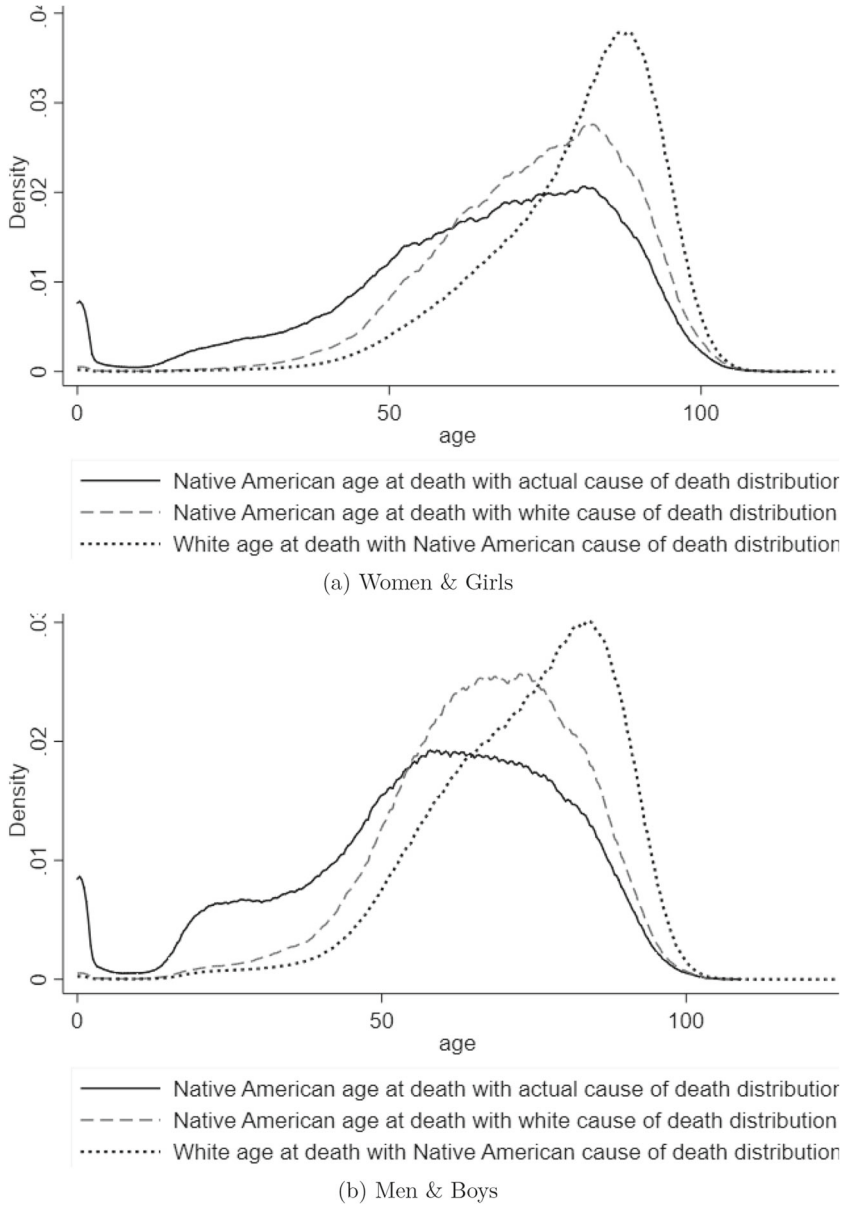


**Fig. 2** Counterfactual age at death distributions for Native Americans given White experiences. Source: NCHS restricted-use data and intercensal population estimates from the Census Bureau 2005 to 2017

the local M/F ratio. We use Eq. 3 to implement ordinary least squares regressions with two outcome variables: age at death and an indicator variable for the death being attributed to homicide. Our main variable of interest is the male to female (M/F) ratio in the county where the death occurred. There is considerable variation in the M/F ratios across different counties; we present results with and without county fixed effects to account for potential unobserved characteristics that differ across counties.

Appendix Fig. A1 shows the distribution of the White American M/F ratio in the counties where Native American deaths occurred. In 2017, the average White M/F ratio is 1.01, with a standard deviation of 0.115 (with each county as an observation).[6]

[6]See Appendix Fig. A2 for maps of the distribution of White male to female ratio by counties in the USA in 2017. Darker blue colors indicate a larger imbalance in the ratio towards men. Counties in the upper Midwest and Rocky Mountain regions have much higher White male to female ratios than counties farther east. The Native American gender imbalance does not follow the same geographic pattern as for White Americans; there are no large M/F imbalances in the Upper Midwest or Rocky Mountain region in the figure.

There is also variation within county over time in the White M/F ratios. Appendix Fig. A3 shows the White M/F ratios in the Bakken Shale region of North Dakota, an area that experienced a boom in hydraulic fracking oil extraction. The White M/F ratios have changed noticeably over the time period in our data: in 2005, the male/female ratio in the North Dakota Bakken region was 1.01, increasing to a peak of 1.13 in 2015 before slightly declining. Mountrail County, at the center of the Bakken Shale formation, saw an increase in the male/female ratio from 1.2 in 2005 to 1.4 at the peak of the boom, before returning to 1.3 in 2017.

We plot the average age at death and proportion of deaths attributed to homicide for Native Americans in Fig. 3 for all counties in the USA over the period 2005–2017 using the confidential-use NCHS data and M/F ratios for each county from the U.S. Census Bureau estimates. The graphs show the relationship between these outcomes at the county level (grouped in bins to preserve county-level anonymity) and the White American male to female ratio (left panels) and the Native American male to female ratio (right panels) in the county where the death occurred. Counties with extreme ratios (below 0.9 or above 1.3) are included in the appropriate end categories.

The left panel in Fig. 3 shows that there is a negative relationship between Native American age at death and the *White* American M/F ratio. There is a downward trend in both lines showing the average age at death for Native American women and men across all of the White M/F ratio. Native American women in counties with a White M/F ratio of 1.3 die six years earlier than those in counties with a male to female ratio of 0.9 and Native American men die about eight years earlier in similar counties. The left panel in Fig. 3 shows that there is no relationship between age at death and the Native American male to female ratio.

In Table 6, we present the regression results of age at death on the M/F ratios.[7] All regressions control for year fixed effects; columns 2, 4, 6, and 8 additionally control for county-level fixed effects. In particular, year and county fixed effects control for differences across counties and across time that are not directly related to the measured ratios.[8] The first result is that there are level differences in the average age at death by race and gender as shown in the differences in the estimated constant across all eight columns in this table. This mirrors the previous results where we documented the persistent gap in age at death between White American and Native American people.

The second result shown in columns 1 and 3 is that a higher White American M/F ratio *across counties* is associated a lower age at death for Native Americans. Columns 2 and 4 show that *within counties* a higher White American male to female ratio is associated with a lower age at death for Native American men (column 4) but not women (column 2). That is, the dramatic negative relationship between the White American M/F ratio and age at death for Native American women is largely between counties, rather than in response to an increase in the White American M/F ratio within the same county over time. However, for Native American men, the relationship is large and statistically significant at −6.7. This implies that a ten percentage point increase (less than one standard deviation) in the M/F ratio will decrease the average age at death by about 0.67 years or by about 8 months on average. In contrast, columns 4 through 6 show that a higher AIANNH M/F ratio is associated with White American women and men dying at slightly *older* ages.[9]

These results suggest that White male to female ratios are associated with differences in average age at death for both Native American men and women, but that short run changes locally in that ratio will be associated with larger effects for men only. On the other hand, more permanent changes in the relative prevalence of White men are more likely to affect both Native women and men dramatically. This finding may speak to the discussion of missing and murdered Indigenous women and girls as well as the fact that many tribal communities are unable to prosecute "non-Indians" on reservations. Specifically, if Native American women are more likely to partner with White men if there is a surplus of them around for longer (i.e., fixed differences in county male to female ratios), issues of domestic violence and institutional power may be more important than if there is a short-term change in the male to female ratio.

We further explore the connection between M/F ratios and deaths by violence in Table 7. We use the same regression framework from the previous analysis; however,

[7]Summary statistics for the variables included in the regression are presented in Appendix Table A4

[8]We do not present the relationship between age at death and own race group, because this can simply be mechanical (e.g., when White woman die younger, it increases the White American male/female sex ratio).

[9]To more fully investigate the role of sex ratio imbalances and violence against women, Appendix Table A5 focuses on the M/F ratio for the age 15–39 population of Native Americans and White Americans. This age group is the relatively young, marriageable population and may be more salient when considering intimate partner violence. The first difference is that effect of the White male to female ratio for this young age group has a negative impact on the age of death for Native American women. While not statistically significant, the point estimate on the relationship between Native American women's age at death and the White male to female ratio is −1.855, implying that a ten percentage point increase in the White male to female ratio among young people will decrease age at death by 0.1855 years or 2.2 months. On the other hand, we find that the male to female ratio for Native Americans in this young age group does not have a large (nor statistically significant) effect on the age at death of White women.


**Fig. 3** Age at death and proportion of deaths from homicide by county male-female ratio. Source: NCHS restricted-use data and intercensal population estimates from the Census Bureau 2005 to 2017. 95% confidence intervals shown by dotted lines

we also examine the relationship between a death being attributed to homicide and own race M/F ratios. The first four columns of Table 7 indicate that there is no relationship between either the White or Native American M/F ratio and whether the manner of death is homicide for Native American women or girls. In the next four columns, we present similar analysis for Native American men and boys. We find that higher White male to female ratio within

**Table 6** Age at death by race and gender

| | Native American | | | | White American | | | |
|---|---|---|---|---|---|---|---|---|
| | Women and girls | | Men and boys | | Women and girls | | Men and boys | |
| Outcome: Age at death | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| White M/F ratio | −2.442*** | 0.390 | −3.865*** | −6.713** | | | | |
| | (0.513) | (4.030) | (0.408) | (3.318) | | | | |
| AIANNH M/F ratio | | | | | 0.755*** | 0.202*** | 0.528*** | 0.0658 |
| | | | | | (0.0207) | (0.0534) | (0.0230) | (0.0595) |
| Constant | 66.25*** | 63.35*** | 60.32*** | 63.33*** | 76.50*** | 77.03*** | 69.35*** | 69.81*** |
| | (0.580) | (4.042) | (0.477) | (3.345) | (0.0272) | (0.0585) | (0.0301) | (0.0652) |
| Observations | 96,543 | 96,543 | 116,913 | 116,913 | 14,213,856 | 14,213,856 | 14,194,710 | 14,194,710 |
| *R*-squared | 0.001 | 0.071 | 0.004 | 0.062 | 0.000 | 0.023 | 0.001 | 0.022 |
| County FE | No | Yes | No | Yes | No | Yes | No | Yes |

Note: Authors' calculations from the restricted-use NCHS mortality data and intercensus population estimates, 2005 to 2017. All regressions include year fixed effects. Standard errors are in parentheses and clustered at the county level. Data represents the entire age distribution for the relevant population. Data: Authors' calculations from the restricted-use NCHS data and intercensus population estimates, 2005 to 2017. Significance stars: ***$p<0.01$, **$p<0.05$, *$p<0.1$

**Table 7** Death by homicide for Native Americans by gender

| | Native American Women and girls | | | | Native American Men and boys | | | |
|---|---|---|---|---|---|---|---|---|
| Outcome: Death attributed to homicide | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| White M/F ratio | 0.00176 | 0.00182 | | | 0.00317 | 0.0674*** | | |
| | (0.00220) | (0.0178) | | | (0.00296) | (0.0245) | | |
| AIANNH M/F ratio | | | −0.00264 | −0.00496 | | | −0.0104*** | −0.00285 |
| | | | (0.00277) | (0.0104) | | | (0.00305) | (0.0130) |
| Constant | 0.00917*** | 0.00937 | 0.0136*** | 0.0161 | 0.0259*** | −0.0392 | 0.0394*** | 0.0314** |
| | (0.00249) | (0.0179) | (0.00298) | (0.0104) | (0.00346) | (0.0247) | (0.00352) | (0.0131) |
| Observations | 96,543 | 96,543 | 96,543 | 96,543 | 116,913 | 116,913 | 116,913 | 116,913 |
| *R*-squared | 0.000 | 0.020 | 0.000 | 0.020 | 0.000 | 0.020 | 0.000 | 0.020 |
| County FE | No | Yes | No | Yes | No | Yes | No | Yes |

Note: Authors' calculations from the restricted-use NCHS mortality data and intercensus population estimates, 2005 to 2017. Data represents the entire age distribution for the relevant population. All regressions include year fixed effects. Linear probability model used. Standard errors are in parentheses and clustered at the county level. Data: Authors' calculations from the restricted-use NCHS data and intercensus population estimates, 2005 to 2017. Significance stars: ***$p<0.01$, **$p<0.05$, *$p<0.1$

a county over time is associated with a sizable increase in the proportion of Native American men who die by homicide. A ten percentage point increase in the White male to female ratio is associated with a 0.67 percentage point increase in the proportion of Native American men and boys whose deaths are attributed to homicide. We also see that a higher Native American M/F ratio is associated with a lower probability of death by homicide for Native American men and boys.

In Table 8, we present a similar analysis for death by homicide for White Americans. An increase in the White male/female sex ratio is associated with an increased proportion dying by homicide for both women and men. A ten percentage point increase in the White male to female ratio is associated with a 0.3 percentage point increase in the proportion of White men and boys who die from homicide. Increases in the Native American male to female ratio is not associated with differences in death by homicide for White

**Table 8** Death by homicide for White Americans by gender

| | White women and girls | | | | White men and boys | | | |
|---|---|---|---|---|---|---|---|---|
| Outcome: Death attributed to homicide | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| White M/F ratio | 0.00958*** | 0.00733*** | | | 0.0326*** | 0.0300*** | | |
| | (0.000302) | (0.00181) | | | (0.000471) | (0.00289) | | |
| AIANNH M/F ratio | | | −8.01e−05 | −0.000176 | | | −0.00106*** | −7.22e−05 |
| | | | (5.82e−05) | (0.000152) | | | (9.80e−05) | (0.000256) |
| Constant | −0.00699*** | −0.00480*** | 0.00240*** | 0.00251*** | −0.0249*** | −0.0224*** | 0.00795*** | 0.00687*** |
| | (0.000296) | (0.00176) | (7.63e−05) | (0.000166) | (0.000464) | (0.00281) | (0.000129) | (0.000281) |
| Observations | 14,213,856 | 14,213,856 | 14,213,856 | 14,213,856 | 14,194,710 | 14,194,710 | 14,194,710 | 14,194,710 |
| *R*-squared | 0.000 | 0.001 | 0.000 | 0.001 | 0.000 | 0.003 | 0.000 | 0.003 |
| County FE | No | Yes | No | Yes | No | Yes | No | Yes |

Note: Authors' calculations from the restricted-use NCHS mortality data and intercensus population estimates, 2005 to 2017. Data represents the entire age distribution for the relevant population. All regressions include year fixed effects. Linear probability model used. Standard errors are in parentheses and clustered at the county level. Data: Authors' calculations from the restricted-use NCHS data and intercensus population estimates, 2005 to 2017. Significance stars: ***$p<0.01$, **$p<0.05$, *$p<0.1$

Americans except for a decrease in homicides among White men and boys when we do not control for county fixed effects (shown in column 7).

In Appendix Table A6 we provide regression results where the outcome of the manner of death is not specified on the death certificate for Native Americans. We do this to investigate the potential explanation that our lack of correlation being Native women and girl homicide and the male to female ratio being due to Native women and girls being more intensely affected by their causes of death not being recorded when homicide occurs as the male to female ratio increases. The "not-specified" designation occurs when the manner of death is simply not indicated on the death certificate. We find that increases in the White M/F ratio is strongly associated with an increases in the proportion of "not specified" deaths for Native American women and the correlation is stronger for Native women and girls than for Native men. This suggests that our results may underestimate the effect of the M/F ratio on homicide for Native women and girls.

Taken together, these regression results present a troubling picture of mortality disparities. Increases in the White M/F ratios over time are associated with Native American men dying younger and more often from homicide. That is, temporary increases in the population of men appears to be associated with these two negative outcomes for Native American men's mortality. Native women and girls also seem to be affected by a higher White M/F ratio, but more clearly so when a high M/F ratio is more permanent in nature. However, short-term changes in deaths by homicide for Native women and girls may be more intensely affected by their causes of death simply never being recorded.

## Conclusion

We see our work as having three main takeaways that are important for public policy. First, Native peoples' lives are shorter in the same places where White lives are longer. On average Native Americans die 12 to 13 years earlier than Whites Americans and a significant part of this difference is attributable to Native people dying sooner from the same causes of deaths as White Americans; even if the distribution of the causes of death were the same, Native people would still die about six years earlier on average. This result is consistent with Native peoples experiencing systemically poorer care when negative health events occur and/or being more vulnerable due to historical conditions. This implies improving the availability of quality care for Native peoples when negative health events occur and reducing other economically generated vulnerabilities is a critical part of reducing differences in life expectancy. Besides the obvious tragedy of the loss of years of life, there are cultural implications of the early ages of death among Native people. Native American elders are essential to preserving and passing on language and culture; as such, early death among elders can be particularly damaging (Sparks, 2021). In addition, while elders are the essential purveyors of cultural knowledge, the loss of young lives prevents the intergenerational transmission of this knowledge that often cannot be replaced once lost.

Second, we document that because of confidentiality restrictions, CDC public-use data omits disaggregated information on Native Americans in the vast majority of counties where Native people live. Out of 3,143 counties and county equivalents in the 50 states and the District of Columbia, Native American mortality rates are masked for more than 90% of all counties. This implies that research into the systemic, geographically determined factors that influence Native health are virtually impossible with public data. In order to facilitate actionable research on the factors that influence Native mortality, policy makers should consider how existing policies and procedures limit access to data. These limitations affect the ability of community members and academic allies to advocate and/or conduct meaningful evaluation on these topics. Identifying data-sharing solutions that allow for advocacy and/or research while maintaining privacy guidelines should be a priority.

Our final main result is that the local White male-female ratio has implications for Native mortality. For both Native men and women, the average age of death and the proportion of deaths due to homicide are higher in areas with higher male-female ratios. This aligns with the literature documenting gender or sex imbalances associated with higher levels of violence (Hesketh and Xing 2006; D'Alessio and Stolzenberg 2010; La 2017; Diamond-Smith and Rudolph 2018). This suggests that when policy makers are considering supporting local industries that create imbalances in the population of men and women, they should account for the potential costs associated including increased violence against Native people. For example, fracking is generally associated with gender imbalances and much of the extant literature focuses on the benefits of fracking industries; positive impacts of fracking and related industries include those on earnings, fertility rates, and wages of migrants (Kearney and Wilson 2018; Wilson 2020) and reductions in crime (Street 2018). However, these benefits appear to be concentrated among migrants to the locations examined (Gittings and Roach 2020) who are disproportionately White and male. Even studies that uncover adverse impacts of fracking and related industries on such health outcomes as sexually transmitted diseases do not isolate these impacts by Indigenous status (Komarek and Cseh 2017). Our results generally suggest that industries

associated with gender imbalances have important costs that are not evenly distributed across communities and that also need to be considered in policy decisions.

Indeed, failure to count the preventable deaths of Native Americans in the assessment of the net-benefits, of say, investments in extraction industries that lead to booming economic outcomes for Whites, will overstate these net-benefits (Nanney et al. 2019). While this research has focused on age at death and systematic and persistent differences between Natives and Whites, it is important to highlight that this research does not affirm the myth of differences in mortality being due solely to biological causes, dysfunctional behaviors, or cultural deficits. Rather it points to the systemic factors that may influence the life expectancy of Native Americans. We should also point out that the nature of the statistical analysis generalizes a very diverse set of experiences of tribal communities. Future work should continue to carefully consider the structural and systemic forces that reduce the life expectancy of Native Americans and take lessons from that Tribal Nations who have successfully evaded the average statistics.

**Supplementary Information** The online version contains supplementary material available at doi:10.1007/s41996-021-00095-0.

**Funding** This work received support from the Minnesota Population Center (P2C HD041023) funded through a grant from the Eunice Kennedy Shriver National Institute for Child Health and Human Development (NICHD). The views expressed here are not necessarily those of, and should not be attributed to, the Federal Reserve System, its Board of Governors or any Federal Reserve Bank.

**Data Availability** We will provide all public data and replication files used in this article via authors' websites. We will additionally provide the replication files used on the restricted-use data; while we are not able to provide the restricted-use data itself, this will allow other researchers with NCHS-approved access to replicate our findings.

## Declarations

**Conflict of Interest** The authors declare no competing interests.

## References

Abbasi J. Why are American Indians dying young?. Jama. 2018;319(2):109–111.

Akee R, Reber S. American Indians and Alaska Natives are dying of COVID-19 at shocking rates. Washington: Brookings Report; 2021. https://www.brookings.edu/research/american-indians-and-alaska-natives- are-dying-of-covid-19-at-shocking-rates/.

Arias E, Heron MP, Hakes JK. The validity of race and Hispanic origin reporting on death certificates in the United States: an update National Center for Health Statistics. Vital Health Stat. 2016;2:172.

Barnes PM, Adams PF, Powell-Griner E. Health characteristics of the American Indian or Alaska native adult population, United States, 2004-2008 National Health Statistics Reports. 2010.

Carlos AM, Feir D, Redish A. Indigenous nations and the development of the US economy: Land, resources, and dispossession. QUCEH Working Paper Series, No. 2012-04. 2021.

Coalition to Stop Violence Against Native Women. #MMIWG2S – Missing and Murdered Indigenous Womxn, Girls, and Two Spirit. 2021.

D'Alessio SJ, Stolzenberg L. The sex ratio and male-on-female intimate partner violence. J Crim Justice. 2010;38(4):555–561.

Diamond-Smith N, Rudolph K. The association between uneven sex ratios and violence: Evidence from 6 Asian countries. PloS one. 2018;13(6):e0197516.

Dougherty TM, Janitz AE, Williams MB, Martinez SA, Peercy MT, Wharton DF, Erb-Alvarez J, Campbell JE. Racial misclassification in mortality records among American Indians/Alaska Natives in Oklahoma from 1991-2015 Journal of public health management and practice: JPHMP. 2019. 25, Suppl 5 Tribal Epidemiology Centers Advancing Public Health in Indian Country for Over 20 Years. S36. 2019.

Espey DK, Jim MA, Cobb N, Bartholomew M, Becker T, Haverkamp D, Plescia M. Leading causes of death and all-cause mortality in American Indians and Alaska Natives. Amer J Public Health. 2014;104(S3):S303–S311.

Feir D, Akee R. First Peoples lost: Determining the state of status First Nations mortality in Canada using administrative data. Can J Econ/Rev Can d'écon. 2019;52(2):490–525.

Gittings RK, Roach T. Who benefits from a resource boom? Evidence from the Marcellus and Utica shale plays. Energy Econ. 2020;87:104489.

Gracey M, King M. Indigenous health part 1: determinants and disease patterns. The Lancet. 2009;374(9683):65–75.

Hesketh T, Xing ZW. Abnormal sex ratios in human populations: causes and consequences. Proc Natl Acad Sci. 2006;103(36):13271–13275.

Honor the Earth. Fossil Fuel Extraction Dangers: Native American and Women's Organizations Request UN Help on Sexual Violence. 2018.

Indian Health Service. Indian Health Disparities. Rockville, MD: Indian Health Service. https://www.ihs.gov/newsroom/factsheets/disparities/. 2019.

Jim MA, Arias E, Seneca DS, Hoopes MJ, Jim CC, Johnson NJ, Wiggins CL. Racial misclassification of American Indians and Alaska Natives by Indian Health Service contract health service delivery area. Amer J Public Health. 2014;104(S3):S295–S302.

Jones DS. The persistence of American Indian health disparities. Amer J Public Health. 2006;96(12):2122–2134.

Kearney MS, Wilson R. Male earnings, marriageable men, and nonmarital fertility: Evidence from the fracking boom. Rev Econ Stat. 2018;100(4):678–690.

Komarek T, Cseh A. Fracking and public health: Evidence from gonorrhea incidence in the Marcellus Shale region. J Public Health Policy. 2017;38(4):464–481.

La MG. Civil conflict, domestic violence and intra-household bargaining in post-genocide. Rwanda J Dev Econ. 2017;124:168–198.

Lucchesi A, Echo-Hawk A. Missing and Murdered Indigenous Women and Girls. Seattle: Research Report of the Urban Indian Health Institute; 2018. http://www.uihi.org/wp-content/uploads/2018/11/Missing-and-Murdered-Indigenous-Women-and-Girls-Report.pdf.

Martin K, Barrick KL, Richardson NJ, Liao D, Heller DC. International RTI. Violent victimization known to law enforcement in the Bakken oil-producing region of Montana and North Dakota, 2006-2012. 2019.

Nanney MS, Myers SL, Xu M, Kent K, Durfee T, Allen ML. The economic benefits of reducing racial disparities in health: the case of Minnesota. Int J Environ Res Public Health. 2019;16(5):742.
Native Women's Wilderness. Murdered and Missing Indigenous Women. 2021.
Quintero L, Simeonova E, Akee R. Pandemic Protocols, Native Nutrition: Grocery Store Access from American Indian Reservations during COVID-19. AEA Papers Proc. 2021;111:602–06.
Rodriguez-Lonebear D, Barceló NE, Akee R, Carroll SR. Research Full Report: American Indian Reservations and COVID-19: Correlates of Early Infection Rates in the Pandemic. J Public Health Manag Practice. 2020;26(4):371.
Ruddell R, Jayasundara DS, Mayzer R, Heitkamp T. Drilling Down: An Examination of the Boom-Crime Relationship in Resource Based Boom Counties. Western Criminol Rev. 2014;15(1):3–17.
Sarche M, Spicer P. Poverty and health disparities for American Indian and Alaska Native children: current knowledge and future prospects. Ann New York Acad Sci. 2008;1136:126.
Sequist TD. Urgent action needed on health inequities among American Indians and Alaska Natives. Lancet (London, England). 2017;389(10077):1378–1379.
Stehr-Green P, Bettles J, Robertson LD. Effect of racial/ethnic misclassification of American Indians and Alaskan Natives on Washington State death certificates, 1989–1997. Amer J Public Health. 2002;92(3):443–444.
Street B. The impact of economic opportunity on criminal behavior: Evidence from the fracking boom Working Paper. 2018.
Unal D. Sovereignty and social justice: how the concepts affect federal American Indian policy and American Indian health. Soc Work Public Health. 2018;33(4):259–270.
Wilson R. Moving to economic opportunity: the migration response to the fracking boom. Journal of Human Resources. 0817–8989R2. 2020.

**Publisher's Note** Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

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