Motor Vehicle Deaths Among American Indian and Alaska Native Populations

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In the United States, the American Indian and Alaska Native (AI/AN) population has the highest motor vehicle death rate, which is significantly greater than that of any other race or ethnic group. To better understand why this significant disparity exists and how to eliminate it, the authors conducted a systematic review of the published scientific literature. Included studies were published between January 1, 1990, and January 31, 2011, and identified risk factors, or implemented and tested interventions, targeting motor vehicle deaths among the AI/AN population. Only 14 papers met the study’s inclusion criteria. Most of the epidemiologic studies explored alcohol use as a risk factor for deaths of both motor vehicle occupants and pedestrians; few studies addressed risk factors specifically for pedestrians. All of the intervention studies focused on mitigating risks for motor vehicle occupants. On the basis of the authors’ review, injury prevention interventions that are multifaceted and involve partnerships to change policy, the environment, and individual behavior can effectively mitigate motor-vehicle-related deaths among AI/ANs. Priority should be given to implementing interventions that address pedestrian safety and to sound investment in the states with the highest AI/AN motor vehicle death rates because reducing their burden can dramatically reduce the overall disparity.

INTRODUCTION

Unintentional injuries are the leading cause of death for individuals between the ages of 1 and 44 years in the United States (1). The primary cause of most of these deaths is motor vehicle crashes, which is the leading cause among individuals aged 5–34 years. Motor vehicle deaths in the United States are costly, generating an estimated $100 billion in lifetime costs annually (2). Motor vehicle deaths are in large measure also preventable because injury research has identified modifiable risk factors involving the individual, vehicle, and physical and policy environments. Successfully addressing these risk factors has resulted in significant reductions in motor vehicle deaths, making motor vehicle safety, according to the Centers for Disease Control and Prevention, one of the 20th century’s 10 great public health achievements in the United States (3).

Despite these declines in overall motor vehicle deaths, segments of the US population remain disproportionately burdened by these injuries. The American Indian and Alaska Native (AI/AN) population has the highest motor vehicle death rate, which is 3 times the rate for the Asian and Pacific Islander population—the population with the lowest rate. Across the United States, the AI/AN motor vehicle death rate varies significantly, and, in 5 states (South Dakota, Wyoming, Montana, North Dakota, and Arizona), it is more than twice the national average for all AI/ANs and more than 4 times the rate for the general US population (1).

This disproportionate burden of motor vehicle deaths among the AI/AN population is perhaps not surprising given that injuries are the leading cause of death among AI/ANs aged 1–44 years (4–6). Injuries alone account for approximately 55% of all deaths among AI/ANs in this age group (1). The lifetime cost from injuries in this population is estimated at over $2.1 billion each year (7).

The National Institutes of Health defines health disparities as “significant disparity in the overall rate of disease incidence, prevalence, morbidity, mortality, or survival rates in the population as compared to the health status of the general population” (8). In 2005, midway through the decade of Healthy People 2010, a review of the nation’s health objectives assessed progress toward eliminating health disparities.
Disparities between groups for each health objective were measured by the difference between the rates for the worst group and the best group (9). Applying this measure to motor vehicle deaths, the disparity increased by at least 10 percentage points between 1999 and 2002, with AI/ANs having the highest rates. These racial disparities are still evident using 2007 motor vehicle death data, which show disparities in motor vehicle deaths across racial and ethnic groups (Table 1) and by specific mechanism of motor vehicle death (Table 2).

Some of the earliest information on the disproportionate burden of motor vehicle deaths among AI/ANs described the inequality in death rates related to differences in seat belt use and rates of alcohol-impaired driving (10). Even with the knowledge that was available in the 1980s, the gap between rates in the AI/AN population and other groups remains striking. Therefore, we conducted this systematic review to examine research published over the last 2 decades to determine 1) what has been learned about modifiable risk factors that contribute to the higher rates of motor vehicle occupant and pedestrian deaths among AI/ANs and 2) what interventions have been implemented and evaluated specifically for this population. We also include recommendations for next steps to reduce disparities in these motor-vehicle-related deaths and mitigate the excessive burden among AI/AN populations.

### METHODS

### Search methodology

We systematically sought published English-language studies in the peer-reviewed literature by searching the electronic public health databases CINAHL, EMBASE, and PubMed/MEDLINE for articles published between January 1, 1990, and January 31, 2011. We also searched the Web sites from the Indian Health Service (IHS) (http://www.ihs.gov); Morbidity and Mortality Weekly Report (http://www.cdc.gov/mmwr/mmwrsrch.htm); and individual electronic issues (between January 1997 and January 2011) of the IHS Primary Care Provider, a journal developed to publish educational articles on topics of interest to “Indian Health Service, tribal, and urban Indian health care professional providers.” We searched the Native Health Database (https://hscssl.unm.edu/nhd/), which is a free search engine for finding health and medical information on AI, AN, and Canadian First Nations populations. Finally, we reviewed the bibliographies of articles that met the study’s inclusion criteria to identify referenced sources that we may have missed.

The search terms were developed to address the study aims and were informed by national data that show high fatality rates among motor vehicle occupants and pedestrians (Tables I

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**Table 1.** Leading Causes of Unintentional Fatal Injury, Total Numbers, a and Rates per 100,000, by Race and Ethnicity, According to the Centers for Disease Control and Prevention Web-based Injury Statistics Query and Reporting System (WISQARS), 2007

<table>
<thead>
<tr>
<th>Rank</th>
<th>White, Non-Hispanic (n = 94,584)</th>
<th>Black, Non-Hispanic (n = 13,332)</th>
<th>American Indian/Alaska Native, Non-Hispanic (n = 1,606)</th>
<th>Asian/Pacific Islander, Non-Hispanic (n = 2,119)</th>
<th>All Races, Hispanic (n = 11,723)</th>
<th>Overall (N = 123,706)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cause Motor vehicle traffic</td>
<td>Motor vehicle traffic</td>
<td>Motor vehicle traffic</td>
<td>Motor vehicle traffic</td>
<td>Motor vehicle traffic</td>
<td>Motor vehicle traffic</td>
</tr>
<tr>
<td></td>
<td>No. 29,403</td>
<td>5,281</td>
<td>706</td>
<td>933</td>
<td>5,602</td>
<td>42,031</td>
</tr>
<tr>
<td></td>
<td>Rate 14.17</td>
<td>14.14</td>
<td>27.62</td>
<td>7.02</td>
<td>12.81</td>
<td>13.76</td>
</tr>
<tr>
<td>2</td>
<td>Cause Poisoning</td>
<td>Poisoning</td>
<td>Poisoning</td>
<td>Fall</td>
<td>Poisoning</td>
<td>Poisoning</td>
</tr>
<tr>
<td></td>
<td>No. 23,531</td>
<td>3,215</td>
<td>350</td>
<td>456</td>
<td>2,436</td>
<td>29,846 (24.1%)</td>
</tr>
<tr>
<td></td>
<td>Rate 11.61</td>
<td>8.81</td>
<td>14.11</td>
<td>4.5</td>
<td>5.88</td>
<td>9.83</td>
</tr>
<tr>
<td>3</td>
<td>Cause Fall</td>
<td>Fall</td>
<td>Fall</td>
<td>Poisoning</td>
<td>Fall</td>
<td>Fall</td>
</tr>
<tr>
<td></td>
<td>No. 19,791</td>
<td>1,001</td>
<td>126</td>
<td>211</td>
<td>1,212</td>
<td>22,631</td>
</tr>
<tr>
<td></td>
<td>Rate 7.59</td>
<td>3.61</td>
<td>7.23</td>
<td>1.42</td>
<td>5.09</td>
<td>7.08</td>
</tr>
<tr>
<td>4</td>
<td>Cause Unspecified Suffocation</td>
<td>Natural/environmental</td>
<td>Drowning</td>
<td>Drowning</td>
<td>Unspecified</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No. 5,205</td>
<td>909</td>
<td>69</td>
<td>141</td>
<td>480</td>
<td>6,019</td>
</tr>
<tr>
<td></td>
<td>Rate 1.98</td>
<td>2.76</td>
<td>3.05</td>
<td>1.04</td>
<td>0.99</td>
<td>1.87</td>
</tr>
<tr>
<td>5</td>
<td>Cause Suffocation</td>
<td>Fire/burn</td>
<td>Suffocation</td>
<td>Suffocation</td>
<td>Suffocation</td>
<td>Drowning</td>
</tr>
<tr>
<td></td>
<td>No. 4,511</td>
<td>779</td>
<td>69</td>
<td>100</td>
<td>395</td>
<td>3,443</td>
</tr>
<tr>
<td></td>
<td>Rate 1.94</td>
<td>2.37</td>
<td>3.03</td>
<td>0.9</td>
<td>1.17</td>
<td>1.13</td>
</tr>
</tbody>
</table>

a The total number of crashes does not include the “other (combined)” race group; thus, the row totals do not equal the overall total.
and 2). We included combinations of PubMed Medical Subject Headings terms and text words (Table 3). The search was completed by one of the authors (J. L. Y.) and was repeated by a second author (K. M. P.) to validate the search methodology.

### Inclusion and exclusion criteria

Epidemiologic studies were included if they were published in English, focused on risk factors for fatalities, included AI or AN populations either separately or in combination with other race or ethnic groups, presented original research, were conducted in the United States, and were published in print or online between January 1, 1990, and January 31, 2011. Intervention studies were included if they were published during the same time period and also presented evaluation data. Studies that focused on nonfatal injuries, included data on risk factors that could not be isolated specifically for AI/ANs, or measured the prevalence of safety behaviors but did not provide data on fatal outcomes were not included in the review; however, they were used to inform the conclusions and recommendations. Studies were not excluded based on the methodological quality; thus, no attempt was made to assess the quality of the included papers.

### Data extraction

Information on the study setting, study setting, sample size, point estimates for the outcomes of interest (rounded to whole numbers for reporting), and specific comments on prevention was collected. For the intervention studies, information on

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**Table 3. Specific Medical Subject Headings**

<table>
<thead>
<tr>
<th>Study Aim</th>
<th>Search Terms</th>
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<tbody>
<tr>
<td>To identify studies of motor vehicle deaths involving occupants</td>
<td>Motor vehicle crashes and American Indians, motor vehicle crashes and Alaska Natives, motor vehicle crashes and Native Americans, motor vehicle crashes and American Indians/Alaska Natives, crashes and American Indians, crashes and American Indians, crashes and Native Americans, crashes and American Indians/Alaska Natives, traffic and American Indians, traffic and Alaska Natives, traffic and Native Americans, and traffic and American Indians/Alaska Natives</td>
</tr>
<tr>
<td>To identify studies of motor vehicle deaths involving pedestrians</td>
<td>Pedestrians and American Indians, pedestrians and Alaska Natives, pedestrians and Native Americans, pedestrians and American Indians/Alaska Natives, pedestrian injuries and American Indians, pedestrian injuries and Alaska Natives, pedestrian injuries and Native Americans, and pedestrian injuries and American Indians/Alaska Natives</td>
</tr>
</tbody>
</table>

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*Medical subject headings (MeSH) were obtained from PubMed/MEDLINE, National Institutes of Health, Bethesda, Maryland.*
RESULTS

This search yielded 148 unique abstracts. We reviewed each of the abstracts and, after excluding those that did not meet the inclusion criteria, collected the full articles for the remaining papers. After reading the articles, we included a total of 14 studies in this review: 7 epidemiologic studies (11–17) (Table 4) and 7 intervention studies (18–24) (Table 5). Below, we present the findings for the epidemiologic and intervention studies separately, first for motor vehicle occupants and then for pedestrians.

Epidemiologic studies

Motor vehicle occupants. Most of the studies of motor vehicle occupant deaths have been descriptive. One study reviewed fatalities among AI adults in New York (11). Of the 57 deaths explored, 74% were men, 55% occurred in rural areas, and 62% happened at night. The deceased was the driver in 33% of the cases, a passenger in 29% of the cases, and a pedestrian in 28% of the cases. Nearly 75% of the deaths occurred at the scene of the crash. Among the cases whose blood alcohol concentration levels were available (n = 32), 77% had detectable levels of alcohol well over the legal limit. Average blood alcohol concentration levels were greatest for pedestrians. The author of this study stated that these data support a need for an increased focus on primary prevention to reduce drinking and driving and intoxicated pedestrians and for environmental modifications, especially in rural communities.

Motor vehicle fatalities were explored in Arizona among the AI relative to the non-AI population (12). Relative to non-AIs, AIs had increased relative risks for motor vehicle deaths in each age and gender category. Excess mortality among AIs relative to non-AIs attributed to alcohol ranged from 37% to 67%, and excess mortality rates for pedestrians ranged from 27% to 55%. The authors reported that the relative risk for fatality rates among AIs compared with non-AIs was elevated for all age groups, and the relative risk for pedestrians in the AI versus the non-AI group was elevated for those between ages 15 and 74 years. Of the cases for whom blood alcohol concentration levels were provided (29% of AIs and 30% of non-AIs), a greater percentage of AI fatalities were intoxicated, at high blood alcohol concentration levels, when compared with the non-AI fatalities. The authors recommended, based on these data, that efforts to reduce motor vehicle deaths among AIs should aim to prevent pedestrian death and alcohol-related occupant and pedestrian fatalities, which will impact motor vehicle fatalities overall.

Another study conducted in Arizona explored motor vehicle deaths among AIs compared with other residents (13). Consistent with prior studies, these results showed the importance of rural residence, alcohol use, and pedestrian deaths in contributing to the disparity. This study also presented data that seat belt use was lower, and occupant fatality rates higher, for AI versus non-AI populations. Comments regarding prevention were similar to those mentioned in prior studies; however, these authors also described the autonomous legal status of reservations as a factor to consider to fully address these deaths. As an example, Arizona was described as having 22 Indian reservations, each with its own traffic laws.

Pedestrians. Research on pedestrian fatalities in New Mexico over a 30-year period reported that pedestrian fatality rates were significantly higher for AIs compared with Hispanics and non-Hispanic whites (14). Across age-specific death rates, the pedestrian death rate was highest for AI men aged 35–44 years. Approximately 88% of the pedestrian fatalities resulted from motor vehicle traffic. Although they did not present deaths by geography, the authors suggest that the rural setting is likely a major factor influencing the disproportionate rates among the AI population.

Another study of pedestrian fatalities in New Mexico reported that, compared with other state residents, AIs were 8 times more likely to die in pedestrian motor-vehicle-related crashes (15). Of the 347 pedestrian deaths involving motor vehicles examined, 76% were male. The authors also explored an additional 142 hypothermia deaths because all were pedestrians; 86% were male. Blood alcohol concentration results were available for 80% of the pedestrian deaths involving motor vehicles, and alcohol was present in 91% of the cases, with a median blood alcohol concentration value of 0.24 g/dL. Alcohol was also present in 90% of those who died of hypothermia, and the median blood alcohol concentration value was 0.18 g/dL. Two-thirds of all pedestrian and hypothermia deaths occurred off the reservation, although all of those who died were thought to live on the reservation.

To prevent these deaths, the authors (15) specifically mentioned a need to reconsider prohibition policies on reservations. They also suggested establishing a van service to patrol roads between reservations and neighboring towns to transport individuals home; creating an inpatient rehabilitation shelter; distributing reflective clothing; restricting hours of alcohol sale in neighboring towns; and enforcing laws for speeding, driving under the influence, and selling alcohol to intoxicated persons.

The influences of rural residence and alcohol were also identified as important risk factors for pedestrian fatalities among AIs in Arizona (16). Rural residents accounted for 27% of the excess AI pedestrian mortality. AIs had 6 times the rate of alcohol-related pedestrian deaths as non-Hispanic whites did. Of the blood alcohol concentration results measured, 65% of AIs had levels greater than 0.20 g/dL. On the basis of these data, the authors called for a focus on addressing the strong influence of alcohol and rural residence on these fatalities. The authors pointed to a need for interventions to address the built environment and the adoption of programs to reduce alcohol-impaired driving.

One national study explored 288 pedestrian fatalities among AI/ANs in the United States, with a focus on differences between urban and rural settings (17). Consistent with prior studies, this research showed that rural pedestrian crashes occurred on highways lacking traffic control devices and artificial lighting. Study findings supported the strong role of alcohol in pedestrian deaths that occurred in both urban and rural settings; 40% and 55%, respectively, of the deaths...
involved alcohol. This study also showed that most crashes in rural areas occurred in the dark and predominantly on weekends, with alcohol involvement by the driver or pedestrians noted in 55% of the cases.

**Intervention studies**

**Motor vehicle occupants.** Of the 7 interventions that we identified, 5 focused on increasing occupant restraint use and the other 2 on decreasing alcohol-impaired driving. The Navajo Nation safety-belt campaign combined primary enforcement of a safety-belt use law and an education campaign (18). The Navajo Nation implemented the primary seat belt law, followed by a public information campaign to increase awareness of the law. From baseline to the follow-up survey, the prevalence of seat belt use increased from 14% to 60%. During the same time period, motor-vehicle-related injury hospitalizations decreased by 29%. The authors noted that, although the decline in injuries coincided with the increase in seat belt use, a clear causal relation could not be established; however, the increase in seat belt use was thought to have resulted directly from having a law in place that was well promoted and enforced.

“Buckle Up for Life” was implemented on the Uintah and Ouray Reservation of the Ute Tribe in Utah (19). The intervention was created because, although the Bureau of Indian Affairs Police on the reservation adopted the Utah law on seat belt and car seat use, citations for violations were not a local police priority. The intervention was an incentive program that involved local merchants who donated gift certificates for a community raffle. Advertisements described the program, the increase in enforcement, and monetary fines for violators. During observations, law enforcement stopped drivers to assess occupant restraint use. If all occupants in the vehicle were properly restrained, the driver received a coupon and was entered into a drawing to win a gift certificate.

Results of the postincentive observations showed that driver seat belt use increased 218% among those riding in pickup trucks and 111% among those riding in sedans/station wagons. Seat belt use by passengers increased 227% among those riding in pickup trucks and 57% among those riding in sedans/station wagons. Infant car seat use increased 209% for vans and 389% for sedans/station wagons. These increases were maintained at 1 year after the incentive campaign. The authors noted the importance of incentive campaigns to change behaviors on the reservations, although the question of how to sustain such a long-term effort was raised.

In the Yakama Nation in Oregon, an intervention was implemented based on the 3 E’s of injury prevention—education, enforcement, and environmental modification (20). These principles were used to deliver a child safety seat education and free distribution program. Education sessions occurred at prenatal clinics for expectant parents at the Yakama Nation Maternal and Child Health Program. An intensive public awareness and educational campaign was also implemented to encourage all occupants to buckle up. Baseline data showed that only 17% of the population was wearing seat belts and 10% of child passengers were appropriately restrained, despite the presence of a secondary seat belt law and a law requiring the use of child safety seats.

At 1-year postintervention, seat belt use increased to 41% and, at 18 months, decreased to 35%. The authors attributed the decline in usage to lack of consistency in providing education, waning awareness among the community (since the education campaign was inconsistent), and failure to provide enough child safety seats to meet the demand. Data on changes in child safety seat use were not presented. The coalition that worked to implement the injury prevention intervention recognized the limited effectiveness of education alone and advocated for the passage of a primary seat belt law on the reservation. Their efforts were successful; the law that was passed included a requirement that 50% of the fines for seat belt violations be used to purchase child safety seats for the distribution program.

The IHS implemented the Ride Safe Program at 14 Tribal Head Start Centers in 6 states (21). The program aimed to increase knowledge and skills of Head Start staff and parents about the use of child safety seats. It included a curriculum and free distribution of child safety seats. The program reached 3,500 children and over 1,700 parents/family members. Baseline data were collected from 2002 to 2003, and follow-up data were collected for 3 consecutive years (2003–2004, 2004–2005, 2005–2006).

Results suggested strong initial success within the first year of the intervention; however, the increase in use was not sustained. The authors noted limitations of the study’s methods for measuring change over time as one reason the data did not show a sustained impact. The authors (21) did find that the limited impact might also be due in part to the fact that only one car seat per family could be distributed. For families with several children, many were left unrestrained. Despite these challenges, the authors thought that education together with child safety seat distribution/installation was an important component of any strategy to address occupant deaths. The authors also mentioned the important role of the Tribal Head Start Centers in distributing information because they are trusted sources for information in many AI/AN communities.

The Ride Safe Program (implemented slightly differently from the previously described program with the same name), as part of the CDC Tribal Motor Vehicle Injury Prevention Program, was implemented in the Ho-Chunk Nation in rural Wisconsin. The specific components included those identified by the Task Force on Community Preventive Services that were adapted for the local context (22), including education events (e.g., crash simulations), media awareness, targeted distribution of child safety seats and education about their proper use, and enforcement/policy (e.g., enhanced Click-It or Ticket programs).

Between 2005 and 2008, seat belt use increased from 51% to 63% for drivers and from 33% to 56% for passengers (22). Child safety seat use increased from 26% in fall 2003 to 78% in spring 2008. These measurable increases in occupant restraint were present even though Wisconsin’s law allowed for secondary enforcement only. Successful collaboration between tribal law enforcement, federal partners at the IHS and CDC, and the Ho-Chunk Nation Motor Vehicle Injury Prevention Program resulted in successful adaptation of effective strategies to local conditions.

The Ute Indian Tribe, located on the Uintah and Ouray Reservation in northern Utah, implemented a comprehensive
<table>
<thead>
<tr>
<th>First Author, Year (Reference No.)</th>
<th>Study Purpose</th>
<th>Population (Geographic Location and Sample Size)</th>
<th>Source of Data and Measures Collected</th>
<th>Key Findings</th>
<th>Comments on Prevention</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>N = 57 individuals of NA descent</td>
<td></td>
<td>28% resulted from pedestrian collisions.</td>
<td>Education: warn against walking in the roadways.</td>
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<td></td>
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<td>Most frequent fatality (to occupants or pedestrians) involved a pedestrian being hit in a MVC.</td>
<td>Increase awareness of risk-taking behaviors.</td>
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<td>Blood alcohol concentration testing was performed for 32 people who died; 77% had detectable levels of blood alcohol.</td>
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<td>Median age at death: 17 years for women and 25 years for men.</td>
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<td></td>
<td></td>
<td></td>
<td>Excess mortality for alcohol ranged from 37% to 67%.</td>
<td>Behavioral: address alcohol use by occupants and pedestrians.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FARS and NCHS Multiple Cause of Death data from 1979 to 1988</td>
<td></td>
<td>Excess mortality for pedestrian rates ranged from 27% to 55%.</td>
<td>Increase seat belt use.</td>
</tr>
<tr>
<td></td>
<td>Measure the contribution of pedestrian fatalities, alcohol, and rural residence to AI fatality rates</td>
<td>Compared AIs with non-AIs in Arizona</td>
<td></td>
<td>Influence of alcohol and pedestrian deaths was greater for urban versus rural residents.</td>
<td>Improve the built environment.</td>
</tr>
<tr>
<td>Campos-Outcalt, 1997 (12)</td>
<td></td>
<td>6,344 deaths: 5,383, non-AIs, 961 AIs</td>
<td></td>
<td>Rural residence explained only a small proportion of excess MVC mortality among AIs.</td>
<td>Improve access in rural areas to emergency services.</td>
</tr>
<tr>
<td></td>
<td>Explore rates of MVC fatalities by race/ethnicity and urban/rural setting in Arizona</td>
<td>AIs versus AAs, NHWs, and Hispanics</td>
<td>FARS and NCHS Multiple Cause of Death data</td>
<td>Fatality rate for occupants was greatest for those aged 15–24 years, followed by 25,034 for those aged 35–44 years.</td>
<td>Aggressively address alcohol use and pedestrian fatalities.</td>
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<tr>
<td></td>
<td></td>
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<td>Fatality rate for pedestrians was greatest for those aged &gt;75 years.</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Being AI increased the risk of death for both men and women, in urban and rural settings, and among occupants and pedestrians.</td>
<td>The major disparity in MVC fatality in Arizona is among AIs.</td>
</tr>
</tbody>
</table>
4,775 matched records: 2,758 NHW, 1,024 Hispanic, 825 AI, 114 AA, 54 other; 393 NHW, 200 AI, 200 Hispanic, 22 AA, 13 other

1990–1996 Excess mortality was due to rural residence, lower rates of seat belt use, and alcohol. Risk factors include rural residence, low rates of seat belt use, high rates of alcohol-related crashes, high rates of alcohol-related fatalities, and a high number of occupants.

Al’s had the slowest rate of decline in MVC deaths of all race/ethnic groups. Increase seat belt use.

Improve access in rural areas to emergency services. Address alcohol use. Adopt recommendations from the Task Force on Community Preventive Services.

Over the 30-year period, frequency of pedestrian fatalities was greatest among AI/AN males and females. Education and public health strategies need to focus on minority populations.

87% were attributed to MVCs. Need to address exposure to roadway without designated pedestrian areas (especially in rural areas), increase access to emergency services, and improve enforcement of traffic speeds.

Rates were highest for AI/AN males aged 35–44 years. Needed are comprehensive interventions that include prevention, treatment, and rehabilitation.

NAs were 8 times more likely to die in pedestrian crashes and 30 times more likely to die of hypothermia. Consider repealing prohibition on reservations, which may lower pedestrian risks, but ensure that other alcohol-related injuries and illnesses do not increase.

At the time of death, 90% of those tested were highly intoxicated (blood alcohol concentration >0.18 g/dL). Assign a van to patrol the roadways between the reservation and other towns to transport people back home.

Table continues
<table>
<thead>
<tr>
<th>First Author, Year (Reference No.)</th>
<th>Study Purpose</th>
<th>Population (Geographic Location and Sample Size)</th>
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<th>Key Findings</th>
<th>Comments on Prevention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Campos-Outcalt, 2002 (16)</td>
<td>Explore rates of pedestrian fatalities in Arizona</td>
<td>AIs versus NHWs in Arizona; 833 pedestrian deaths</td>
<td>FARS and NCHS Multiple Cause of Death data</td>
<td>Risk of pedestrian deaths was 6–13 times greater for AIs compared with NHWs.</td>
<td>Establish a protective shelter to house intoxicated people and provide rehabilitation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>393 NHW, 200 AI, 200 Hispanic, 22 AA, 13 other</td>
<td>1990–1996</td>
<td>Al deaths rates were greater in rural versus urban areas.</td>
<td>Distribute reflector patches to increase visibility at night; restrict availability of alcohol at towns neighboring the reservations, utilize strict traffic enforcement, and limit the sale of alcohol to intoxicated individuals.</td>
</tr>
<tr>
<td>LaValley, 2003 (17)</td>
<td>Compare fatal pedestrian crashes of AI/ANs between urban and rural locations</td>
<td>288 AI/AN deaths in the United States</td>
<td>FARS and WISQARS, 2000–2001</td>
<td>Rural pedestrian deaths occurred on highways, especially those lacking traffic control devices and artificial lighting.</td>
<td>Modify the built environment by improving street lighting, adding sidewalks and barriers, lowering speed limits, and enhancing law enforcement; regarding alcohol: establish protective custody for heavy drinkers and vendor/server training to recognize at-risk walkers.</td>
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<td></td>
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<td>6.1 deaths per 100,000; urban: 3.9 deaths per 100,000</td>
<td></td>
<td>No difference was found in mean age for urban versus rural drivers; most crashes involved those aged 26–45 years.</td>
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</table>

Abbreviations: AA, African American; AI, American Indian; AN, Alaska Native; FARS, Fatality Analysis Reporting System; MVC, motor vehicle crash; NA, Native American; NCHS, National Center for Health Statistics; NHW, non-Hispanic white; WISQARS, Web-based Injury Statistics Query and Reporting System.
community-based intervention designed to increase child safety seat use, sobriety checkpoints, and seat belt use (23). A key component of this intervention was including the tribal police department as a partner. In the 2 decades prior to the intervention, enforcement of seat belt use or use of driving-under-the-influence checkpoints was minimal. Funding for the intervention was used to hire a dedicated police officer and field an education campaign. Child safety seat clinics were also established. Seat belt use increased from 22% (2002–2003) to 42% (2004–2005), and overall crashes decreased by 9% during the same time period. The number of fatal crashes decreased by 67%, and the number of alcohol-related crashes declined by 34%. Pre-surveys and post-surveys revealed that knowledge of the laws increased by 18%. The authors concluded that the program effectively improved behaviors through the strong partnerships between law enforcement and the tribe’s Injury Prevention Coalition.

The San Carlos Apache Indian Reservation in Arizona also implemented a Tribal Motor Vehicle Injury prevention program to reduce motor-vehicle deaths and injuries using the strategies from the Task Force on Community Preventive Services (24). The intervention focused on addressing driver alcohol use by increasing the number of sobriety checkpoints, creating a public information campaign, and advocating for passage of 0.08 as the legal blood alcohol concentration limit for drivers on the reservation. Between 2004 and 2006, there was a 33% increase in driving-under-the-influence arrests, a 20% reduction in crashes involving fatalities/injuries, a 33% reduction in nighttime crashes, and a 17% reduction in fatal crashes. Because the largest decrease in crashes occurred at night, the authors thought that this reduction reflected a decline in drunk driving. They concluded that a combination of increased enforcement and education effectively reduced alcohol-associated crashes. It is important to note that, in 2007, the Tribal Council passed a resolution adopting a 0.08% blood alcohol concentration as the legal limit for drivers and a primary occupant restraint law.

Pedestrians. We did not identify any interventions implemented that specifically sought to improve pedestrian safety.

**DISCUSSION**

If injury disparities are going to be eliminated, research needs to target those groups disproportionately impacted and identify strategies for closing the gap. As described in this paper, motor vehicle deaths are one health outcome characterized by significant disparities. To our knowledge, this review is the first to assemble the evidence on risk factors and interventions to address this disparity specifically among AI/AN populations in the United States. As a result, we identified potential opportunities and future research needed to reduce the disproportionate burden experienced by AI/AN populations.

Despite the fact that our search spanned more than 2 decades, we were able to identify only a few studies describing the epidemiology of the problem, and even fewer that implemented and tested interventions. This small number of studies in the peer-reviewed literature is surprising given the enormous human and economic impact of motor-vehicle-related deaths in this population (4, 5, 7). Furthermore, the disparities in alcohol-involved motor vehicle mortality, along with the high rates experienced by Native populations, have long been recognized (10, 25, 26).

The studies reviewed suggest the problem is being driven by multiple risk factors that involve behaviors, policies, and the environments in which deaths occur. The epidemiology of this problem also reveals a high level of pedestrian involvement (11, 14–16) and the risks associated with rural locations, including those off the reservation (11, 15–17). The intervention studies reported impressive gains such as increases in seat belt (18–20, 22, 23) and car seat (19, 20, 22, 23) use and reductions in drinking and driving (23, 24). In many cases, the size of the changes measured leaves little doubt about the impact of the interventions tested, even though none of the studies included comparison groups or randomized designs. The successful interventions involved multiple strategies (18, 20, 21, 23, 24), frequently relied on the evidence base in their choice of intervention methods (20, 22, 24), and involved collaborations with law enforcement or other partners (22–24).

Finally, we note the consistency of recommendations across the research reviewed. In spite of the dearth of pedestrian-focused interventions, the epidemiologic data supported these studies’ emphasis on environmental modifications such as improved sidewalks and lighting for pedestrians as well as the need for better emergency response systems in rural areas. The need to address the availability and use of alcohol is another common theme gleaned from this literature. Furthermore, while partnerships with law enforcement to increase enforcement of drinking and driving laws appeared to have a positive impact on motor vehicle mortality, other recommended strategies include alcohol server training and policies that address access to alcohol. The recommendations offered by the authors of this literature incorporate the diversity of strategies that have developed over decades in the field of injury prevention.

This research was strengthened by a carefully conducted review process, which was validated by 2 authors. A further strength is the inclusion of studies from the IHS Primary Care Provider and the Native Health Database, which aided our ability to identify peer-reviewed articles that may not have been indexed in PubMed/MEDLINE.

However, the results are limited by the insufficient detail reported in many of the published studies and by the few studies that met our inclusion criteria. In addition, most of the epidemiologic studies were descriptive, and, although valuable, several studies had small sample sizes and were limited in their research methodology. Also, we did not search the “gray literature” to find studies not in the peer-reviewed literature; therefore, we cannot rule out the possibility of publication bias. Publication bias is of concern for this population since it has been hypothesized that not all studies involving AI/ANs are published in the peer-reviewed literature. Although the extent of this bias is difficult to estimate, we acknowledge that, although we identified all papers that met our inclusion criteria, unpublished studies likely were missed. A final potential limitation is that this review focused on identifying risk factors and interventions to prevent motor vehicle deaths among AI/ANs.
<table>
<thead>
<tr>
<th>First Author, Year (Reference No.)</th>
<th>Population</th>
<th>Intervention and Components</th>
<th>Outcome</th>
<th>Key Findings</th>
<th>Conclusions</th>
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<tbody>
<tr>
<td>Centers for Disease Control and Prevention, 1992 (18)</td>
<td>Navajo Nation, Arizona</td>
<td>A newly implemented primary enforcement safety-belt-use law was evaluated, and an educational campaign was initiated.</td>
<td>Use of safety belts</td>
<td>Baseline: safety belt use by 14.4% of males and 13.8% of females</td>
<td>More attention is needed to increase safety-belt use to decrease MVC-related deaths and injury.</td>
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<td>Direct observation of front-seat occupants</td>
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<td>Seat belt use at baseline (June 1988) 14%; increased to 60% in September 1991</td>
<td>American Indians/Alaska Natives are at increased risk of death because of less access to emergency medical services, travel on isolated roads, riding unrestrained along 2-lane highways, and the population overall being young and risk takers (drinking and driving, no restraints, etc.).</td>
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<td>Also a decline in injury hospitalizations</td>
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<td>Program: Buckle Up for Life.</td>
<td>Use of car seats and seat belts by direct observation</td>
<td>Increased driver seat belt use for all vehicle types: low of 17% for a vans/4-wheel-drive vehicle to 218% for pickup trucks</td>
<td>Incentives “work” to change behavior; questions were raised about how to sustain an incentive program.</td>
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<td>Incentive campaigns were created to change behavior to increase car seat and seat belt use.</td>
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<td>Range for passenger seat belt use from –29% for vans/4-wheel drive vehicles to 225% for pickup trucks</td>
<td>Campaign was a “success”; however, enforcement also increased.</td>
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<td>Donations were sought from vendors in exchange for mention in radio advertising and on a poster created for the campaign.</td>
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<td>Increase in car seat use from 209% for 4-wheel drive vehicles/vans to 389% for sedans or station wagons</td>
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<td>Law enforcement stopped drivers to assess occupant restraint use; if all occupants were properly restrained, the driver received a coupon and was entered into a drawing to win a gift certificate.</td>
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<td>1 year after the intervention, seat belt use and car seat use still well above baseline values</td>
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<td>John, 2001 (20)</td>
<td>Yakama Nation Reservation, Portland, Oregon</td>
<td>Multiple strategies were implemented based on the 3 E’s: education, enforcement, and environmental modification targeting infant and child safety seats (1996).</td>
<td>Observational survey of car seat and seat belt use</td>
<td>Baseline survey (1997): use of seat belts by 17% of the population and use of child safety seats by 10% of child passengers</td>
<td>Education alone was of limited effectiveness.</td>
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1998: 1 year after the public education campaign, seat belt use at 41%. Decline in usage was due to lack of consistency in providing education, waning awareness among the community (since the education campaign was inconsistent), and failure to provide enough infant and child safety seats to meet the demand.

In 1997, a car seat distribution registry was added. 6 months after the campaign ended, seat belt use at 35%. Momentum resulted in formation of a coalition that began in October 2000 to advocate for a primary seat belt law that was passed in December 2000; 50% of the fine from not wearing a seat belt would go toward the purchase of child safety seats for families.

Later, an intensive public awareness and education campaign (included 1-on-1 counseling with all expectant parents through tribematal and child health program) was added; the message was, “Buckle Up.” No data presented on changes in child safety seat use.

Letourneau, 2008 (21) 14 Tribal Head Start Centers in Arizona, Michigan, Minnesota, New Mexico, Nevada, and Wisconsin. The Ride Safe Intervention was designed to increase child safety seat use. 4 school years between 2002 and 2006, baseline data from 2002 to 2003 and follow-up data analyzed for 2003–2004, 2004–2005, and 2005–2006. Strong initial success within the first year of the intervention, but increase not sustained. Improvement in the first year in use of car seats led to a range of 30%–71% for use, still below the US rate.

Methodological challenges: incomplete reporting by some of the sites may have resulted in underestimation of the program’s impact in terms of child safety seats distributed; limitations with using direct observation of child safety seat use was also mentioned. Education and child safety seat distribution/installation is important.

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<td>Letourneau, 2009 (22)</td>
<td>Ho-Chunk Nation, Wisconsin</td>
<td>A Tribal Motor Vehicle Injury prevention program was created to reduce motor-vehicle deaths and injuries using the strategies from the Task Force on Community Preventive Services; it focused on occupant protection.</td>
<td>Direct observations</td>
<td>Between 2005 and 2008, increase in seat belt use from 50.5% to 62.7% for drivers and from 32.6% to 56.0% for passengers</td>
<td>Measurable increases in occupation restraint were found, even those located in a state with a secondary seat belt enforcement law.</td>
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<td>10 data collection points over 5 years</td>
<td>Increase in child safety seat use from a baseline of 26.4% in fall 2003 to 78.4% in spring 2008</td>
<td>Collaboration was used successfully, and successful strategies were adapted to local conditions.</td>
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<td>Billie, 2007 (23)</td>
<td>Northern Ute Indian Tribe, Utah</td>
<td>Community-based, enforcement-centered intervention was designed to increase child safety seat use, increase sobriety checkpoints, and increase use of safety belts; a key component was inclusion of a police officer as a partner.</td>
<td>Baseline in 2002–2003 and follow-up in 2004–2005 (program implemented)</td>
<td>Increase in seat belt use from 22% to 42%</td>
<td>Program effectively improved behaviors because of the strong partnerships among law enforcement and the Tribe Injury Prevention Coalition.</td>
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<td>MVC data, number of citations, number of DUI attests</td>
<td>There was a strong emphasis on enforcement, and partnership is important for success.</td>
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<td>Direct observation of seat belt and car seat use</td>
<td>67% decrease in number of fatal crashes</td>
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<td>34% decline in number of alcohol-related crashes</td>
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<td>Pre- and postsurveys: increase in knowledge of the laws (18% increase in the number of correct responses on a survey)</td>
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<tr>
<td>Reede, 2007 (24)</td>
<td>San Carlos Apache Indian Reservation, Arizona</td>
<td>A Tribal Motor Vehicle Injury prevention program was created to reduce motor-vehicle deaths and injuries using the strategies from the Task Force on Community Preventive Services; it focused on addressing driver alcohol use by increased sobriety checkpoints, a public information campaign, and efforts to implement a 0.08 blood alcohol concentration limit for drivers on the reservation.</td>
<td>Program implemented in 2004 and follow-up data collected in 2005 and 2006</td>
<td>33% decrease in DUI arrests</td>
<td>The finding that the largest decline in MVCs occurred during nighttime hours supports the fact that drunk driving declined.</td>
</tr>
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</table>
deaths and did not include studies focused on acute care or emergency services.

**Gaps in the literature**

The literature is clearly limited by the small number of studies and by the absence of research in areas with some of the highest motor vehicle death rates in Native communities. Our examination of motor vehicle death rates across states revealed that among the 5 states with the highest death rates (South Dakota, Wyoming, Montana, North Dakota, and Arizona), only one (Arizona) was included in the papers identified through our review (excluding the studies that examined the entire US population) (1). Understanding the variation among states, particularly with regard to the policy implications of complex tribal/state/federal jurisdictional authorities, cultural differences among tribes, and access to alcohol, should be a priority for future research.

We were surprised by the absence of pedestrian-focused interventions, which should be a priority. The literature suggests that reducing alcohol use should be a component of such efforts. With the increasing attention to walking for health as a strategy to address obesity and diabetes, a focus on the risks associated with walking is needed (27–29).

**Research issues**

Public health researchers have long identified the need for more accurate and complete data on AI/AN health status. The negative effects of inadequate data on the prospects for reducing health disparities is clear (30). Without adequate data, important health issues may not be recognized and etiologies unique to particular populations may remain unspecified. Aggregate data mask local, tribal, state, and regional concerns, leaving tribal disparities in disease and injury rates unrecognized.

The misclassification of race in vital statistics also understates AI/AN mortality rates (31). Research has shown that for AI/AN specifically, race-specific mortality rates can substantially underestimate disease burden when death certificate coding is inconsistent (32). Improving surveillance efforts will help to accurately monitor progress toward national health objectives and allocate scarce resources to improve health.

Clearly, more intervention research is needed. Future intervention studies should have sufficient resources to ensure conduct of the most rigorous evaluations possible. The IHS, the primary sponsor of several intervention efforts, recognizes the need for reliable data and community engagement as essential to successful, sustainable injury prevention interventions and has established tribal capacity building as one of its core program objectives supported by providing technical assistance to tribes participating in the Tribal Injury Prevention Cooperative Agreements Program (33, 34). This involvement may help to increase the research capacity of tribes.

Along with intervention trials is the need for dissemination and implementation research (35). Such translational research can help assure that evidence-based policies and programs are effectively disseminated and implemented in all AI/AN populations. Mixed-methods research designs that utilize...
both qualitative and quantitative data are increasingly being used for such purposes and may be particularly well suited to the AI/AN context, in which multiple languages and cultures need to be accommodated.

Conducting research in AI/AN communities presents particular challenges. The complexities of tribal infrastructures, complicated jurisdictional concerns, a history of colonization and exploitation, and incredible diversity of languages and cultures in Native communities require special attention. Native communities have become wary of researchers who are unwilling or unable to adequately invest in a mutually beneficial relationship. Exploitative research associations have created a legacy of mistrust and skepticism and have been characterized as an instrument of colonization that must be examined and restructured to better serve the interests of indigenous communities (36, 37). While several tribes have intentionally built productive, mutually beneficial relationships with researchers, others remain skeptical and question whether the research enterprise will ultimately benefit the tribes in ways that are on par with the benefits realized by researchers (38). These challenges may be one reason that AI/AN research is limited or is not published in the peer-reviewed literature.

**Moving forward**

The disparity in motor vehicle death rates between AI/ANs and other race and ethnic groups is staggering. Although the literature that addresses this topic is slim, it reveals some promising clues as to how to best proceed to reduce the death on the roadways that disproportionately affects Native people. Our view of the clues offered by the literature may be characterized by 3 words: evidence-based, holistic, and partnership.

First, evidence-based interventions exist for reducing motor vehicle occupant deaths, and, when those interventions are applied to Native communities, our review shows they work (22, 24). The evidence also points to the need to address alcohol; here again, evidence-based interventions are available. Unfortunately, we did not find evidence that they have been applied to the problem of motor vehicle crash deaths in the AI/AN population.

Second, the available evidence-based interventions and the data reviewed here support the need to be holistic. Motor vehicle deaths are a multifaceted problem, with multiple intervention points and multiple intervention strategies. Interventions that aim to change policy, behavior, and the environment will be stronger and more effective than interventions limited to one of these approaches.

Interventions to reduce alcohol-related motor vehicle deaths provide an example of the need and benefits of a holistic approach (39, 40). Policies that regulate the distribution and sale of alcohol are in place. Understanding these systems and the differences in these systems across communities is needed, because the evidence suggests that, in some locations, these systems result in increased access to and consumption of low-cost, high-alcohol-content products (41). Policy changes can affect the availability of alcohol, establish rules about alcohol use, and change how people consume alcohol as well as how they behave when under the influence, as the interventions that use sobriety checkpoints, enhanced enforcement strategies, and public education campaigns demonstrate (18, 19, 22, 24). One study reported that after the intervention ended, inconsistent messages led to reduced awareness of the problem by the tribal community (20). Assuring that the public is aware of policies and having enforcement systems in place to discourage alcohol use are essential to maximizing effectiveness. However, such policy interventions must take into account the diversity of tribal governmental infrastructures and the capacity of the tribes to make policy within their respective jurisdictions.

Tribal leaders can have a substantial impact given the legal authority of tribes as sovereign nations (42). The federal government recognizes 334 tribes in the United States (exclusive of Alaska and Hawaii) with legislative control over alcohol policy on tribal and trust lands. Given the diversity of tribal approaches to alcohol, comparative studies evaluating the effectiveness of different approaches to preventing alcohol-related mortality should be undertaken (26). The capacity of tribes to enforce prevention policies should also be evaluated from a legal, political, and economic standpoint.

Being holistic also requires attention to structural issues such as poverty. At the tribal level, poverty severely limits tribal governments capacity to provide for the safety of the community. Significant resource disparities among tribes should be noted and considered in allocating scarce public resources to address health disparity concerns. Wealthier tribes, with lucrative gaming enterprises, apply revenues to create employment, fund community services, advance language and cultural revitalization, and supplement the incomes of tribal members and build tribal infrastructure (43). Such tribes are in a much better financial position to provide leadership in resourcing, evaluating, and disseminating best practices to address motor vehicle occupant and pedestrian deaths among AI/ANs. Including injury prevention expertise in economic development efforts that are reshaping the built environment could reduce injury and deaths.

Third, any holistic approach to addressing motor vehicle deaths among AI/ANs will likely benefit from healthy, well-functioning partnerships. Some papers included in this review provide examples of the groups involved in such partnerships and offer evidence of the impact that working together can have (22, 23). Scarce resources for enforcement and the vertical orientation of many tribal infrastructures that depend heavily on federal funding represent significant challenges as well as opportunities for community-centered interventions tailored to local needs. Cooperative ventures between tribal units, supported by different funding streams such as public safety and Head Start, can be replicated in many tribes (19–24).

A community-based participatory research approach to address motor vehicle fatalities could achieve sustainable long-term change by building tribal capacity to assess, intervene, evaluate, and disseminate best practices. Indeed, the complexity of tribal structures and jurisdictional associations with state and federal governments demonstrates the diversity of stakeholders and thus demands a multilevel and participatory investigative approach to health disparities research. A substantial body of work on community-based participatory research is now available and could be useful in guiding future academic-tribal research partnerships (44).
The alignment between community-based participatory research and contextualized Native research approaches has been articulated, along with strategies for effective engagement and reciprocity (38). Such partnerships are critical for intervention research to help assure that program and policy solutions are driven by the values and goals of the people affected as well as by the scientific evidence, and to maximize the likelihood of sustainable change and capacity building.

Conclusion

Motor vehicle deaths disproportionately affect AI/AN populations. The disparity between this population and the overall US population demands attention. Fortunately, the literature, albeit limited, does provide some solid guidance as to how best to address this disparity. Interventions can be successful when they combine multiple methods and use partnerships to change policy, the environment, and individual behavior. Priority should be given to sound investment in the states with the highest AI/AN motor vehicle death rates because reducing their burden will dramatically reduce the overall disparity. With the benefit of the science and the help of partners, the roadway deaths that occur all too frequently in and around Native communities can be reduced.

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REFERENCES


