Historical Trends and Regional Differences in All-Cause and Amenable Mortality Among American Indians and Alaska Natives Since 1950

Stephen J. Kunitz, MD, PhD, Mark Veazie, DrPH, and Jeffrey A. Henderson, MD, MPH

American Indian and Alaska Native (AI/AN) death rates declined over most of the 20th century, even before the Public Health Service became responsible for health care in 1956. Since then, rates have declined further, although they have stagnated since the 1980s. These overall patterns obscure substantial regional differences. Most significant, rates in the Northern and Southern Plains have declined far less since 1949 to 1953 than those in the East, Southwest, or Pacific Coast. Data for Alaska are not available for the earlier period, so its trajectory of mortality cannot be ascertained. Socioeconomic measures do not adequately explain the differences and rates of change, but migration, changes in self-identification as an AI/AN person, interracial marriage, and variations in health care effectiveness all appear to be implicated. (*Am J Public Health.* 2014;104: S268–S277. doi:10.2105/AJPH.2013.301684)

When the US Public Health Service (PHS) assumed responsibility for the health care of American Indians and Alaska Native (AI/AN) persons in 1955, it undertook a large study of conditions that, although subject to many of the same reporting and definitional problems with which researchers continue to struggle, remains a useful source of baseline information from which to measure change.[1]

Evidence in the 1950s indicated that (1) American Indians had higher mortality than non–American Indians (Alaska Natives were not included in the original study), (2) they were more likely to die from communicable than noncommunicable diseases, and (3) regional differences existed in both socioeconomic and health conditions that were largely explained by regional ecologies and histories of contact with non-Natives and by differences in regional economies. Here, we briefly review some of the results of the original study and subsequent changes. We also consider current regional differences in causes of death amenable to health care interventions, although we do not analyze the overall impact of health care interventions on either change in total mortality or regional differences in mortality decline since 1950. The available evidence indicates, however, that health care has had a beneficial impact, especially on the decline in childhood and infectious diseases.[2–5]

"Amenable deaths" are deaths that ought to be avoidable if a health care system is providing adequate and timely services appropriate to the needs of its public. Health services include prevention and primary, secondary, and tertiary care; clinical and public health programs; and care provided by voluntary organizations, ambulance services, and the like. Amenable deaths are sentinel events: they should alert providers and the public to potential problems with the health care system that deserve further scrutiny.[6] Circumstances other than limitations of the health care system may be involved in causing amenable deaths—for example, the reluctance of the public to use services. Nonetheless, these events may well reflect problems in the health care system, and when comparisons among regions and populations reveal large differences in rates, they ought to be investigated with an eye to correcting whatever deficiencies have been found.

We describe the different regions in which AI/AN persons live and the ways in which those different contexts appear to have influenced mortality in the 1950s and the changes since then. We argue that variations in socioeconomic conditions across regions do not by themselves adequately explain regional differences in mortality, which require much greater understanding of, among other factors, biases in both reporting of deaths and identification of AI/AN race in the US Census and differences in tribal enrollment criteria, migration, and health care.

METHODS

We used 2 data sources: (1) information published by the PHS in 1957[1] based on surveys on reservations and analyses of state vital statistics and census data and (2) death rates for 1990 to 2009 calculated from the AI/AN Mortality Database file described elsewhere.[7] Each data source is independent of the other. We further classified the 1990 to 2009 rates as (1) all-cause mortality for 1999 to 2009, age adjusted to the 1950 US standard population to be comparable with the results published in the original PHS report, and (2) all-cause and amenable causes of death for 1990 to 1998 and 1999 to 2009, age adjusted to the 2000 US standard population.

Death rates are expressed per 100 000 population. For a more complete description of both the numerator and the denominator used to calculate death rates for 1990 to 2009, see Espey et al.[7] Briefly, the numerator consisted of the number of AI/AN decedents whose residence at the time of death was in 1 of 637 Contract Health Services Delivery Area (CHSDA) counties and who were identified as an AI/AN person on the death certificate or linked to Indian Health Service (IHS) registration records. To be an IHS beneficiary, one must be an enrolled member of a federally recognized tribe. As a denominator, we used the bridged single-race population estimates released by the Census Bureau and the National Center for Health Statistics as described

elsewhere in this supplement,[7] whether enrolled in a federally recognized tribe or not. During preliminary analyses, it was discovered that the updated bridged intercensal population estimates significantly overestimated AI/AN individuals of Hispanic origin.[8] Therefore, to avoid underestimating mortality in the AI/AN population as a whole, analyses were limited to non-Hispanic AI/AN persons. Non-Hispanic Whites were chosen as the most homogeneous referent group. For conciseness, the term "non-Hispanic" is omitted henceforth when discussing both groups. CHSDA counties are aggregated into 6 regions: East, Pacific Coast, Alaska, Southwest, Northern Plains, and Southern Plains (see Table 1 for definition of regions).

The diseases and age-of-death cutoffs considered amenable to health care interventions are displayed in Table A (available as a supplement to the online version of this article at http://www.ajph.org). The list differs from others in that lung cancer is included. Other investigators often exclude it because the lag time between quitting smoking and measurable decline in death caused by lung cancer is long. However, because services provided to AI/AN persons in CHSDA counties have generally been administered by PHS either directly or indirectly since the mid-1950s, at a time when the dangers of cigarette smoking had become widely known to the medical community, and because the PHS has had responsibility for preventive as well as personal services, we have included it.

The original PHS report used states as well as agencies as the units of analysis. Agencies were the basic Bureau of Indian Affairs administrative units, each of which had jurisdiction over 1 or more reservations.[1] For statistical purposes, the Bureau of Indian Affairs and the PHS used the concept of Indian Agency Area in the original 1957 report. All the counties containing a reservation under the jurisdiction of a particular Bureau of Indian Affairs agency were combined and used as the reporting unit, thus including some AI/AN persons living in the county but not on a reservation. Agency areas are comparable to those CHSDA counties that include reservations. As such, they make up a subset of all CHSDA counties and are the units of analysis used here. The analyses are at the ecological, not the individual, level of analysis. That is, we can only consider county-level attributes and their associations with death rates.

TABLE 1—Death Rates Among American Indians for 1949–1953 and Among American Indians/Alaska Natives for 1999–2009, by Indian Health Service Region: United States

Variables	IHS Region					
	Northern Plains	Alaska	Southern Plains	Southwest	Pacific Coast	East
1949–1953						
Total state AI death rate[a]	1000 (1060)	. . .	730 (910)	1190 (1180)	1270 (1250)	710 (610)
AI agency death rate[b]	1200 (1160)	. . .	990 (1050)	1330 (1300)	1430 (1430)	910 (890)
AI nonagency death rate[c]	870 (840)	. . .	470 (470)	1030 (950)	770 (570)	650 (570)
Ratio of actual to expected non-Native deaths[d]	1.53 (1.50)	. . .	1.05 (1.28)	1.75 (1.79)	1.74 (1.72)	1.13 (0.90)
Tuberculosis death rate[e]	104 (111)	. . .	108 (108)	152 (134)	107 (113)	28 (13)
IMR/1000 live births[e]	67.5 (70.4)	. . .	38.9 (48.2)	103.3 (120.5)	75.4 (71.1)	60.4 (57.7)
1999–2009 AI/AN Mortality Database						
AI/AN death rate[f]	995.0	820.2	846.7	697.7	718.4	558.2
CHSDA counties/agency population, %	85.3	. . .	92.3	53.0	54.5	61.8
AI/AN:White RR	2.18	1.84	1.48	1.45	1.51	1.17
AI/AN tuberculosis death rate	1.2	2.4	0.7	1.4	0.6	0.0
AI/AN:White tuberculosis RR	24.3	44.2	5.5	15.1	9.2	0.0
AI/AN IMR/1000 live births (crude rates)	5.6	6.0	3.7	3.8	4.2	3.5

Note. AI/AN = American Indian/Alaska Native; CHSDA = Contract Health Service Delivery Area; IHS = Indian Health Service; IMR = infant mortality ratio; RR = rate ratio. Dashes indicate data not available. Death rates are per 100 000 and are age adjusted to the 1950 US standard population. Analyses are limited to people of non-Hispanic origin. AI/AN race is reported from death certificates or through linkage with the IHS patient registration database. IHS regions are defined for 1990–2009 as follows: Alaska[g]; Northern Plains (IL, IN,[g] IA,[g] MI,[g] MN,[g] MT,[g] NE,[g] ND,[g] SD,[g] WI,[g] WY[g]); Southern Plains (OK,[g] KS,[g] TX[g]); Southwest (AZ,[g] CO,[g] NV,[g] NM,[g] UT[g]); Pacific Coast (CA,[g] ID,[g] OR,[g] WA,[g] HI); East (AL,[g] AR, CT,[g] DE, FL,[g] GA, KY, LA,[g] ME,[g] MD, MA,[g] MS,[g] MO, NH, NJ, NY,[g] NC,[g] OH, PA,[g] RI,[g] SC,[g] TN, VT, VA, WV, DC). Percentage regional coverage of AI/AN persons in CHSDA counties to AI/AN persons in all counties: Northern Plains = 64.8%; Alaska = 100%; Southern Plains = 76.3%; Southwest = 91.3%; Pacific Coast = 71.3%; East = 18.2%; total US = 64.2%. IHS regions for 1949–1953 are broadly comparable with present-day regions but include a higher proportion of AI/AN persons living on their reservations than in CHSDA counties.

Source. US Public Health Service[1]; AI/AN Mortality Database (1990–2009).

[a]Numbers in parentheses are average annual rates weighted by the Native population of each state.

[b]Numbers in parentheses are average annual rates weighted by the Native population of each agency.

[c]Numbers in parentheses are average annual rates weighted by the Native population of the nonagency areas of each state.

[d]Numbers in parentheses are the ratios of the rates weighted by the number of Natives in each state.

[e]Rates are for Natives in agencies; numbers in parentheses are weighted by the number of Natives in each agency.

[f]Death rate of AI/AN persons in CHSDA counties as a percentage of deaths of Native persons in agencies, age adjusted to the 1950 standard million population.

[g]Identifies states with ≥1 county designated as CHSDA.

Socioeconomic variables in the contemporary period (i.e., 1990–2009) are at the CHSDA county level and include each county's place on the urban–rural continuum, the percentage of unemployed AI/AN persons in each county, the percentage who have less than a high school education, the percentage living in poverty, and the percentage in white-collar occupations. For 1948 to 1953, we grouped counties into regional categories large enough to minimize the confidence intervals; for 1990 to 2009, we grouped CHSDA counties into IHS regions.

Socioeconomic variables were only available for AI/AN race alone, non-AI/AN race alone, and AI/AN race in combination with other groups. This is a potential source of bias because AI/AN race alone and AI/AN race in combination with others may have very different socioeconomic characteristics, and their relative proportions may differ among regions.

RESULTS

According to the original PHS study,[1] mortality of American Indian (AI) persons in 1950 was half as high as that of non-AI persons (rate ratio [RR] = 1.45). Non-Natives died overwhelmingly of noninfectious conditions, whereas infectious diseases played a greater role among American Indians. Even then, however, chronic diseases had begun to make a significant contribution to mortality.

Tuberculosis, pneumonia, and influenza had declined in both populations since 1935, but the rates among AI persons were still far higher than those among non-AI persons and in 1953 were about the same as they had been for non-AI persons almost 20 years earlier.[1] However, heart disease had increased gradually in each population since 1935. Arteriosclerotic heart disease was by far the single most important category, especially for non-AI individuals: The rate for AI males was 91.3; AI females, 48.3; non–AI males, 286.5, and non–AI females, 153.8.[1]

Much has changed in the subsequent 60 years. Mortality declined among AI/AN and non-AI/AN populations, and the RR narrowed somewhat to 1.34, but the patterns have differed. Among non-AI/AN persons, the rate of all-cause mortality declined steadily from the early 1970s to the early 2000s, whereas among AI/AN persons the rate declined until the mid-1980s, when a slight increase occurred.[9] This increase appears to have persisted into the early 2000s and was primarily due to diabetes and lung cancer.

The generalizations about aggregate, all-cause mortality mask regional differences in baseline conditions and in the way change has occurred. Thus, Table 1 displays age-adjusted all-cause, tuberculosis, and infant death rates for AI persons for 1949 to 1953 by region, as reported in the original PHS study, and all-cause mortality for 1999 to 2009, age adjusted to the 1950 population. The geographic subdivisions among the 6 regions are not precisely consistent between the 2 periods, but the agencies in the 1949 to 1953 period are broadly comparable with the CHSDA counties in 1999 to 2009. However, because agency areas included a higher proportion of people living on reservations than do CHSDA counties, which also include major metropolitan areas, death rates reported from 1999 to 2009 may be lower than if only counties with reservations had been included.

Considering the early period first, several findings stand out. AI persons in the East had unusually low age-adjusted rates compared with AI persons elsewhere in the country. Indeed, they were virtually the same as rates among non-AI persons. Rates on the Pacific Coast and in the Southwest were higher than elsewhere. Tuberculosis and infant death rates were far higher in the Southwest than anywhere else in the country. In every region, death rates of AI people living on agencies were higher than those of AI people living elsewhere in the same state. The RR (weighted by agency population) was 1.6.

Sixty years later, rates had declined in all regions, but unevenly. The RR between the regions with the highest and lowest rates (CHSDA counties only) was 1.78. Rates were still unusually low in the East, but now AI/AN people on the Pacific Coast and in the Southwest had lower rates than AI/AN people on the Northern Plains, who had the highest rates. When we calculated 1999 to 2009 death rates (age adjusted to 1950) as a percentage of the 1949 to 1953 death rates, we found that the smallest decline occurred among AI/AN persons in the Southern Plains, followed closely by the Northern Plains. The declines were greatest on the Pacific Coast and in the Southwest, followed by the East. Moreover, AI/AN:White RRs declined everywhere except the Northern and Southern Plains, where they increased.

Several possible interrelated reasons exist as to why mortality has varied among regions in the past and in the present and why change among regions has proceeded at different rates: bias and differences in rates of emigration and immigration, self-identification in the US Census, health-related behaviors and health care, tribal enrollment criteria, and socioeconomic conditions. We consider each briefly.

Socioeconomic Differences

Table 2 displays socioeconomic data for 1950 from the PHS report[1] and for 2000 from the US Census. Considering the earlier period first, the Southwest stands out in several ways: education and income were lowest there, AI lands were far more extensive than elsewhere, and a very high proportion was controlled by tribes rather than having been allotted to individuals, both AI and non-AI. The proportion of AI land controlled by tribes was almost as high in the East, but these lands were mere remnants of lands previously controlled by tribes and the least extensive of any region because dispossession had occurred before tribes negotiated treaties with the US government. The pattern elsewhere was very different: virtually all Indian reservation land on the Southern Plains and much of that on the Northern Plains and the Pacific Coast had been allotted to AI and non-AI persons and was owned by individuals, not tribal entities.

Allotment of Indian reservation land was federal policy in the late 19th and early 20th centuries. It involved assigning reservation land to Natives as individuals, usually 160 acres to each head of household and 80 acres to other members. The "excess" land that was left after the allotment to AI people was then made available for homesteading by non-AI individuals. After a number of years, when AI persons were considered "competent," they could dispose of their allotments. Thus, over a period of years much of what had originally been reservation land controlled by tribes as corporate entities was fragmented into individual holdings. The reasons for the policy were both to make large tracts of land available to non-AI settlers and to "Americanize" Natives

TABLE 2—Socioeconomic Variations Among American Indians in 1950 and American Indians/Alaska Natives in 2000, by Indian Health Service Region: United States

Variables	IHS Region					
	Northern Plains	Alaska	Southern Plains	Southwest	Pacific Coast	East
			1950			
Median school years completed, AIs aged ≥ 25 y[a]						
Male	7.6 (7.7)	. . .	7.9 (7.9)	4.2 (3.5)	7.9 (8.1)	6 (6)
Female	7.9 (7.9)	. . .	7.5 (7.5)	3.6 (2.0)	7.8 (7.9)	6.4 (6.4)
Median family income,[b] $						
Unweighted	1509	. . .		951	1633	1552
Weighted[c]	1262		. . .	727	1706	1552
Total AI land in acres, state average	1 719 790	. . .	916 961	6 027 254	1 442 867	39 087
% AI land tribally owned, state average	51.9	. . .	4.4	95	70.4	90.4
% AI land allotted, state average	43.8	. . .	94.7	4.5	28.2	0.6
No. of states in each region	9	1	2	5	4	4
			2000[d]			
Median income[e]						
Current $ (range[f])	24 957 (75 000–649 000)	33 588 (196 000–517 000)	27 814 (132 000–407 000)	24 605 (149 000–408 000)	32 947 (144 000–539 000)	31 483 (194 000–547 000)
1950 $ (range)	3493 (10 000–91 000)	4701 (27 000–72 000)	3892 (18 000–57 000)	3444 (21 000–57 000)	4611 (20 000–75 000)	4406 (27 000–77 000)
% below federal poverty line (range)	32.0 (0–65.4)	18.2 (4.0–26.4)	19.3 (5.4–50.4)	32.5 (0–64.5)	19.9 (0.7–50.0)	19.5 (0–35.3)
Education,[g] % (range)						
High school graduate	74.3 (53.2–92.8)	71.8 (62.5–83.3)	76.3 (11.1–91.7)	64.7 (52.1–87.0)	73.2 (52.6–93.3)	68.9 (39.8–84.6)
Bachelor's degree	8.8 (0–23.1)	6.0 (1.4–10.9)	13.3 (2.3–25.9)	7.5 (0–22.5)	10.8 (0–30.7)	12.3 (0–27.3)
% AI/AN alone living in urban counties[h]	10.3	22.7	43.6	33.6	56.6	60.9

Note. AI/AN = American Indian/Alaska Native; CHSDA = Contract Health Service Delivery Area; IHS = Indian Health Service. Dash indicates that data are not available. IHS regions are defined for 2000 as follows: Alaska[i]; Northern Plains (IL, IN,[i] IA,[i] MI,[i] MN,[i] MT,[i] NE,[i] ND,[i] SD,[i] WI,[i] WY[i]); Southern Plains (OK,[i] KS,[i] TX[i]); Southwest (AZ,[i] CO,[i] NV,[i] NM,[i] UT[i]); Pacific Coast (CA,[i] ID,[i] OR,[i] WA,[i] HI); East (AL,[i] AR, CT,[i] DE, FL,[i] GA, KY, LA,[i] ME,[i] MD, MA,[i] MS,[i] MO, NH, NJ, NY,[i] NC,[i] OH, PA,[i] RI,[i] SC,[i] TN, VT, VA, WV, DC). Percentage regional coverage of AI/AN persons in CHSDA counties to AI/AN persons in all counties: Northern Plains = 64.8%; Alaska = 100%; Southern Plains = 76.3%; Southwest = 91.3%; Pacific Coast = 71.3%; East = 18.2%; total US = 64.2%. IHS regions for 1950 are broadly comparable but include a higher proportion of AI/AN persons living on their reservations than do the present-day regions.

[a]Unweighted averages for residents of AI agencies. Figures in parentheses are weighted by the number of AI persons in each agency.

[b]For reservation families. The states for which data were included were as follows: East, FL; Northern Plains, MN, MT, ND, SD, WI, and WY; Pacific Coast, CA, ID, OR, and WA; Southwest, AZ, NV, NM, and UT.

[c]Weighted by the number of families on each reservation.

[d]2000 US Census restricted to the CHSDA counties with ≥ 50 AI/AN unweighted cases responding to the 2000 Long Form.

[e]Median household income and percentage below poverty line are county averages weighed by AI/AN alone population.

[f]Ranges show the value for the lowest and highest county within the region.

[g]Education attained figures are county averages weighted by the number of AI/AN > 25 y in the county.

[h]Urban county is a metropolitan county with an urban population > 250 000.

[i]Identifies states with ≥ 1 county designated as CHSDA.

by breaking up communally controlled land into individually owned parcels. The Southwest was the exception to this policy, probably because the aridity of the region made homesteading on reservation lands impractical.

Currently, the Southwest still has slightly lower educational attainment than the other regions, but with respect to levels of income and poverty it is very similar to the Northern Plains. Each is substantially poorer than the other IHS regions. The Pacific Coast and the East are by far the most urbanized, with well over half living in metropolitan counties of more than 250 000. The Northern Plains and Alaska are the least urbanized.

Regional Mortality and Socioeconomic Patterns, 2000

Table 3 displays age-adjusted death rates from 1990 to 2009 for AI/AN persons in relation to a variety of socioeconomic characteristics (see also Figures A–E, available as a supplement to the online version of this article at http://www.ajph.org).With the exception of the urban–rural categories, the CHSDA counties are classified by the characteristics of AI/ANs alone. Considering first the urban–rural continuum (Table 3), notice the following characteristics:

1. AI/AN mortality is always higher than White mortality in the same counties, with the exception of the East, in which urban AI/AN people have lower mortality than Whites.
2. We found very few discernible patterns in death rates across the urban–rural continuum, except for the East and the Pacific Coast, in which urban mortality is lower than rural mortality.
3. Examining the variation in death rates across the rows describing the urban–rural continuum, we found no consistent pattern of mortality. We found substantially greater variation among AI/AN persons than among Whites in rates across regions within urban–rural designation.

On average, variables in Table 3 have a coefficient of variation in the rates across regions that is 3 times greater for AI/AN persons than for Whites.

The association of mortality with the percentage of AI/AN persons unemployed, living in poverty, or both (Figures B and C) was equally inconsistent: death rates did not always follow the expected trend by increasing as the percentage living in poverty increased. We observed similarly inconsistent results when we analyzed education and type of employment (Figures D and E). That is, in some regions, we found the expected association between socioeconomic characteristics and mortality and in others we did not, and within the same categories, rates varied enormously by region.

When AI/AN death rates were aggregated across all regions (Figures F–J, available as a supplement to the online version of this article at http://www.ajph.org), we observed somewhat more consistent patterns. Death rates increased as populations became increasingly rural (Figure F); educational attainment (Figure G) was unrelated to death rates, but high levels of poverty (Figure H) and unemployment (Figure I) were both associated with increased mortality; and a high level of white-collar employment (Figure J) was associated with reduced mortality. Thus, at the national level, total all-cause mortality was associated with socioeconomic measures, as might be expected, but at the regional level, we observed no such consistency. This lack of consistency may mean that commonly used socioeconomic variables measured at the county level are of little use in explaining regional differences in AI/AN mortality. What other characteristics, then, might help to account for the great regional differences in mortality that we observed? We consider several potentially contributing factors.

Assimilation and Identity

The authors of the PHS report wrote,

> One of the major reasons for lack of specificity in Indian population data is the variation from place to place as to the inclusion or exclusion of persons of mixed ancestry in the Indian tally.[1(p14)]

Using very imperfect self-report data from the 1950 Census, they estimated the distribution of reservation residents with 100% Native ancestry as follows: (1) in the Southwest, Window Rock Agency, 95% to 100%; Albuquerque Agency, about 95%; and Phoenix Agency, about 90%; (2) on the Pacific Coast, Portland Agency, about 70%, and Sacramento Agency, about 20%; and (3) in the Northern Plains, Aberdeen and Billings Agencies, about 40% each, and in the Minneapolis Agency, 25% to 30%. No data were reported for the Southern Plains, Alaska, or the East, but the 1900 Census showed that even 50 years previously about 40% of Cherokees on the Southern Plains had married non-AI persons, a higher proportion than in any other AI population studied at the time.[10] Tenuous as these data are, they do suggest that in the Southwest, marriage with non-AI individuals occurred substantially less than in most of the rest of the country.

Across the entire AI population, marriage with non-Natives increased dramatically after 1960,[11] as did tribal exogamy (AI persons of 1 tribe marrying AI persons of another tribe). Recent studies have indicated that tribal endogamy is greatest in the Southwest[12]; endogamous couples are those least likely to migrate across state lines[13]; and AI persons married to non-AI persons living on a reservation are more likely to identify their children as only American Indian than are exogamous couples who live elsewhere.[14]

Since the 1960s, a large increase has also occurred in the number of people claiming full or partial AI identity, as a result of changes in self-definition and in the way the census has allowed people to classify themselves.[15] With respect to self-identification, most people who claimed some degree of AI ancestry did not claim AI identity: only about 21% in 1980 and 22% in 1990. Thus, there was a great deal of room for people to change their identity to AI/AN alone or in combination with another race. Changing self-identification to that of an Native person occurred much more frequently in states with small AI/AN populations, which are overwhelmingly in the East, than in states with large reservations, large concentrations of AI/AN people, or both, which are west of the Mississippi.[15] In the 2000 Census, the proportion of self-identified AI/AN people who said they were AI/AN alone was lowest in the East (47%) and the Pacific Coast (54%), followed by the Northern and Southern Plains (63%), and then Alaska and the Southwest (82%).[16]

The consequences of changing identification are potentially important. It may, for example, inflate population denominators without affecting the numerator because in places in

TABLE 3—Death Rates for American Indians/Alaska Natives and Whites, by Indian Health Service Region and Contract Health Service Delivery Area County Characteristics: United States, 1990–2009

Characteristic	Northern Plains		Alaska		Southern Plains		Southwest		Pacific Coast		East		Total	
	AI/AN	White	AI/AN	White	AI/AN	White	AI/AN	White	AI/AN	White	AI/AN	White	AI/AN	White
Urban–rural designation														
Urban counties in metropolitan areas ≥ 250 000 pop	1326.5	793.4	1389.4	786.1	1236.6	916.8	1151.3	812.2	949.9	819.9	660.7	806.5	1068.9	814.5
Urban counties in metropolitan areas < 250 000 pop	1434.5	798.4	1337.9	797.6	1327.4	823.6	888.2	734.6	1150.1	828.1	773.8	862.7	1052.8	812.8
Urban pop ≥ 20 000 adjacent to a metropolitan area	1582.3	782.6	–	–	1302.7	925.0	1046.4	877.7	1112.7	849.5	895.7	863.8	1087.3	853.6
Urban pop ≥ 20 000 not adjacent to a metropolitan area	1406.4	796.9	1172.8	719.4	1378.2	968.5	1095.5	879.9	1230.9	889.5	716.6	804.5	1229.7	843.3
Urban pop of 2500–19 999, adjacent to a metropolitan area	1459.3	811.0	–	–	1369.5	967.5	1008.9	843.7	1263.8	826.3	1090.4	940.9	1198.9	871.7
Urban pop of 2500–19 999, not adjacent to a metropolitan area	1648.1	820.8	1224.8	790.3	1399.4	991.1	987.5	816.7	1187.8	860.6	1633.5	863.6	1387.7	846.1
Rural pop < 2500 pop not adjacent to metropolitan area	1598.5	790.3	1134.4	736.5	1303.0	941.2	1287.0	853.7	1223.1	789.8	1562.4	880.3	1469.0	805.4
% AI/AN alone unemployed in county														
< 10	1411.3	787.7	1172.8	719.4	1272.4	927.8	936.6	786.2	933.1	790.9	733.9	807	1137.9	810.4
10–14	1428.4	789.3	1259.5	728.5	1366.5	928.3	1139.4	821.7	1012.1	841.2	895.5	793.1	1152.8	819.7
15–19	1488.0	820.3	1252.4	778.0	1644.6	934.9	923.7	770.6	1068.8	833.4	934.3	887.2	1098.4	843.5
≥ 20	1627.1	792.9	1225.0	801.2	1523.1	947.7	1040.6	801.2	1327.3	866.9	1308.6	836	1248.2	830
% AI/AN alone with < high school education in county														
< 20	1431.1	758.7	1213.5	765.7	1288.0	874.6	918	770.4	1046.3	797.2	1224.4	852.7	1177.0	795.5
20–29	1524.1	806.9	1342.6	785	1317.7	965.5	1052.1	828.2	1113.9	830.1	902.5	803.8	1248.5	824.9
≥ 30	1597.8	798.5	1158.2	791.6	1300.9	932	1037.4	798.6	976.3	853.2	718.7	817.7	1080.3	823.8
% AI/AN alone living below federal poverty line in county														
< 20	1387.9	786.8	1282.8	779.9	1284.0	891.2	884.7	938.9	904.5	786.8	702.8	817.7	1131.0	815
20–29	1512.2	792.8	1195.1	789.7	1299.0	955.4	1094.9	782.6	1132.2	843.8	916.9	798.6	1171.3	819.3
30–49	1535.9	803.1	–	–	1455.5	983.3	1029.5	771.2	1072.2	882	933.5	889.8	1161.6	832.6
≥ 50	1741.6	749.1	–	–	710.9	1013.6	1033.4	833.7	–	–	–	–	1683.1	759.3
% AI/AN alone working in white-collar professions in county														
< 20	1523.9	810.6	1252.2	790.4	1391.6	978.6	1103.2	773.2	1030.1	825.6	915.3	857.6	1210.7	824.5
20–29	1484.7	781	1276.5	776.1	1297.9	937.4	1021.9	816.8	1021.1	837.4	851.3	820.2	1131.8	828.8
30–39	1581.3	750.6	1127.3	820.7	1287.2	850.7	1005.6	796.6	1258.1	779.2	689.4	778.3	1254.9	778.7
≥ 40	1430.5	832	–	–	710.9	1013.6	–	–	903.7	741.5	645.9	769	997.3	768.2

Note. AI/AN = American Indian/Alaska Native; IHS = Indian Health Service; pop = population. Death rates are per 100 000 and are age-adjusted to the 2000 US standard population (19 age groups; Census P25-1130). Analyses are limited to persons of non-Hispanic origin. AI/AN race is reported from death certificates or through linkage with the IHS patient registration database.

which there are few AI/AN persons, race is often misclassified. This appears to have occurred especially in the East and may help account for the lower death rates in this region.

Criteria for tribal enrollment are established by tribes and are most often determined by degree of ancestry in that particular tribe: one half, one quarter, one eighth, one sixteenth, one thirty-second, or no minimum at all. In general, reservation-based tribes have more stringent requirements than do those without reservations.[17] This is likely to influence death rates if health risks of people vary with degree of AI/AN ancestry, which may be a reflection of socioeconomic status. That is, in some parts of the country, mixed-race AI/AN people may have lower mortality than those who are AI/AN alone because of differences in socioeconomic status. Among regions, the Southern Plains and the East are the regions in which most tribes are without a federally recognized reservation (see map in online supplement, available at http://www.ajph.org) and where enrollment criteria may be least stringent.

Migration

AI people often left reservations to work in the late 19th and first half of the 20th centuries, but it was not until the 1940s that they left in large numbers, first to work in defense industries and to serve in the military during World War II, and then as part of the government's relocation programs in the 1950s. Emigration has continued, and now well over half of self-identified AI/AN persons live in urban centers. However, emigration differs across the country.

Differential emigration from rural CHSDA counties may have an impact on death rates if healthy people are more likely to leave (the healthy migrant effect) and sick people, elderly people,[18] and those retired from urban employment remain on, or return to, reservations. There is some evidence that both may be at work. People who remain on reservations are poorer,[19,20] less well educated, and at higher risk for substance misuse than those who migrate.[21,22] Thus, the lower the rate of migration, the healthier the population that remains at home may be, because if employment and educational opportunities are available on or near reservations, the most employable and healthiest may have greater reason to remain.[23] Moreover, a study of urban AI/AN persons suggested that some diagnoses are associated with return visits to reservations.[23]

There are no comparative long-term cohort studies of migration patterns among regions, but it is clear that emigration from reservations since the 1940s has been considerable and that it has varied regionally. The 1970 Census listed Natives by tribal membership and the proportion who were living on identified reservations. Of identified tribal members in the Southwest, 50% to 70% were living on reservations, a substantially greater percentage than in other parts of the country. Only the Blackfeet and Sioux on the Northern Plains were at all similar: 45.9% and 53.4%, respectively, lived on reservations.[24]

As we have noted, analyses of the 1980 Census have suggested that growth of the AI/AN population in the eastern United States was a result of increasing self-identification. In the same census, growth of AI/AN populations in cities on the Pacific Coast was found to be caused by in-migration.[15] By 1990, the Pacific Coast and southwestern Sunbelt cities had become major destinations for AI/AN immigrants, as they had for immigrants of other races.[25–27]

Combining population data from the 2000 Census[28] with tribal enrollment data,[29] we estimate that on average 68.7% of enrolled members of Southwestern tribes live on reservations compared with 46.8% of enrolled members of Northern Plains tribes.[30] We have not attempted similar estimations for other regions, but these limited data indicate that emigration has differed substantially from 1 region to another for many years, and it would be surprising if there were no consequences for the regional distribution of death rates caused by differential sorting of people by risk profile. Thus, regional differences in self-identification, enrollment criteria, and migration patterns may influence regional differences in mortality by inflating or deflating both the numerators and the denominators, but each may result in real (i.e., unbiased) differences in mortality nonetheless.

Amenable Mortality

A final source of variation to be considered, the effectiveness of health services, is more readily estimated. Table 4 displays death rates from amenable causes among AI/ANs in CHSDA counties. With the exception of the Southwest from 1990 to 1998, rates of amenable deaths were significantly higher among AI/AN than White persons. In every region, amenable deaths in each population declined from 1990 to 1998 to 1999 to 2009, but total all-cause mortality of AI/AN persons across the country did not decline as a result of slight increases in all-cause mortality among AI/AN persons on the Pacific Coast and on the Southern Plains. Elsewhere, mortality among AI/AN populations declined. The range of rates for both amenable and nonamenable causes of death across regions is far greater for AI/AN than for White persons. Amenable and nonamenable death rates were more highly correlated among AI/AN than White people within each population and period. That is, where amenable causes are high, so too are nonamenable causes. As a percentage of all-cause mortality, amenable mortality is generally similar between AI/AN and White populations, but amenable mortality is lower both absolutely and relatively among AI/AN persons in the Southwest than in any other region.

DISCUSSION

The major question raised by this historical overview is how to account for the great regional differences in mortality and rates of change among AI/AN persons, differences that are far greater than those among Whites. As with other Indigenous peoples subjected to invasion by Europeans, AI/AN persons have experienced catastrophic population losses as a result of warfare and disease, expropriation of land and natural resources, and economic deprivation and social isolation. However, great differences have existed among them as well, resulting from differences in geography, in the Europeans who first contacted them and the time of first contact, in tribal culture, and in subsequent patterns of social and economic change.

For example, the English who first contacted Natives on the East Coast of North America in the 17th century differed from the Spanish who entered the Southwest at about the same time. They found very different societies, they had different aspirations, and they encountered very different ecologies. The English pursued

TABLE 4—Rates of Amenable, Nonamenable, and All-Cause Mortality for American Indians/Alaska Natives and Whites, by Indian Health Service Contract Health Service Delivery Area Counties: United States, 1990–2009

IHS Region	AI/AN Mortality			White Mortality			Rate Ratio AI/AN:White	
	Amenable	All Cause	Amenable as % of All Cause	Amenable	All Cause	Amenable as a % of All Cause	Amenable	All Cause
				1990–1998				
Alaska	181	1242	14.6	131	852	15.3	1.44*	1.5*
East	161	889	18.1	146	859	17.0	1.18*	1.07
Northern Plains	295	1634	18.1	135	837	16.1	2.26*	1.98*
Southern Plains	222	1218	18.2	159	928	17.1	1.49*	1.5*
Pacific Coast	161	992	16.2	139	870	15.9	1.21*	1.16*
Southwest	132	1043	12.6	140	846	16.5	1.03	1.25*
Range	132–295	889–1634	12.6–18.2	131–159	820–928	15.3–17.1		
Total	182	1152	15.8	140	859	16.2	1.32*	1.35*
				1999–2009				
Alaska	172	1230	14.0	99	746	13.2	1.84*	1.69*
East	140	862	16.2	116	746	15.5	1.27*	1.08*
Northern Plains	232	1479	15.7	107	767	13.9	2.24*	1.95*
Southern Plains	208	1321	15.7	145	926	15.6	1.47*	1.44*
Pacific Coast	157	1103	14.2	112	792	14.1	1.45*	1.41*
Southwest	126	1024	12.3	111	788	14.1	1.17*	1.31*
Range	126–232	862–1479	12.3–16.2	99–145	746–926	13.2–15.6		
Total	170	1175	14.5	114	795	14.3	1.49*	1.48*

Note. AI/AN = American Indian/Alaska Native; CHSDA = Contract Health Service Delivery Areas; IHS = Indian Health Service. Death rates are per 100 000 and were age adjusted to the 2000 US standard population (19 age groups; Census P25-1130). Analyses are limited to people of non-Hispanic origin. AI/AN race is reported from death certificates or through linkage with the IHS patient registration database. IHS regions are defined as follows: Alaska[a]; Northern Plains (IL, IN,[a] IA,[a] MI,[a] MN,[a] MT,[a] NE,[a] ND,[a] SD,[a] WI,[a] WY[a]); Southern Plains (OK,[a] KS,[a] TX[a]); Southwest (AZ,[a] CO,[a] NV,[a] NM,[a] UT[a]); Pacific Coast (CA,[a] ID,[a] OR,[a] WA,[a] HI); East (AL,[a] AR, CT,[a] DE, FL,[a] GA, KY, LA,[a] ME,[a] MD, MA,[a] MS,[a] MO, NH, NJ, NY,[a] NC,[a] OH, PA,[a] RI,[a] SC,[a] TN, VT, VA, WV, DC). Percent regional coverage of AI/AN in CHSDA counties to AI/AN in all counties: Northern Plains = 64.8%; Alaska = 100%; Southern Plains = 76.3%; Southwest = 91.3%; Pacific Coast = 71.3%; East = 18.2%; and total United States = 64.2%.

Source. AI/AN Mortality Database (1990–2009). The following states and years of data were excluded because Hispanic origin was not collected on the death certificate: LA, 1990; NH, 1990–1992; and OK, 1990–1996.

[a]Identifies states with ≥ 1 county designated as CHSDA.

*$P < .05$.

a policy of extermination and ethnic cleansing different from anything done by the Spanish north of Mexico. Moreover, because the Southwest was arid, it did not lend itself to the establishment of the small farms or plantations that developed in the East. Indeed, from the East across the northern and southern plains all the way to the Pacific Coast, the environment made farming and ranching viable activities, and belief in progress and manifest destiny justified dispossession of Natives. The fact that in the Southwest tribal lands are more extensive and a higher proportion are controlled by tribes than by individuals reflects the fact, as noted previously, that homesteading was not possible in much of the region and that allotment of AI lands occurred in only a few places.[30] Isolation in turn explains the higher rates of Indian endogamy and diminished access to health care and education, resulting in the lower levels of education and high infant mortality and tuberculosis rates observed in the 1950s. Although Alaska was not included in the original PHS study, patterns there appear to have been similar.

Regional socioeconomic differences do not explain contemporary regional differences in mortality. For instance, Northern Plains and Southwest AI/AN people at the same level of poverty have very large differences in mortality. This is perhaps the most striking result of our analyses: that county-level socioeconomic conditions do not explain regional differences in mortality among AI/AN persons. These are ecological analyses and so must be treated with caution. However, analyses of individual-level data from the National Longitudinal Mortality Study have shown that income and education do not explain the differences between the likelihood of death of AI/AN persons on the Northern Plains and in the Southwest.[31] We have therefore considered other factors that might be important.

Migration and identification in the census and on death certificates are all sources of potential bias, but each may also be of value in explaining real regional variations in mortality. To the degree that each spuriously inflates or deflates the numerator (mortality) or the denominator (population), the rates may be more or less inaccurate. Changing self-identification may increase the population claiming AI/AN identity on the US Census, but many individuals may not match the criteria for inclusion in the mortality data, for instance by not being classified as an AI/AN person on the death certificate or not being enrolled in a tribe and

thus not registered with the IHS, thus spuriously lowering the death rate. This is likely to occur in the East and in metropolitan areas in which the population includes few AI/AN people and individuals who fill out death certificates may not be aware of the presence of AI/AN persons.[32]

Another potential source of bias is the exclusion of Hispanic AI/AN individuals from the analyses. Although it reduced the overall deaths among AI/AN persons by less than 5%, it may have disproportionately excluded some tribal members in states along the US–Mexico border and elsewhere who have Hispanic surnames and may be coded as Hispanic at death.

Finally, the healthy migrant effect has an impact on the numerator in both the place of origin and the destination, reducing the number of low-risk people in the former and increasing it in the latter. Again, demographic studies have suggested that emigration may be especially great from the Northern and Southern Plains to the Pacific region, thus having measurable consequences for rates in each region.

All of these are very real possibilities, but they are only biases if they mean that the criteria for inclusion in the numerator and denominator differ. Neither the effect of migration nor differing enrollment criteria is a bias if the individual is included in both the numerator and the denominator of the place of residence at the time of death. Instead, each is a source of real difference because each may influence the risk profiles of individuals. Without actual field studies in various parts of the country, however, it is impossible to know how important these considerations are in shaping the rates that we have reported. It does seem reasonable to view the data as least biased in places in which there are large concentrations of Natives. Evidence has revealed more accurate recording of race on death certificates in areas in which there are many people of the same race in the population[32]; IHS services are widely available and alternatives less so, because AI/AN persons are then likely to be registered with the IHS; and enrollment criteria include the vast majority of the population who identify themselves as an AI/AN person in the census. The Southwest, the Northern and Southern Plains, and Alaska regions appear to meet all or most of these criteria better than the East or the Pacific Coast regions, and it is reasonable to suppose that death rates from the former are more accurate than those from the latter.

Of course, amenable mortality is subject to all of the same potential biases. Nonetheless, biases are unlikely to account for all the differences, especially among regions in which, as we have observed, there are many AI/AN people and a wide range of IHS services. Why, for example, are amenable death rates in the Southwest almost half those on the Northern and Southern Plains and about three quarters those in Alaska? Understanding the reasons for such differences is important because, unlike the other determinants of regional variation in mortality, the quality of health care can be addressed by those responsible for the provision of services. Because amenable deaths are only an indicator of possible problems, however, the differences cannot be understood without investigation of health care in particular settings.

The lesson to be drawn from these results is that histories of AI–non-AI contact and the experience of being an AI/AN person vary so greatly across the country that generalizations about the causes of regional differences in mortality are not yet possible. Only careful consideration of the particularities of each region will allow for fuller understanding of what for now must remain plausible speculations. ■

About the Authors

At the time this article was written, Stephen J. Kunitz was with the Department of Public Health Sciences, University of Rochester School of Medicine, Rochester, NY. Mark Veazie was with the Indian Health Service, US Public Health Service, Flagstaff, AZ. Jeffrey A. Henderson was with the Black Hills Center for American Indian Health, Rapid City, SD.

Correspondence should be sent to Stephen J. Kunitz, MD, PhD, Division of Social and Behavioral Medicine, Department of Public Health Sciences, University of Rochester Medical Center, 265 Crittenden Boulevard, CU 420644, Rochester, NY 14642-0644 (e-mail: Stephen_Kunitz@urmc.rochester.edu). Reprints can be ordered at http://www.ajph.org by clicking the "Reprints" link.

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Contributors

S. J. Kunitz contributed to the conceptualization of the article and the use of historical material and did the writing. M. Veazie generated graphical and tabular analyses of the data and collaborated on the design of the article. J. A. Henderson contributed to the design and editing of the article.

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