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# A Historical Perspective of Healthcare Disparity and Infectious Disease in the Native American Population



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## ABSTRACT

The incidence and severity of COVID-19 infections have been disproportionately high in Native American populations. Native Americans are a high-risk group for COVID-19 because of a variety of healthcare disparities. Historically, these populations suffered excessively during previous epidemics in the United States (US). Several epidemics occurred when disease-naïve indigenous peoples were exposed to European settlers with herd immunity. Native American populations had four times higher mortality in the 1918 Spanish flu epidemic. Deaths from H1N1 infections were higher in Native Americans and most cases and deaths from the Hantavirus pulmonary syndrome (HPS) occurred in Native Americans. Other infectious diseases, including HIV, hepatitis A and hepatitis C are more also common. Diabetes, alcoholism and cardiovascular diseases, all risk factors for severity and mortality in COVID-19 infection, are also more common in this group. Addressing the root causes of enhanced risk in Native American populations will improve outcomes from COVID-19 and future pandemics.

**Key Indexing Terms:** Native American; SARS-CoV-2; COVID-19; Coronavirus; Medical History; Healthcare disparities; Epidemiology; Epidemic; Pandemic, Small pox; Tuberculosis; Hantavirus; Sanitation; Hepatitis A; HIV; Alcoholism; Poverty. [*Am J Med Sci* 2022;363(4):288–294.]

## INTRODUCTION

There were almost 115,000,000 COVID-19 infections and more than 2,500,000 deaths worldwide from SARS-CoV-2, COVID-19 coronavirus as of March 1<sup>st</sup>, 2021. The United States of America (US) has the largest number of cases and deaths reported from COVID-19 infections. Ethnic background, population density, smoking, and gender are all epidemiological factors associated with prevalence and fatalities from COVID-19.<sup>1</sup> Medical risk factors for severe COVID-19 infection include diabetes, obesity, cardiac and pulmonary diseases. Impoverished populations have higher disease transmission rates and worsened consequences of COVID-19 infection.<sup>2</sup> The risk of a specific minority population developing and dying from COVID-19 infection in the USA appears to be strongly influenced by their economic status, the general health of the community, and access to hospitals and long-term care facilities.<sup>3–6</sup> The Native American populations of North America have been severely affected by COVID-19 infections.<sup>7</sup>

In this review, we examine the history of health care in the Native American population, specifically in relation to other infectious epidemics. Our purpose is to provide an understanding of Native Americans as a high-risk group during a pandemic and to emphasize the role of socioeconomic conditions and healthcare

disparity in producing their excess vulnerability during COVID-19 pandemic.

## THE US GOVERNMENTAL ROLE IN NATIVE AMERICAN HEALTHCARE

The US government has a political relationship with Native American people including the provision of healthcare based on treaties signed in the past as well as Article I, Section 8 of the Constitution.<sup>8</sup> Beginning in the 1880s, the US government assumed responsibilities for the healthcare of Native communities. These were administered by a branch of the War Department. In the 1920s, the US government formally acknowledged its responsibility to honor treaties made with Native Americans that included provision of healthcare in exchange for Native American lands. This process was formalized in the Snyder Act of 1921 allowing Congress to allocate funds for this cause. In the 1950s, a decision was made to transfer these services delivered by the Indian Health Services (IHS), from the Bureau of Indian Affairs to the Federal Department of Health and Human Services. This decision was further refined in 1975 with the Indian Determination Act that gave Federally recognized tribes authority over their own tribal proceedings, including the provision of healthcare. In 2010, the Indian Healthcare Improvement Act sought to add to existing funding, while

allowing patients being cared for in Indian Health Services to have access to Medicare, Medicaid, and the Veteran's Affairs Hospital Network.<sup>8,9</sup>

Currently, IHS provides care to 2.6 million American Indians and Alaska Natives who belong to 574 Federally recognized tribes.<sup>9</sup> IHS consists of hospital systems and a network of outpatient clinics. Yearly funds cover these services and provide separate funding for high level care. Despite the large community serviced by the IHS, budget is limited (about \$6,000,000 dollars for 2020). Experience from previous years has shown that IHS funding generally is depleted by the middle of its yearly funding cycle.<sup>10</sup> Estimates indicate that per person funds allocated to the IHS is only about \$3,000-5,000 USD per person per year, far short of \$8,000-13,000 per year for provided for the healthcare needs incarcerated prisoners, Medicaid, and Medicare participants.<sup>11</sup> Furthermore, healthcare facilities in the IHS system may not be updated to accommodate increases in population in the communities served. If Native Americans live outside of reservations, they receive even less funding through Urban Indian Health programs. Estimates indicate that Urban Indian Health programs function with funding of about \$600 per patient per year.<sup>10</sup> According to the Center for Disease Control, Native Americans often lack personal healthcare providers, and despite having health care coverage, many community members are lacking in access care beyond IHS facilities. Lack of accessibility, in turn has the predictable effect of poorer performance on key healthcare indicators including lower life expectancy, poorer quality of life and higher prevalence of a variety of health conditions.<sup>11</sup> The 2018 US Commission on Civil Rights report to congress entitled "Broken Promises: Continuing Federal Funding Shortfall for Native Americans" provides a specific outline of these discrepancies.<sup>12</sup> The treaties provide specific documentation of commitments made to the Native American community. Thus, these commitments related to the provision of health care for Native Americans should not be viewed as a form of entitlement. In fact, these treaties represent promises that have been under funded and by extension, have not been fulfilled. As a reminder, Native Americans repeatedly were removed from their lands. In exchange, their communities ended ongoing conflicts in exchange for provision of health care, education, and some commodities.

## EPIDEMICS IN NATIVE AMERICAN POPULATIONS

Infectious diseases had a profound historical impact on Native American populations beginning with the arrival of European settlers who introduced new diseases to previously naive populations.<sup>13</sup> During the initial phase of European colonization, infectious diseases were the primary killer among Native American communities. Infections ranging from smallpox, bubonic plague, chickenpox, cholera, the common cold, diphtheria, influenza,

malaria, measles, scarlet fever, some sexually transmitted diseases, typhoid, typhus, tuberculosis, leptospirosis, and pertussis produced illness and extensive deaths. It is estimated that 95 percent of the indigenous populations in the Americas were killed by infectious diseases during the years following European colonization, amounting to an estimated 20 million people.<sup>14</sup> While Europeans coming to the New World had herd immunity or were asymptomatic carriers of many of these diseases, Native American populations, who were being exposed to pathogens for the first time, experienced deadly epidemics. This has been termed the "Virgin Soil Effect".<sup>15</sup> Although some of these infections were already present in the New World (including tuberculosis and leptospirosis) when settlers arrived, lack of food, violent conflict and changing environment enhanced the virulence of these organisms. The spread of these diseases was intensified by the practice of capturing and selling of Native American slaves along trade routes and the forced concentration of Native Americans into specific areas. For example, it is believed that Dengue fever became endemic in the US after introduction from the slave trade.<sup>16</sup> Social conditions experienced by the Native American population including starvation (due to loss of land and lack of access to hunting and trading routes), lack of clean water, and the destruction caused by warfare are hypothesized to have perpetuated the severity of infectious epidemics among Native American populations.<sup>17</sup> This view is contrary to previous suggestions that genetic predisposition to lowered immunity, rather than social factors, was the major contributing force resulting in heavy losses during these epidemics. Further studies have identified the possibility of higher daily airborne particle exposure as a risk factor for infectious disease exposure in Native populations.<sup>18</sup>

Reports vary and records were not meticulously kept, but historic documents detail the high mortality rates from epidemics in Native American populations. The first case of smallpox was reported in 1520 and this disease continued to re-infect Native American communities for hundreds of years. It is estimated that some tribes lost 50% of their populations due to smallpox.<sup>19</sup> There is also unfortunate evidence that smallpox was used as biological warfare, with infected blankets and other items given to tribes with the purpose of spreading disease.<sup>20</sup> Repeated smallpox epidemics prompted a vaccine campaign by the US government in 1832.<sup>14</sup> Epidemics of measles, influenza, and multiple unidentified pathogens have also repeatedly swept through Native Communities.

The propensity for widespread epidemics to devastate Native American communities continued in the early 20th century with a Spanish Flu<sup>21</sup> with mortality rates of Native Americans estimated to be four times those of the general population.<sup>22</sup> Native American populations continue to experience higher mortality during influenza season with yearly influenza and pneumonia death rates being twice as high as non-Native controls.<sup>23</sup> In 2009, a

study by Castrodale et al showed that among 426 H1N1 deaths, 42 (9.9%) were among Native American and Alaskan Natives (in the states of Alabama, Alaska, Arizona, Michigan, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Utah, Washington, and Wyoming) although they made up 3% of the population in those states. This increased mortality only represents an average, with the young and elderly populations of Native Americans showing mortality ratios as high as seven times the general population in similar age groups.<sup>24</sup>

The Hantavirus pulmonary syndrome (HPS) caused by Sin Nombre Virus (SNV) also had a higher impact on the Native American population. SNV caused an outbreak in 1993 in the Four Corners Region, an area that spans parts of Colorado, Utah, Arizona, and New Mexico, a semi-autonomously area run by the tribal nations. Within the Four Corners Region, 14 cases with a 50% mortality rate, were identified among members of the Navajo, Hopi, Ute, and Zuni tribes.<sup>25</sup> The syndrome is characterized by generalized fever, malaise and gastrointestinal symptoms and may progress to include noncardiogenic pulmonary edema Childs et al performed a serological study that involved trapping rodents and other mammals and found that deer mice were the primary reservoir for SNV.<sup>25</sup> The virus is not transmitted person to person, but by rodent infestations that are a common occurrence on reservations (CDC Hantavirus).

### OTHER INFECTIOUS DISEASES IN NATIVE AMERICAN POPULATIONS

CDC data show that Native Americans are four times more likely than non-Native Americans to contract sexually transmitted infections such as chlamydia and gonorrhea. Syphilis infections occur twice as frequently in Native Americans. HIV infections are about five times more common in Native American females compared to Caucasian American females.<sup>30</sup> These conditions have been specifically associated with poverty in communities throughout the world, and thus represent opportunities for intervention.<sup>26,27</sup> Tuberculosis (TB) has also historically been higher among Native American communities. Currently, TB infection rates are five times higher for Alaskan Indians and American Indians and 13 times higher among Native Hawaiians and Pacific Islanders than Caucasian Americans.<sup>28</sup>

Hepatitis A is a viral disease with historically high incidence among Native Americans. For example, the risk of hepatitis A virus (HAV) infection among AIANs living on reservations and in Alaskan villages was estimated at about 90%. During the 1990s, hepatitis A 5.0%–8.7% of all US cases of hepatitis A occurred in Native Americans, who at the time represented 0.86% of the US population. The disease was characterized by large epidemic episodes on Indian reservations and Alaskan villages. Fortunately, with the advent of vaccination programs, the incidence of hepatitis A declined by 20-

**Table 1.** Infectious diseases that have disproportionately affected the Native American population.

<b>Historic Epidemics</b>
Smallpox
Bubonic plague
Chickenpox
Cholera
Diphtheria
Influenza
Malaria
Measles
Scarlet fever
Sexually transmitted diseases
Typhoid
Typhus
Pertussis
Spanish flu
Other viral upper respiratory illnesses
Additional unidentified pathogens
<b>Recent Epidemics</b>
Hantavirus pulmonary syndrome (HPS) caused by Sin Nombre Virus (SNV)
Influenza
SARS-CoV-2, COVID-19
<b>Other Recent Infections</b>
Chlamydia
Gonorrhea
Syphilis
Tuberculosis
HIV
Hepatitis A
Hepatitis C

fold in the Native American population.<sup>29</sup> Native Americans are also twice as likely to contract Hepatitis C.<sup>30</sup>

Table 1 shows infectious diseases that have disproportionately affected the Native American population.

### GENERAL HEALTH DISPARITIES IN NATIVE AMERICAN POPULATIONS

As our understanding of the critical role of chronic disease in the occurrence and severity of COVID-19 evolves, a review of general health disparities helps to create a perspective on the impact of COVID-19 in Native American populations. Health disparities in Native American populations compared with non-Native communities have been significant, with chronic health conditions appearing at higher rates.<sup>30</sup> Studies also show that the life expectancy of Native Americans is 5.5 years shorter than the national average.<sup>9</sup> Like the general population, leading causes of death in the Native American populations include heart disease, malignancy, and accidents. However, Native Americans are more than three times higher mortality from complications of diabetes, are more than six times more likely

to die from alcoholism and have a greater than four times higher mortality from liver diseases.<sup>30</sup>

Native Americans also have the highest prevalence of diabetes of any ethnic or racial group in the US.<sup>31</sup> These high rates of diabetes have been attributed to sedentary lifestyle (in part from loss of the traditional active lifestyle), and distribution of unhealthy food to Native American communities.<sup>10</sup> These conditions are known to predispose to the prevalence and deaths from COVID-19 infection. Alcoholism, suicide, homicide, domestic violence, and sexual assault are high in Native American communities. Poverty has been shown to be associated with these conditions in other communities.<sup>32</sup>

In 1819 Indian Civilization Act Fund and the Peace Policy of 1869 began the process of taking Native American children from their homes with the specific goal of cultural re-education and systematic destruction of Native cultures and communities. Although the exact number of is unknown, hundreds of thousands of Native American children were taken from their homes and families and placed in boarding schools. The administration of these schools was under the control of the federal government and the churches.<sup>33</sup> The roles of intergenerational trauma due to loss of language and culture and adverse childhood events (ACEs) experienced in residential boarding schools as risk factors for these conditions has been explored.<sup>34,35</sup>

Recently, efforts to teach Native American languages has been associated with a decrease in suicidal ideation among Native American teens. Ray et al found that patients that attended a family program to address ACEs had a 36% reduction in use of substance disorder clinics and emergency room visits.<sup>34</sup> Similar emphasis on traditional diets and ways of life have been associated with decreased obesity and diabetes.<sup>31</sup> In addition, estimates show that 13 percent of Native American homes lack access to safe drinking water, while only one percent of the general US population lacks access to safe water which can be a source of preventable infectious diseases and makes preventing infectious disease difficult.<sup>36</sup> Furthermore, a recent study by Rodriguez-Lonebear provided evidence that the lack of running water correlated with an increased risk of COVID-19.<sup>37</sup> Overcrowding can also contribute to the spread of infectious diseases, with surveys showing that 16 percent of Native Americans live in overcrowded conditions, a level that is eight times higher than the general population in the US.<sup>36</sup>

In the past, Native Americans have been subjected in medical experimentation and forced sterilization; with examples of these occurring until the 1970s.<sup>10</sup> Some research studies were performed on children in residential schools, without appropriate consent, with detrimental on the future health of test subjects.<sup>35</sup> Methods to enhance the trust of the medical community are being explored. These types of activities have been a high priority for underserved communities. Efforts are also underway to focus on the incorporation of traditional

**Table 2.** Health and resource disparities of Native American populations.

General Health Disparities	
Cardiac Disease	
Diabetes	
Liver Disease and Cirrhosis	
Pneumonia	
Influenza	
Alcoholism	
Drug abuse	
Kidney disease	
Suicide	
Homicide	
Domestic violence	
Sexual assault	
Resource Disparities	
Low access to healthcare	
Low funding for healthcare	
Overcrowding	
Lack of safe drinking water	
Lack of running water	

medicinal practices, culturally sensitive focus of clinic environments, and recruitment of healthcare workers from the communities served are some potential means of improvement.<sup>38</sup> Research is also focusing on community input to optimize clinical care.<sup>35</sup>

Table 2 shows a list of health and resource disparities of the Native American population.

### A REVIEW OF PUBLISHED SCIENTIFIC LITERATURE ON COVID-19 AND THE NATIVE AMERICAN COMMUNITY

There are remarkably few papers published in the scientific literature that specifically address the effects of COVID-19 on Native American communities. Most information on the internet is from non-peer reviewed sources. Available studies agree that disparities exist in these communities compared with nearby white communities. The Indian Health Services has reported more than 30,000 cases of COVID-19, but this could represent an underestimate, as tribal nations are not required to report their cases.<sup>9</sup> One of the first reports in the scientific literature derived from CDC data from June 2020 identified 1.3% of COVID-19 cases occurring in American Indian (AI) or Alaskan Natives (AN) although these communities only comprise 0.7% of the US population.<sup>39</sup> Hatcher, et al reviewed laboratory-confirmed COVID-19 cases occurring between January 22-July 3, 2020. Among 424,899 confirmed COVID-19 cases reported by states, 340,059 (80%) had complete information about the race and ethnicity of the infected patients. 9,072 (2.7%) of these cases occurred among AI/AN persons, while 138,960 (40.9%) were in white persons. Cumulative incidence of COVID-19 infections among AI/AN persons

was 594 per 100,000 AI/AN population (95% confidence interval [CI] = 203-1,740) and was 169 per 100,000 (95% CI = 137-209) in the white population, (rate ratio [RR] = 3.5; 95% CI = 1.2-10.1). COVID-19 infections were seen in younger members of the AI/AN population (median age = 40 years; interquartile range [IQR] = 26-56 years) compared to the white population (median age = 51 years; IQR = 32-67 years).<sup>40</sup> Tai et al also reviewed CDC data and noted that African Americans, Latin Americans, and American Indians were more affected compared to Whites Americans in the US. Specifically, they reported that 13% of COVID-19 cases in Arizona occurred in Native Americans and 18% of COVID deaths were Native Americans. However, only 5.3% of Arizona's entire population is made up of Native American. The authors also suggest that underreporting of racial makeup of patients is occurring in CDC data.<sup>41</sup> Furthermore, data collected from the State of Montana from March to November 2020 showed higher death rates from COVID-19. The cumulative COVID-19 mortality rate among AI/AN persons (267 deaths per 100,000). This was 3.8 times higher than deaths in white persons (71 deaths per 100,000).<sup>42</sup>

A limited number of mathematical models were used to help predict risk in Native American communities. Raifman, et al, from the Boston University School of Public Health, used existing data from the 2018 Behavioral Risk Factor Surveillance System from the CDC to model groups at higher risk for severe disease from COVID-19.<sup>43</sup> The CDC has specific criteria that stratifies risk among patients that get COVID-19 and the model described in the study used different categories of racial or economic disparity to predict patients would meet those high-risk criteria. The categories studied included age distribution within the group, race/ethnicity, and household income (<\$25,000 or higher). They used Poisson regression analysis to identify prevalence ratios and confidence intervals between the stated categories and the patient's potential risk for identified criteria for severe disease from COVID-19. They found that among adults younger than 65, 42% of Native Americans were at increased risk for one or more criteria for severe disease compared to 27% of Caucasian American adults (PR=1.53, 95% CI=1.41, 1.66). Native Americans also had increased risk of multiple high-risk criteria than Caucasian Americans (18% compared to 8%). In adults greater than 65 years of age, 69% of Native Americans were at risk for one or more criteria compared to 54% of Caucasian American adults (PR=1.28, 95% CI=1.18, 1.38). These data also predicted disparities among African American patients.<sup>43</sup>

Other research has focused on potential socio-economic determinants of health in Native American communities. Rodriguez-Lonebear et al.<sup>37</sup> published a multivariate regression analysis with population weights for the primary outcome of the rate of COVID-19 cases per 1,000 individuals. Their secondary endpoints included evaluating several socioeconomic risk factors in the

Native American communities. They controlled for the following variables in their Poisson regression analysis: percentage of Indian households on the reservation, disease transmission rates within the states of residence (the study included the inhabitants of several states), average household size, household median age, percentage of household marriages, level of education (i.e., bachelor's degree or higher education), percentage of population that was male, and median household income. Using a least squares model for COVID-19 infection rate data, they found that the rate of COVID cases per 1000 people (that the time of publication in April 2020) was 0.24 for reservation inhabitants compared to the rate of 0.057 for the general US population. This is approximately a four times higher COVID-19 infection rate among the Native American population. An important finding of the study was the positive correlation found between homes lacking indoor plumbing and rate of COVID-19 infection (10.38,  $p=0.001$ ). Further, there was a negative correlation between English-only speaking households and rate of COVID-19 infection (-2.43,  $p=0.03$ ). No significant correlation was found for overcrowding on COVID-19 infection rates (-6.40,  $p=0.326$ ). This study was able to provide evidence for lack of running water and non-English speaking as social determinants that correlated with an increased risk of the disease.<sup>10</sup>

Hathaway addressed the question of social determinants of health using a tool created by the CDC known as the Social Vulnerability Index (SVI) that uses data from the US Census. The SVI includes fifteen factors that can be sorted into four general categories: socioeconomic status, housing, language, and household characteristics. Using this tool, researchers were able to show that the tribal regions surveyed had a higher percentage of poverty compared to US average (15.6%) ranging from 19.2% (Oklahoma) to 40.2% (Navajo), as well as higher than average unemployment, and lower than average per capita income (See Table 1). Some regions also have higher rates of adults with no high school diploma averages. The US average of persons without a high school diploma was 13.4% while rate in the Navajo population was 26.9%. Using the SVI tool, the composition of Native American households also included more people with disabilities in several regions, above the US average of 15.9% and ranging from 16.8% to 17.9% in the Oklahoma area. Further, the data demonstrated crowded living conditions above US housing averages of 2.4% of houses with more people than rooms, ranging from 3.4% in the Oklahoma area and up to 17.4% in the Navajo community. Finally, all the tribal regions had higher rates of uninsured people compared to the US average of 10.1%, with up to 26.7% uninsured in United South and Eastern Tribes. The author also concluded that Navajo peoples faced an especially high risk of social vulnerability due to their higher rates of unemployment, poverty, lower overall per capita income, and overcrowding.<sup>44</sup> The Navaho Nation has focused on strategies of testing and vaccination. At the start of

vaccination efforts, data collected in March 2021, showed that 86 percent of the Navajo Nation community had received at least one COVID-19 vaccine dose, with 33.8 percent fully vaccinated, outpacing the rest of the country.<sup>45</sup> As of November 2021 American Indian populations continued to lead with higher rates of first dose vaccination at 62.4% of their population vaccinated with one dose of the vaccine compared with 48.3% of the White Non-Hispanic population, and 50% of the Hispanic population. For fully vaccinated populations, American Indians also lead with 51.4% of their population fully vaccinated as compared with 43.1% of the White Non-Hispanic population, and 43.3% of the Hispanic population.<sup>46</sup>

In association with poverty and lack of access to care, Graves et al published a letter to the editor which described the lack of internet access as another area of disparity in Native American communities. Despite telemedicine becoming an important tool for healthcare providers in the post-COVID-19 US, Native Americans often lack access to the internet making telemedicine unavailable in those communities. According to the US Census Bureau in 2018, 58.1%-87.7% of households in the Navajo Nation lacked broadband Internet access compared to 19.6% of the average US population. Additionally, compensatory measures such as utilizing public resources, such as libraries are not practical when discussing sensitive medical information.<sup>47</sup>

Despite lack of clear guidelines to help vulnerable communities, a hospital serving a Native American community in Arizona was able to act preemptively based on the risk factors known to these communities.

Close and Stone described a system that was developed for contact tracing. Contract tracing defines persons with an infectious disease such as COVID-19 as cases and persons who have been possibly exposed to cases. The goal of contact tracing is limit further spread of infections using methods such as voluntary social isolation and quarantining of cases in their homes. Their interventions with the contact tracing included house visits and phone follow ups for patients who tested positive for COVID-19 but did not require hospitalization and high-risk individuals who did not test positive during the incubation period. By checking on these individuals, doctors in this system were able to identify serious low oxygen levels (hypoxemia) prior to the symptoms being reported by patients. They also worked to advise isolating family members that tested positive, sometimes outside in tents to protect the rest of the family. At the time of publication, their case fatality rates were 1.1%, a level that was half the rate of the surrounding state of Arizona.<sup>48</sup>

## SUMMARY

The Native American populations has been particularly vulnerable to the incidence, severity, and mortality from COVID-19 infections. A variety of factors are

responsible for this phenomenon including the preventable causes such as access to and resources that are available for the delivery of high-quality health care. are a high-risk group for COVID-19 because of a variety of healthcare disparities. From a historical perspective, Native Americans communities are consistently hard hit by acute and chronic infections, and particularly so during disease outbreaks including the 1918 Spanish flu, H1N1 and Hantavirus pulmonary syndrome (HPS) epidemics. Risk factors that predispose to infection from COVID-19 and worsened outcomes including chronic diseases, overcrowding and lack of running water are highly prevalent in Native Americans. The Native American community is at high risk for secondary effects of the COVID-19 pandemic including depression and post-traumatic stress disorder; to our knowledge this is an unexplored research area.

## CONCLUSIONS

The COVID-19 pandemic has had a pronounced impact on Native America populations, including a higher incidence of infection and increase in mortality from the disease. This phenomenon reflects historic vulnerability of US Native American populations to infectious epidemics and underscores the healthcare disparities that fuel these susceptibilities. Addressing the root causes of enhanced risk in Native American populations during epidemics will help to prevent disproportionate outcomes from COVID-19 and future pandemics.

## SOURCE OF FUNDING

None.

## DECLARATION OF COMPETING INTEREST

The authors have no conflicts of interest to declare.

## REFERENCES

1. **Sze S, Pan D, Nevill CR, et al.** Ethnicity and clinical outcomes in COVID-19: A systematic review and meta-analysis. *EClinicalMedicine*. 2020;29:100630.
2. **Patel JA, Nielsen FBH, Badiani AA, et al.** Poverty, inequality and COVID-19: the forgotten vulnerable. *Public Health*. 2020;183:110-111.
3. **Prata DN, Rodrigues W, Bermejo PH.** Temperature significantly changes COVID-19 transmission in (sub)tropical cities of Brazil. *Sci Total Environ*. 2020;729:138862.
4. *Income and Wealth in the United States: An Overview of the Latest Data*. Peter G. Peterson Foundation; 2019. Available at: <https://www.pgpf.org/blog/2019/10/income-and-wealth-in-the-united-states-an-overview-of-data>. Accessed February 28, 2022.
5. **2017 STATE WELL-BEING RANKINGS.** State of American Well-Being. *Gallup-Sharecare Well-Being Index 2017:2017*. Available at: [https://wellbeingindex.sharecare.com/wp-content/uploads/2018/02/Gallup-Sharecare-State-of-American-Well-Being\\_2017-State-Rankings\\_FINAL.pdf](https://wellbeingindex.sharecare.com/wp-content/uploads/2018/02/Gallup-Sharecare-State-of-American-Well-Being_2017-State-Rankings_FINAL.pdf). Accessed February 28, 2022.
6. **NCES Fast Facts Tool.** *National Center for Education Statistics (NCES) Home Page, a Part of the U.S. Department of Education*; 2020. nces.ed; Available at: [gov/fastfacts/display.asp?id=62](http://gov/fastfacts/display.asp?id=62). Accessed February 28, 2022.
7. **"AZDHS: COVID-19 Dashboards."** Arizona Department of Health Services, 2020. Available at: [www.azdhs.gov/preparedness/epidemiology-](http://www.azdhs.gov/preparedness/epidemiology-)

- disease-control/infectious-disease-epidemiology/covid-19/dashboards/index.php. Accessed February 28, 2022.
8. National Academies of Sciences, Engineering, and Medicine; Health and Medicine Division; Board on population health and public health practice; committee on community-based solutions to promote health equity in the United States; Baciu A, Negussie Y, Geller A, et al., editors. *Communities in Action: Pathways to Health Equity*. Washington (DC): National Academies Press (US); 2017 Jan 11. Appendix A, Native American Health: Historical and Legal Context. Available at: <https://www.ncbi.nlm.nih.gov/books/NBK425854/>. Accessed February 28, 2022.
  9. "About IHS." Office of Urban Indian Health Programs. Available at: <https://www.ihs.gov/aboutihs/>. Accessed February 28, 2022.
  10. **Agent Dan.** *Don't Get Sick After June*. American Indian Healthcare; 2010. Available at: <https://www.richheape.com/american-indian-healthcare.htm>. Accessed February 28, 2022.
  11. Available at: <https://www.cdc.gov/mmwr/volumes/67/wr/mm6747a4.htm>. Accessed February 28, 2022.
  12. Available at: <https://www.usccr.gov/pubs/2018/12-20-Broken-Promises.pdf>. Accessed February 28, 2022.
  13. **Hughs Art.** "Native American Calling." Broadcast. Covid-19 Disparities Tuesday July 21, 2020, no. COVID-19 disparities. Native American Calling. July;21:2020.
  14. **Childs David.** Learning from history: pandemics are nothing new in native communities. *Democracy and Me*. April 8, 2020. Available at: <https://www.democracyandme.org/learning-from-history-pandemics-are-nothing-new-in-native-communities/>. Accessed February 28, 2022.
  15. **Guns Germs & Steel: Variables. Smallpox.** PBS. Public Broadcasting Service; 2005. Available at: <https://www.pbs.org/gunsgermssteel/variables/smallpox.html>. Accessed February 28, 2022.
  16. **Powell JR, Tabachnick WJ.** History of domestication and spread of *Aedes aegypti*—a review. *Mem Inst Oswaldo Cruz*. 2013;(Suppl 1):11–17.
  17. **Ostler Jeffrey.** Disease has never been just disease for Native Americans. *The Atlantic*. Atlantic Media Company. April 29, 2020. Available at: <https://www.theatlantic.com/ideas/archive/2020/04/disease-has-never-been-just-disease-native-americans/610852/>. Accessed February 28, 2022.
  18. **Ghio AJ.** Particle exposure and the historical loss of Native American lives to infections. *Am J Respir Crit Care Med*. 2017;195(12):1673.
  19. **Dunbar-Ortiz Roxanne.** *An Indigenous Peoples' History of the United States*. Boston, MA: Beacon Press; 2015.
  20. **Barras V, Greub G.** History of biological warfare and bioterrorism. *Clin Microbiol Infect*. 2014 Jun;20(6):497–502. PMID: 24894605. Available at: <https://www.penninsulaclarion.com/news/100-years-ago-spanish-flu-devastated-alaska-native-villages/>. Accessed February 28, 2022.
  21. **Davies James Giago.** It was called the 'Spanish Flu.' But it killed hundreds of Indians too. *Indianz*. Indianz. Available at: <https://www.indianz.com/z.png>. May. 24:2018. Accessed February 28, 2022.
  22. **Groom AV, Hennessy TW, Singleton RJ, et al.** Pneumonia and influenza mortality among American Indian and Alaska Native people, 1990–2009. *Am J Public Health*. 2014;104(Suppl 3):S460–S469.
  23. **Castrodale L.** *Deaths Related to 2009 Pandemic Influenza A (H1N1) Among American Indian/Alaska Natives — 12 States*. Centers for Disease Control and Prevention; 2009 Centers for Disease Control and Prevention, December 11, 2011; Available at: <https://www.cdc.gov/mmwr/preview/mmwrhtml/mm5848a1.htm>. Accessed February 28, 2022.
  24. **Childs JE, Ksiazek TG, Spiropoulou CF, et al.** Serologic and genetic identification of *Peromyscus maniculatus* as the primary rodent reservoir for a new hantavirus in the southwestern United States. *J Infect Dis*. 1994;169(6):1271–1280.
  25. **Loosier PS, Haderxhanaj L, Beltran O, Hogben M.** Food insecurity and risk indicators for sexually transmitted infection among sexually active persons aged 15–44. *National Survey of Family Growth*. 2020;135(2):270–281.
  26. **DeShields RD, Lucas JP, Turner M, et al.** Building partnerships and stakeholder relationships for HIV prevention: longitudinal cohort study focuses on community engagement. *Prog Community Health Partnersh*. 2020;14(1):29–42.
  27. **Bloss Emily.** Tuberculosis in indigenous peoples in the U.S., 2003–2008." *Public Health Reports*. 2011;126(5):677–689.
  28. **Bialek SR, Thoroughman DA, Hu D, et al.** Hepatitis A incidence and hepatitis A vaccination among American Indians and Alaska Natives, 1990–2001. *Am J Public Health*. 2004 Jun;94(6):996–1001.
  29. **American Indians and Alaska Natives.** *Centers for Disease Control and Prevention. Centers for Disease Control and Prevention*. March 14, 2014. Available at: <https://www.cdc.gov/nchhstp/healthdisparities/americanindians.html>. Accessed February 28, 2022.
  30. **McLaughlin Sue.** Traditions and diabetes prevention: a healthy path for Native Americans." *Diabetes Spectrum*. American Diabetes Association; October 2, 2010. Available at: <https://spectrum.diabetesjournals.org/content/23/4/272>. Accessed February 28, 2022.
  31. **Jones-Webb R, Snowden L, Herd D, et al.** Alcohol-related problems among black, Hispanic and white men: the contribution of neighborhood poverty. *J Stud Alcohol*. 1997 Sep;58(5):539–545. PMID: 9273921; Available at: <https://boardingschoolhealing.org/education/us-indian-boarding-school-history/>. Accessed February 28, 2022.
  32. **Ray L, Outten B, Gottlieb K.** Health care utilization changes among Alaska Native adults after participation in an indigenous community programme to address adverse life experiences: a propensity score-matched analysis. *Int J Circumpolar Health*. 2020;79(1) 1705048.
  33. **Hyett S, Marjerrison S, Gabel C.** Improving health research among Indigenous Peoples in Canada. *CMAJ*. 2018;190(20):E616–E621.
  34. **Givens, Maria** "The coronavirus is exacerbating vulnerabilities Native communities already face." *Vox*. Vox, March 25, 2020. Available at: <https://www.vox.com/2020/3/25/21192669/coronavirus-native-americans-indians>. Accessed February 28, 2022.
  35. **Rodriguez-Lonebear D, Barceló NE, Akee R, et al.** American Indian reservations and COVID-19: correlates of early infection rates in the pandemic. *J Public Health Manag Pract*. 2020;26(4):371–377.
  36. **Vogel Lauren.** Residency programs grapple with new indigenous cultural safety training requirement. *Can Med Assoc J*. 2018;190(25).
  37. **Stokes EK, Zambrano LD, Anderson KN, et al.** Coronavirus disease 2019 case surveillance - United States. *MMWR Morb Mortal Wkly Rep*. 2020;69(24):759–765.
  38. **Hatcher SM, Agnew-Brune C, Anderson M, et al.** COVID-19 among American Indian and Alaska Native persons - 23 states. January 31–July 3, 2020 *MMWR Morb Mortal Wkly Rep*. 2020 Aug 28;69(34):1166–1169.
  39. **Tai DBG, Shah A, Doubeni CA, et al.** The disproportionate impact of COVID-19 on racial and ethnic minorities in the United States. *Clin Infect Dis*. 2021;72(4):703–706.
  40. **Williamson LL, Harwell TS, Koch TM, et al.** COVID-19 incidence and mortality among American Indian/Alaska Native and White Persons - Montana. March 13–November 30, 2020 *MMWR Morb Mortal Wkly Rep*. 2021 Apr 9;70(14):510–513. PMID: 33830986; PMCID: PMC8030982.
  41. **Raifman MA, Raifman JR.** Disparities in the population at risk of severe illness from COVID-19 by race/ethnicity and income. *Am J Prev Med*. 2020;59(1):137–139.
  42. **Hathaway ED.** American Indian and Alaska Native people: social vulnerability and COVID-19. *J Rural Health*. 2021 Jan;37(1):256–259.
  43. **CDC Covid Data tracker.** *Centers for Disease Control and Prevention*. 2021. Available at: <https://covid.cdc.gov/covid-data-tracker/#vaccination-demographics-trends>. Accessed February 28, 2022.
  44. **Graves JM, Mackelprang JL, Amir S, et al.** Barriers to telemedicine implementation in Southwest Tribal Communities during COVID-19. *J Rural Health*. 2021;37(1):239–241.
  45. **Close RM, Stone MJ.** Contact tracing for Native Americans in Rural Arizona. *N Engl J Med*. 2020;383(3):e15.

Submitted May 12, 2021; accepted January 19, 2022.

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