

American Indian Reservations and COVID-19: Correlates of Early Infection Rates in the Pandemic

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ABSTRACT

Objective: To determine the household and community characteristics most closely associated with variation in COVID-19 incidence on American Indian reservations in the lower 48 states.

Design: Multivariate analysis with population weights.

Setting: Two hundred eighty-seven American Indian Reservations and tribal homelands (in Oklahoma) and, as of April 10, 2020, 861 COVID-19 cases on these reservation lands.

Main Outcome Measures: The relationship between rate per 1000 individuals of publicly reported COVID-19 cases at the tribal reservation and/or community level and average household characteristics from the 2018 5-Year American Community Survey records.

Results: By April 10, 2020, in regression analysis, COVID-19 cases were more likely by the proportion of homes lacking indoor plumbing (10.83, $P = .001$) and were less likely according to the percentage of reservation households that were English-only (-2.43 , $P = .03$). Household overcrowding measures were not statistically significant in this analysis (-6.40 , $P = .326$).

Conclusions: Failure to account for the lack of complete indoor plumbing and access to potable water in a pandemic may be an important determinant of the increased incidence of COVID-19 cases. Access to relevant information that is communicated in the language spoken by many reservation residents may play a key role in the spread of COVID-19 in some tribal communities. Household overcrowding does not appear to be associated with COVID-19 infections in our data at the current time. Previous studies have identified household plumbing and overcrowding, and language, as potential pandemic and disease infection risk factors. These risk factors persist. Funding investments in tribal public health and household infrastructure, as delineated in treaties and other agreements, are necessary to protect American Indian communities.

KEY WORDS: American Indian, COVID-19, household characteristics, incidence

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The authors acknowledge the original caretakers of the lands on which their land-grant institutions are located: UCLA is on the lands of the Tongva Peoples and the University of Arizona is on the lands of the Tohono O'odham Nation and Pascua Yaqui Tribe. The authors are grateful to their ancestors, including the land and their nonhuman kin. They acknowledge the tribal nations and communities who tirelessly work to protect their peoples from COVID-19. The authors thank Nancy Krieger, Donna Feir, Ninez Ponce, and Michele Suina, who provided insight and guidance.

N.B. is supported by the APA SAMHSA Minority Fellowship (grant 1H79SM080388-01). S.R.C. received partial support from the National Institute of Environmental Health Sciences (grant P50ES026089), Environmental Protection Agency (grant R836151), and the Morris K. Udall and Stewart L. Udall Foundation. D.R.L. is supported by the Robert Wood Johnson Health Policy Research Scholars Program and the American Sociological Association Minority Fellowship.

The SARS-CoV-2 virus is causing widespread devastation as rates of coronavirus disease 2019 (COVID-19) grow across the world. The United States is experiencing one of the largest outbreaks, with more than half a million confirmed cases as of mid-April 2020. Throughout the United States, COVID-19 is amplifying race and class

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The authors declare no conflicts of interest.

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DOI: 10.1097/PHH.0000000000001206

differences due to long-standing health and economic disparities that pervade American society. The American Indian population, for example, experiences significant economic deprivation and some of the starkest health outcomes,¹⁻⁴ placing these individuals at a higher risk for COVID-19. Colonial expansion and policies to eradicate American Indian peoples have contributed to the contemporary inequalities in morbidity and mortality and expose American Indians to unique political and structural determinants of health.^{2,5,6} For American Indian residents of tribal reservations, the rate of death and disease remains particularly high.^{3,4}

In total, 574 federally recognized tribal nations are spread across 326, many rural, American Indian Reservations and 50 million acres of land. Tribal nations are sovereign nations within the territory of the present United States. They maintain direct government-to-government relationships with the United States and hold public health authority such as states, counties, and territories.⁷ While tribes have seen great success in managing their own health care and public health systems, challenges remain due to chronic under- and differential funding (eg, indirect through states). In addition, funding has frequently been focused on isolated (ie, not networked) systems, with an emphasis on chronic diseases rather than infrastructure for basic public health functions.^{1,8,13}

With inadequate public health infrastructure, limited medical resources, and high rates of poverty, communities on Indian reservations are poorly equipped to manage a pandemic such as COVID-19. Of particular concern are lack of household plumbing, the need to communicate important public health directives in non-English languages, and household overcrowding, especially in rural areas.¹³⁻¹⁵ American Indian households on tribal reservations are 3.7 times more likely to lack complete indoor plumbing than all other households in the United States (as comparison, the group next most likely to lack indoor plumbing are black households, at 1.2 times more likely).¹⁶ The prevalence of English language use, which is how most public health messages and directives are communicated, ranges dramatically in American Indian communities from 7% to 100%, which straddles the average for all US households at 78%. In addition, American Indians residing on reservations or homelands tend to reside in more crowded dwellings than the average US household (3.4% for the United States and 6.9% for the average reservation).

This study explores the current COVID-19 pandemic in American Indian reservation communities by examining the association between community and household characteristics and the rate per 1000 individuals of publicly reported COVID-19 cases.

Methods

Study population

We use COVID-19 incidence data collected from online and reported deaths for American Indian tribal nations and communities as compiled by *Indian Country Today*.¹⁷ The data include number of cases and deaths for individual American Indian reservations or homelands. We link those COVID-19 cases at the reservation or homeland level to the reservation or homeland characteristics as contained in the 2018 5-Year American Community Survey (ACS).¹⁸ We use this linked data set to investigate the correlates that are associated with a higher number of total COVID-19 cases on American Indian reservations. Our analysis is restricted to the lower 48 US states, as Alaska Natives and Native Hawaiians are not included in the available COVID-19 data collection at this point. This research has been reviewed by UCLA's institutional review board (IRB) and determined not to be human subjects research (IRB#20-000673).

We analyze American Indian tribal nations in the lower 48 US states (n = 287). Our analysis includes the Navajo Nation, which is a large outlier in population and geographic size, as well as Oklahoma tribal nations. Although only a single Oklahoma tribe has a reservation, the Osage Nation, the other Oklahoma tribes have homelands and many tribal members reside on or near those locations. To account for the difference in population sizes for the Navajo Nation and a few of the Oklahoma tribes (which are larger than the median population for the other tribes), we weight our analysis by population size on the reservation or homeland.

Outcome of interest

The outcome variable is the rate of COVID-19 cases per 1000 individuals on the reservation for a particular American Indian tribe as of April 10, 2020. We combine all instances of verified COVID-19 cases from the public database compiled by the online newspaper *Indian Country Today* and create a count for each tribal nation separately.

Focal independent variables

We use the characteristics of the population as provided by the 2018 5-Year ACS data.¹⁸ This data set provides reliable characteristics for small population geographic units. These are the most current data available for these tribal communities. We draw on empirical and anecdotal evidence to hypothesize 3 independent variables that should have a relationship

to the rate of COVID-19 cases per 1000 on American Indian reservations.

The first is the percentage of homes on the reservation lacking complete plumbing, defined in the ACS as missing any or all of the following: flush toilet, hot and cold water, and a tub or shower. We anticipate that this variable should be positively related to the rate of COVID-19 cases, as sanitation and access to running water are important determinants of disease transmission in this pandemic.

We include a second variable in our analysis, which measures the percentage of households on the reservation with more than 1 person per room; this variable is often used to identify “overcrowded” housing stock.¹⁹ Our hypothesis is that higher rates of household crowding would be related to higher rates of COVID-19 cases, as there would be less opportunity to self-quarantine in crowded conditions.

The third variable that we include is the percentage of households on American Indian reservations that speak English-only. This is an important variable, as it may indicate the degree to which public health information and warnings is being effectively communicated to American Indian households on the reservation. We expect this variable to be negatively related to the rate of COVID-19 cases per 1000, as we expect most public health messages and directives to be provided primarily in English in general.

Control variables

To account for other differences across tribal reservations that may be related to the rate of COVID-19 cases per 1000, we control for a number of important social and economic variables that have been shown to influence health.²⁰ We include the percentage of the reservation households that are American Indian; depending upon the location and historical allotment of reservation lands, some may be more interspersed with non-Indian households, land holdings, and accompanying development. We also control for the US state that the majority of the tribal reservation is located in. These variables account for differences across US states that may play a role in the characteristics and composition of adjacent counties, cities, and towns; these differences may influence transmission rates for adjacent American Indian reservations. For instance, there are well-known differences in the timeliness and establishment of shelter-in-place rules across states, and these may subsequently affect the possibility of increased or decreased COVID-19 transmissions to American Indian reservation-based populations in those states.

Additional control variables include the average household size and the median household age. We also

include the percentage of the population that is male and median household income. Finally, we include a measure of the percentage of households married and the percentage of the population with a bachelor’s degree or higher. These last set of variables measure the educational attainment and social characteristics of American Indian reservation populations, which may affect the rate of COVID-19 cases per 1000. We do not report the estimated coefficients from these variables in the analyses that follow, but these results are available upon request from the authors.

Statistical analyses

Our main analysis is an ordinary least-squares model, with the rate of COVID-19 cases per 1000 at the reservation level as the outcome variable. We have also employed a Poisson regression, and this does not qualitatively change our results or interpretation of the data. In our analysis, we regress the rate of COVID-19 cases on the 3 independent variables as well as the control variables. All of our analyses have standard errors clustered at the state level to account for potential correlation in the unobserved error terms. We also weight the reservation-level observations by the total population residing there. All analyses are conducted in STATA (version 14.0).

Results

Sample overview

Table 1 provides the average characteristics of the American Indian reservation population. The first column provides characteristics for all of the US reservations in our analysis; the next column provides characteristics for the United States as a whole for comparison. There are 287 tribal reservations in our analysis.

On average, almost 60% of the population residing on a reservation is American Indian. The median age is 34 years, and the population is approximately evenly divided among genders. Almost 12% of reservation populations hold a Bachelor of Arts degree or higher. The average household size is larger for tribal reservations at approximately 3 people than for the United States as a whole at 2.6. Households on tribal reservations also tend to have a higher percentage of homes that are overcrowded than that in the rest of the United States. Median household income on reservations is almost \$20 000 lower than that for the United States as a whole.

Marital status is lower on average on American Indian reservations than in the United States as a whole. The percentage of English-speaking households is

TABLE 1
Summary Characteristics of Reservations per the 2018 American Community Survey

	US Reservations (n = 287)	United States (n = 1)
Reservation demographics		
Average population, n (SD)	12 515.54 (63 107.85)	327 167 439
% Population AI/AN, % (SD)	58.53 (28.15)	0.86
Median age (SD), y	34.25 (8.52)	38.2
Male, % (SD)	48.65 (5.15)	49
Adults with bachelor's degree or more, % (SD)	11.89 (8.83)	12
Reservation households		
Average household size, n (SD)	3.06 (0.76)	2.6
% Households with >1 person per room, % (SD)	6.91 (7.34)	3.4
Median household income (SD), \$	42 758.37 (17 561.15)	61 397
Married households, % (SD)	36.12 (12.77)	48
% Households with English only, % (SD)	82.82 (18.33)	78
% Homes without indoor plumbing, % (SD)	1.09 (2.57)	0.4
COVID-19		
Total positive cases, n (SD)	3.0 (35.6)	18 586
Total positive cases per 1000, n (SD)	0.24 (2.27)	0.057

Abbreviation: AI/AN, American Indians/Alaska Natives.

higher than the United States on average at 82% as compared with the US average of 78%; however, this average hides the relatively large rates of non-English households on several reservations such as the Navajo and many Pueblo tribes. Finally, there is a relatively large average percentage of incomplete plumbing facilities for the on-reservation population (1%) as compared with the United States as a whole (0.4%). This average obscures the extremely high rates of incomplete plumbing facilities on some reservations, such as the Navajo reservation (18%).

Finally, the average number of COVID-19 cases on reservations as of April 10, 2020, is about 3. At the extreme end, the Navajo Nation has approximately 599 positive COVID-19 cases. In the next row, we provide the rate of COVID-19 cases per 1000 people as of April 10, 2020, which is more than 4 times higher for the population residing on a reservation (0.24) than that for the United States as a whole (0.057).

Analysis for all tribal nations in the lower 48 US states

As of April 10, 2020, the rate of COVID-19 cases per 1000 people was higher on reservations, with larger shares of homes lacking complete indoor plumbing (10.83, $P < .001$) and was lower on reservations with a high percentage of English language-only households (-2.43 , $P = .03$). These results are presented in Table 2. The estimated coefficient on the percentage of households with more than 1 person per room is not

statistically significant at conventional levels (-6.40 , $P = .32$).

We show in Table 3 the top 6 tribes with reported COVID-19 cases and their average reservation and household characteristics. The Navajo Nation and Oklahoma tribes have a high level of COVID-19 cases; they are also outliers in other categories such

TABLE 2
Ordinary Least-Squares Analysis of Reservation Demographic and Household Variables to the Rate of COVID-19 Cases Per 1000 people on US Reservations^a

	US Reservations (n = 287)
% Homes lacking complete plumbing facilities	10.83 ^b (1.890)
% Households with ≥ 1 person per room	-6.395 (6.407)
% Households speaking English-only	-2.431^c (1.069)
Total observations with population weights	3 591 961
R^2	0.509

^aAll COVID-19 cases are current as of April 10, 2020. The outcome variable is the rate of COVID-19 cases per 1000 people. The analysis includes controls for state fixed-effects, percentage of American Indian residing on reservation, median age, percentage of male, median household income, percentage of households married, percentage with a Bachelor of Arts or higher education, and a constant. Standard errors are clustered at the state level.

^b $P < .01$.

^c $P < .05$.

as total population size, English-language use, household overcrowding (for non-Oklahoma tribes), and lacking indoor plumbing. We also find that the highest rates of COVID-19 cases per 1000 are among the Pueblo tribes, which is a factor of both a high incidence of the illness and relatively small populations.

Discussion

This analysis of the incidence of COVID-19 cases on American Indian reservations reveals a strong association with lack of indoor plumbing, English-only households, and no relationship with household overcrowding. Together, these findings support assertions regarding the structural determinants of this disease. Specifically, the social conditions defining day-to-day life—whether or not families have access to water and whether or not health directives are accessible to their understanding—are as consequential as the viral properties that define infectivity and pathogenesis.

Lack of indoor plumbing was the most statistically significant finding in our results demonstrating a strong positive relationship with COVID-19 cases on American Indian reservations. While some reservation communities have elected not to pursue full plumbing facilities for historical, cultural, and environmental reasons, there are certainly solutions such as providing potable water and hand sanitizer that could improve critical sanitation needs.²¹

The statistically significant association we find between English-only households and decreased COVID-19 cases highlights the need for public health campaigns in Indigenous languages. This is of particular concern, given there are 150 different Indigenous languages spoken by more than 350 000 people in the United States today.²² Household overcrowding with more than 1 person per room is not statistically significant at conventional levels. More research is needed to fully evaluate the relationship

between household overcrowding and COVID-19 incidence on Indian reservations. This measure may play a different role as the intensity of the pandemic persists; further follow-up analysis will be required to understand whether there are changes over time.

In summary, we observe 2 significant relationships in the spread of COVID-19 on American Indian reservations that have important public health implications. First, prior to physical distancing mandates and stay-at-home orders, proper hand washing was proclaimed as a universal first line of defense against the spread of SARS-CoV-2. The vulnerability of communities without reliable access to water, however, was largely overlooked.²³ Second, public health warnings and directives are vital to reducing transmission rates during pandemics. Not disseminating public health messages in local languages may hinder the ability of communities and households to prepare effectively.

The federal emergency response has been directed to meet the resource needs of individual states and has not prioritized the needs of American Indian reservations and their populations. While some reservations have invoked State of Emergency Declarations, including executive orders limiting the movement of persons in and out of reservation land,²⁴ these are porous borders and life for many reservation residents is continuous between their reservation home and state neighbors. While there are limited standardized data, persistent underfunding and infrastructure barriers suggest that, at present, American Indian reservations are poorly equipped to respond to a large number of COVID-19 cases and any future pandemics.^{1,8-13,25,26}

Limitations

Limitations include the small sample size, including the relative proportion of reservations with positive cases. This analysis focuses on prevalent conditions of reservation land and how those conditions

TABLE 3
Selected American Indian Reservations by Associated Characteristics and Positive COVID-19 Incidence^a

	COVID-19 Cases	COVID-19 Cases per 1000 Population	% English-Only Household	% >1 Person/Room	% Homes Without Indoor Plumbing
Chickasaw OTSA	20	0.06	93.94	2.35	0.5
Fort Berthold Reservation	22	2.30	17.16	13.46	4.8
Cherokee OTSA	27	0.05	92.41	3.18	0.6
Zia Pueblo and Off-Reservation Trust Land	33	35.33	34.17	21.23	3.8
San Felipe Pueblo	52	14.67	26.05	11.09	2.1
Navajo Nation	599	3.46	32.38	17.34	18.7

^aAs of April 10, 2020.

Implications for Policy & Practice

- We undertook these analyses to identify the relationship between American Indian reservation household characteristics and the rate of COVID-19 cases per 1000 individuals to draw attention to the implications for tribes, reservation communities, and other governments.
- Key findings indicate a positive association between the rate of COVID-19 cases and lack of household plumbing and a negative relationship between English-only households and infection.
- We find no statistical relationship, at the current point in the pandemic, with the rate of COVID-19 cases and the percentage of homes on the reservation that are overcrowded.
- These key findings have implications for communication, implementation, and success of recommendations such as hand washing and state/tribal stay-at-home orders in American Indian reservation communities.
- This study reinforces public health precepts, including population health as more than the sum of individual outcomes, draws attention to health equity concerns regarding racialized distribution of structural/social determinants of health, and uses population need to guide current/future interventions and investments.
- Tribal, other governmental, community, and university financial and human resources support for translation of culturally relevant COVID-19 materials delivered via community-appropriate mechanisms.
- Access to potable water for all American Indian tribal community homes, requiring coordination of federal, state, and tribal governments.
- Continued monitoring of household characteristics associated with COVID-19 incidence.
- Increased coordination among tribal, federal, and state entities to facilitate tribal access to COVID-19 surveillance data.
- In the long term, increase direct public health funding to tribes for infrastructure development and secure American Indian household access to environmental health infrastructure, such as indoor plumbing, where desired.

contextualize health outcomes for the resident population. As such, it does not make inference to what factors will be associated with health outcomes attributable to COVID-19 for American Indian persons living off reservations/in urban settings. Furthermore, this study is limited to reservation-level data collected 2 years prior to the current pandemic and via sampling methods.

Low rates of mortality observed at the time of the analysis prevent detailed analysis of how reservation-level conditions impact death. Unlike positive cases,

however, explorations of death rates on reservations would also require consideration of health care access and infrastructure.

This analysis provides a glimpse into the factors associated with illness on American Indian reservations early in the COVID-19 pandemic. As this pandemic evolves, the overall impact of our focal independent variables will likely change. Acknowledging these limitations, however, these findings direct our attention to the importance of policy and practice implications for preventing pandemic disease spread in American Indian reservation communities.

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