

ORIGINAL ARTICLE

Motor vehicle crash fatalities by race/ethnicity in Arizona, 1990–96

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Objective: To compare rates of motor vehicle crash (MVC) fatalities among different race/ethnic groups in urban and rural Arizona.

Method: Using the Fatality Analysis Reporting System and the National Center for Health Statistics Multiple Cause of Death file, MVC fatalities in Arizona from 1990–96 inclusive were classified by gender, race/ethnicity, and urban or rural residence. Age adjusted rates of total, occupant, pedestrian, and alcohol related fatalities were calculated. The total MVC fatality rate for each race/ethnic group was then adjusted for proportion of rural residence.

Results: Compared with non-Hispanic whites (NHWs), American Indians had raised relative risks for MVC fatality in all gender and residence subgroups. Hispanic females and rural Hispanic males had lower relative risks, as did rural African-American men.

Raised relative risks for American Indian men and women included all subgroups: total, occupant, pedestrian, and alcohol related. Hispanic and African-American men both had raised relative risks of pedestrian related fatalities, and Hispanic men had a slightly higher relative risk while Hispanic women had a lower relative risks, for alcohol related fatality. Hispanic men and women and African-American men had lower occupant fatality rates. Close to half (45%) of the excess MVC fatality among American Indians can be attributed to residence in rural areas, where MVC fatality rates are higher. There were 1.85 occupants in crashes involving NHW deaths compared with 2.51 for Hispanics and 2.71 for American Indians ($p < 0.001$). The proportion of occupants not using a seatbelt was higher in Hispanics and American Indians in both urban and rural areas.

Conclusion: The major disparity in MVC fatality in Arizona is among American Indians. The higher MVC fatality rates among American Indians occur in all age groups, in both urban and rural areas, and among occupants and pedestrians. Rural residence, lower rates of seatbelt use, higher rates of alcohol related crashes, a greater number of occupants, and higher rates of pedestrian deaths all contribute to the American Indian MVC fatality disparity.

High rates of pedestrian fatality occur in men in all three race/ethnic minorities in Arizona and among American Indian women. In contrast to other studies, African-Americans and Hispanics did not have raised total MVC fatality rates and compared to NHWs actually had lower rates in the rural areas of the state.

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Unintentional injuries are the fifth leading cause of death in the US and 45% of injury deaths are caused by motor vehicle crashes (MVC). The MVC death rate differs by race/ethnicity being 16.2/100 000 among non-Hispanic whites, 16.5 among African-Americans, and 14.3 among Hispanics.¹

There has been little scientific research into the causes of different racial/ethnic MVC fatality rates. The bulk of the literature addresses the excess MVC fatality among American Indians.^{2–12} In addition, Schiff and Becker have documented higher MVC fatality rates among both Hispanics and American Indians compared with non-Hispanic whites (NHWs) in New Mexico.⁹ Harper *et al* found that from 1991–95 in Colorado, Hispanics had MVC fatality rates 1.7 times those of NHWs with higher rates among drivers, occupants, and pedestrians.¹³ Baker *et al* found similar rates of occupant fatality among African-Americans, Hispanics, and whites among those ages 5–19 years but when these rates were adjusted for vehicle miles traveled, African-Americans had higher fatality rates in the age range 5–12, followed by Hispanics whereas Hispanics had the highest rates among those 13–19 years of age.¹⁴

Various explanations have been offered for these differences. Several studies have documented higher rates of alcohol involvement^{5 7 8 10 15} and higher rates of pedestrian fatalities^{5–8 16} among American Indians. Hispanic fatalities in

Colorado were associated with higher rates of seatbelt non-use, speeding, and older vehicles.¹³ Others have found lower rates of seatbelt use among Hispanics,^{17–20} African-Americans,^{19 20} and American Indians.^{19 20}

Several studies found increased rates of alcohol involvement among African-Americans and Hispanics^{13 21–24} but two studies using self reported behavior found the same number of, or fewer, episodes of African-American and Hispanic alcohol impaired driving compared with non-Hispanic whites.^{25 26}

It has been documented that rural residents have higher MVC fatality rates than urban residents.²⁷ To the extent that racial/ethnic minorities disproportionately live and drive in rural areas, their MVC rates would be higher partly for this reason.⁸

The purpose of this study is to explore the contribution of alcohol involvement, pedestrian fatalities, and rural residence to differences in race/ethnic specific MVC fatality in one state. We hypothesized that there would be race/ethnic specific

Abbreviations: BAC, blood alcohol concentration; FARS, Fatality Analysis Reporting System; MVC, motor vehicle crash; NCHS, National Center for Health Statistics; NHWs, non-Hispanic whites

Table 1 Annualized MVC fatality rates*, by gender, residence, and race/ethnicity, Arizona, 1990–96

	White		American Indian			Hispanic			African-American		
	Rate (No)	RR	Rate (No)	RR†	95% CI	Rate (No)	RR	95% CI	Rate (No)	RR	95% CI
Male (urban)	16.95 (1294)	1	60.27 (103)	3.56	2.91 to 4.35	17.02 (549)	1.00	0.91 to 1.11	21.55 (73)	1.27	1.00 to 1.61
Male (rural)	28.26 (553)	1	116.12 (474)	4.11	3.63 to 4.65	16.49 (198)	0.58	0.50 to 0.69	14.32 (11)	0.51	0.28 to 0.92
Female (urban)	8.78 (666)	1	27.88 (57)	3.17	2.42 to 4.16	6.05 (194)	0.69	0.59 to 0.81	8.30 (25)	0.94	0.63 to 1.41
Female (rural)	12.18 (245)	1	40.16 (191)	3.30	2.73 to 3.98	6.17 (83)	0.51	0.39 to 0.65	10.05 (5)	0.83	0.34 to 2.00

*Age adjusted per 100000.

†RR, relative risk compared to non-Hispanic whites.

CI, confidence interval.

findings that would vary by rural/urban residence that could help explain existing MVC disparities.

METHODS

This study covers the years 1990 through 1996, inclusive. The Fatality Analysis Reporting System (FARS) is a national data set with information on the vehicle, each person involved, and the circumstances of each fatal MVC. The race of each person killed is not listed. We used all FARS records for crashes that occurred in Arizona during the study period. The National Center for Health Statistics (NCHS) multiple cause of death file is compiled from death certificates and includes the causes of death, personal information including race, and residence. We used the NCHS records for Arizona residents that listed an *International Classification of Diseases* code of E810 through E825 (motor vehicle fatalities).

Using a method first described by Fife, we matched FARS records to NCHS records to create a data set comprising variables from both files.²⁸ We first matched on the common variables of age, gender, date of death, and county of death. Matched records were then extracted from each data set. Since some records differed only by county where the death occurred, we then matched using age, gender, and date of death; again, matched records were extracted. The final match sequence included age, gender, county, and date of death but allowed the age from the FARS record to vary by one year from the NCHS age. We excluded motorcycle and bicycle fatalities.

There were 5500 NCHS records and 6227 FARS records that met the criteria noted; 4307 matches were achieved using all four common variables, 287 matches resulted after excluding the county, and 181 matches used all four variables with age allowed to vary by one year. Thereby, a total of 4775 matches were achieved, 87% of NCHS records and 77% of FARS records, representing 4305 crashes. There was no significant difference between the proportion of death certificates matched for American Indians, African-Americans, Hispanics, and NHWs.

Each fatality was then classified according to race/ethnicity, gender; and urban, rural. We classified race into five groups: African-American, American Indian, NHW, Hispanic, and others based on information from the NCHS record. For the urban/rural variable we classified two counties as urban: Maricopa County, which contains Phoenix, has a population density of 231 per square mile, and Pima County, which contains Tucson, has a density of 73 per square mile. The other 13 Arizona counties, with population densities ranging from 3–24 per square mile, were classified as rural. (One American Indian reservation in Pima County, the Tohono O'odham, was classified as rural due to its size and distant location from Tucson.) Each death was classified as an occupant (drivers and passengers) or pedestrian using the FARS data. Seatbelt use, number of occupants, and the designation of alcohol related were taken from FARS. The alcohol related variable used was the police designation of whether the crash was alcohol related.

Population denominators for each year were derived from the 1990 census and the 1995 population estimate (US Census

Bureau). When calculating rates for the entire period, the 1993 population estimates were used. Age adjusted rates were calculated using the direct method with the 2000 US population as a standard. Annualized rates were calculated by dividing the rates for the entire period by seven.

An urban/rural adjustment was performed by calculating what each race/ethnic specific age adjusted MVC rate would be if the urban/rural residence distribution were the same as for NHWs. Significance levels were set at $p < 0.05$ and 95% confidence intervals were calculated for all statistical tests except for the age group comparisons where, due to the number of comparisons, a $p < 0.01$ was used.

RESULTS

Of the 4775 matched FARS/NCHS records 2758 involved NHWs, 1024 were Hispanic, 825 American Indians, 114 African-American, and 54 other. Because of the low number in the "other" category, these were excluded from further analysis. There were 833 pedestrian deaths: 393 NHWs, 200 Hispanics, 200 American Indians, and 27 African-Americans (13 were not listed).

Table 1 shows the annualized, age adjusted MVC fatality rates by gender and residence for each race/ethnic group. American-Indians had the highest rate in all four groups. Their relative risks were over three times those of NHWs in all groups. Hispanics had lower rates than NHWs in all groups except urban males whereas African-Americans had lower rural rates in males.

Tables 2 and 3 show the occupant, pedestrian, and alcohol related MVC fatality rates for males (urban and rural combined) and females respectively. Compared with NHW males, Hispanic males had lower rates of occupant and total MVC fatality and higher rates of pedestrian and alcohol related fatality while African-American men had a higher pedestrian fatality rate. American Indian males had higher rates in all categories. Compared with NHW females, Hispanic females had lower occupant, alcohol related and total fatality rates, African-Americans had lower occupant fatality rates, and American Indians had higher rates in all categories. Women had lower total, occupant, pedestrian, and alcohol related fatality rates than men in each racial/ethnic group but American Indian women had higher rates in each category than did men in all other racial/ethnic groups.

Table 4 shows what the total MVC fatality rate for each race/ethnic group would be if their urban/rural residence distribution were the same as NHWs (80% urban). The urban/rural adjustment changes the Hispanic and African-American rates only slightly whereas the American Indian rate declines by 26%. Close to half (45%) of the excess mortality of American Indians (the difference between the American Indian and NHW rates) is accounted for by their higher proportion of rural residents.

Table 5 lists the total MVC fatality rate by age for each race/ethnic group. Compared with NHWs, Hispanic females have lower rates in the ages 15–24, 45–54, 65–74, and 75 and above. American Indian men had significantly higher rates in all age

Table 2 Total, occupant, pedestrian, and alcohol related MVC fatality rates* for men by race/ethnicity, Arizona, 1990–96

	Total MVC fatality	Occupant	Pedestrian	Alcohol related
Non-Hispanic whites	19.23	15.18	2.90	5.00
No	1847	1470	270	473
Hispanic	16.72	12.12	3.86	5.88
No	747	568	150	253
RR†	0.87	0.8	1.33	1.18
95% CI	0.8 to 0.95	0.72 to 0.88	1.09 to 1.63	1.01 to 1.37
American Indian	98.97	66.36	31.50	41.97
No	577	408	158	235
RR	5.15	4.37	10.87	8.4
95% CI	4.69 to 5.65	3.92 to 4.88	8.93 to 13.23	7.18 to 9.82
African-American	20.61	13.46	5.06	4.40
No	84	58	18	17
RR	1.07	0.89	1.75	0.88
95% CI	0.86 to 1.33	0.68 to 1.15	1.08 to 2.81	0.54 to 1.43

*Age adjusted per 100000.
 †RR, relative risk compared to non-Hispanic whites.
 CI, confidence interval.

Table 3 Total, occupant, pedestrian, and alcohol related MVC fatality rates* for women by race/ethnicity, Arizona, 1990–96

	Total MVC fatality	Occupant	Pedestrian	Alcohol related
Non-Hispanic whites	8.73	7.37	1.21	1.01
No	911	775	123	96
Hispanic	6.02	4.86	1.13	0.66
No	277	225	50	30
RR†	0.69	0.66	0.93	0.65
95% CI	0.60 to 0.79	0.57 to 0.77	0.67 to 1.30	0.43 to 0.98
American Indian	36.32	29.60	6.49	9.56
No	248	203	42	65
RR	4.16	4.02	5.36	9.45
95% CI	3.62 to 4.79	3.44 to 4.69	3.77 to 7.61	6.90 to 12.95
African-American	8.56	3.98	2.02	0.39
No	30	19	9	2
RR	0.98	0.54	1.66	0.38
95% CI	0.68 to 1.41	0.30 to 0.96	0.85 to 3.27	0.09 to 1.55

*Age adjusted per 100000.
 †RR, relative risk compared to non-Hispanics whites.
 CI, confidence interval.

Table 4 Urban and rural MVC fatality rates* by race/ethnicity, Arizona, 1990–96

	% Urban	Urban rate	Rural rate	Total	Adjusted†
Non-Hispanic white	80	11.19	17.58	12.49	–
Hispanic	74	9.95	9.41	9.71	9.84
American Indian	31	34.78	64.10	55.25	40.64
African-American	87	13.04	14.19	13.26	13.27

*Age adjusted per 100000.
 †Using the formula (0.8 × urban rate + 0.2 × rural rate).

groups except age 75 and older whereas American Indian women had significantly higher rates in seven out of nine age groups. African-American males had significantly higher rates for children under age 5.

The number of occupants (driver plus passengers) did differ by driver race/ethnicity being 1.85 for NHWs, 2.51 for Hispanics, and 2.71 for American Indians (both comparisons with NHWs were significant at $p < 0.001$). Seatbelt non-use by occupants (drivers and passengers) was 86% for American Indians, 81% for African-Americans, 77% for Hispanics, and

68% for NHWs in urban areas ($p < 0.001$) and 88% for American Indians, 85% for Hispanics, 72% for NHWs, and 67% for African-Americans in rural areas ($p < 0.001$).

DISCUSSION

This study has several limitations including the use of police designation of alcohol involvement and the use of race/ethnic identifiers in the NCHS and census data. The police designation of alcohol involvement can be a subjective judgment and may or may not be corroborated by a blood

Table 5 Total MVC fatality rates* by age and race/ethnicity, Arizona, 1990–96

	White	Hispanic	American Indian	African-American
Male				
<5	2.93	3.53	15.69†	10.63†
5–14	5.35	3.59	13.06†	9.94
15–24	27.08	25.25	121.36†	28.68
25–34	23.89	24.68	161.73†	16.24
35–44	26.46	27.47	170.65†	37.55
45–54	16.60	5.73	38.05†	10.54
55–64	17.62	21.82	196.43†	12.42
65–74	14.64	10.85	53.84†	12.39
75+	36.66	20.68	60.60	46.72
Female				
<5	3.09	3.25	12.83†	0
5–14	3.56	2.38	8.49†	3.45
15–24	11.19	7.89†	45.49†	7.38
25–34	8.21	7.92	64.92†	10.66
35–44	10.43	8.77	60.64†	11.28
45–54	8.04	2.37†	14.12	2.68
55–64	7.14	8.32	31.59†	20.70
65–74	10.73	4.23†	27.94†	3.80
75+	20.23	8.88†	45.14	22.19

*Per 100000.

†Compared to non-Hispanic whites the difference is significant at $p < 0.01$.

alcohol concentration (BAC) measurement. One study in western Washington state found that police assessment of driver intoxication was reasonably accurate when investigating crashes that involved a driver who was transported to a trauma center.²⁹ Whether this degree of accuracy is achieved around the country in fatal crashes involving drivers of different races/ethnicities is unknown. There are several variables in FARS pertaining to alcohol, each with limitations. To the extent that a race/ethnic group is subject to bias or police preconceived notions of alcohol impairment, their rates of alcohol involvement will be higher or lower depending on the direction of the bias. This issue is deserving of further study. In our data, there were no race/ethnic differences in the proportion of urban fatalities with BAC measured. However, only 20% of American Indian fatalities in rural areas had a BAC measured compared with 29% of Hispanics and 33% of NHWs ($p < 0.001$). There was an across-the-board lower proportion of fatalities with BAC measured in rural areas (27%) compared with urban areas (60%).

Another limitation is the lack of vehicle and pedestrian exposure data. Without knowing the vehicle miles driven or pedestrian miles walked for different race/ethnic groups, we cannot tell if differences are due to amount of exposure or to other variables.

The problems with race/ethnic identification are well known. The NCHS classification is taken from death certificates and is subject to the degree of accuracy in the state agency responsible for vital statistics (in Arizona, the Arizona Department of Health Services). In New Mexico high accuracy has been found for the designation of Hispanics⁹ but it is unknown if Arizona also achieves this rate of accuracy. Under-classification of American Indian deaths is well documented.³⁰ Under-counting American Indian deaths will result in a mortality rate that will be underestimated. Census classification of race/ethnicity is self designated. There is persistent concern in Arizona that race/ethnic groups are undercounted; this is especially a potential for Hispanics because of the large number of undocumented Hispanics who reside in the state. To the degree that this undercounting occurs, calculated mortality rates will be overestimated.

With the cautions just discussed in mind, this study found that the only race/ethnic group to have consistently higher rates of MVC fatality was American Indians. In comparison with NHWs, Hispanics had significantly lower rates except for urban males. African-American males had slightly higher

rates in urban areas but lower rates in rural areas; African-American females had rates similar to NHWs.

Higher mortality rates for American Indians were found among both occupants and pedestrians, in both men and women in urban and rural areas, and in most age groups. Close to half of the excess American Indian MVC fatalities can be attributed to the proportion who live in rural areas. Alcohol use, number of occupants, seatbelt non-use, and pedestrian deaths were all contributors to the raised American Indian MVC fatality rate. A similar result was found in the Pacific Northwest where raised MVC injury rates were found among American Indians, more so in rural than in urban areas, and alcohol impairment and seatbelt non-use were higher among American Indians.³¹

This study is consistent with one conducted a decade ago that also showed increased rates of rural, occupant, pedestrian, and alcohol related mortality rates among American Indians in Arizona.⁸ Since that time MVC mortality rates have improved among all Arizonans, except American Indian females. However, the improvements have been greater in non-American Indian males and this, plus the lack of improvement in American Indian females, has caused increased American Indian relative risks of MVC mortality in 1990–96 (3.17–4.11) compared with 1979–88 (2.3–3.1).

One issue regarding motor vehicle safety in rural Arizona is the autonomous legal status of reservations. Arizona has 22 Indian reservations, each with separate traffic laws and differing levels of resources devoted to enforcement. This can lead to more lenient law enforcement, which can influence rates of speeding, seatbelt use, or driving under the influence of alcohol. There are examples of motor vehicle safety programs and enhanced enforcement in American Indian communities that have been successful.^{2 32 33} At the time of the study one tribe had passed its own seatbelt law and six others had adopted the Arizona state law, resulting in 82% of the American Indian reservation population being covered by one or the other laws. In addition, the Indian Health Service initiated an emergency medical system on reservations in the 1980s.³⁴ However, it takes about 10 years before such systems can be expected to reduce MVC mortality.³⁵

There are a number of programs communities can adopt to attempt to reduce MVC fatalities. The Task Force on Community Preventive Services has published recommendations on how to increase the use of child safety seats and seatbelts and how to reduce alcohol impaired driving. These recommendations include a combination of community education, stronger

laws, and enhanced law enforcement.³⁶ To the extent that American Indian communities adopt these strategies, their MVC fatality burden should decline.

In addition, half of the American Indian reservations in Arizona prohibit the sale and possession of alcohol, including the two largest. For residents of large and isolated reservations this can mean a long drive or walk to obtain alcohol. The effect of these policies on total MVC mortality is unknown. In urban areas increased availability of alcohol is associated with increased rates of alcohol related crashes,³⁷ whereas research in rural areas has had mixed results when examining the relationship of distance to alcohol outlets and the incidence of alcohol related crashes.³⁸⁻⁴⁰ However, none of these studies are specific to American Indian communities.

This study found lower MVC fatality rates in Hispanics compared with NHWs even though Hispanic men had higher relative risks for alcohol related and pedestrian deaths and men and women combined had a higher proportion of seatbelt non-use among occupants killed. This may reflect fewer vehicle miles traveled compared with other race/ethnic groups. This result is not consistent with two other studies performed in the Southwest where higher MVC fatality was found among Hispanics in Colorado and New Mexico.⁹ One of these, by Schiff and Becker, took place 32 years ago, however.⁹ In addition, New Mexico has a higher proportion of the population that is rural than does Arizona and rural and urban crashes were not analyzed separately. Harper *et al* used a similar method in a nearby state.¹³ While that study included residence (urban, rural) in the variables studied, and Hispanics had a lower proportion of fatalities occurring in rural areas than did whites, separate urban and rural rates were not calculated. It is not possible to discern what the results of adjusting for residence would be. Our results should serve to caution against extrapolating race/ethnic differences in one state to another, even if the states are in the same geographic region.

While this study shows, in our state, that Hispanics and African-Americans have population based MVC rates similar to NHWs, it does not allow any conclusion about risk related to vehicle miles driven or trips taken. It is also unclear how socioeconomic factors, such as income levels, educational levels, employment rates or occupations, affect MVC fatality rates. The higher pedestrian fatalities among the three ethnic minority groups may be related to less access to motor vehicle transportation and public transportation, and increased rates of traveling by foot, and specific circumstances of pedestrian travel that are particularly hazardous such as on roads with poor lighting and no sidewalks.⁵ The greater mean number of passengers among American Indians and Hispanics may also be related to less availability of car transportation, thereby placing a greater number of individuals at risk during a crash. Using an older car can increase risk because of lower safety standards. However, the age of cars at the time of the crash in this study did not differ by the race/ethnicity of the drivers. Income probably also affects the number of miles driven and the exposure to risk of a MVC. All these issues deserve further study.

While improvements in MVC fatality continue to be made, there remains a marked disparity in Arizona for American Indian MVC fatality. Ways to decrease pedestrian and alcohol related fatalities, increase use of seatbelts and to affect the factors associated with rural related MVC fatality, such as road conditions and access to emergency services, need to be found if this disparity is to be reduced.

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Key points

- In Arizona, from 1990–96, American-Indians had raised relative risks, compared with non-Hispanic whites, of motor vehicle crash fatalities, in both men and women, in urban and rural areas, and among both vehicle occupants and pedestrians.
- Much of the excess American-Indian mortality is associated with rural residence, lower rates of seatbelt use, alcohol related crashes, and high rates of pedestrian fatalities.
- High rates of pedestrian fatalities occur among Hispanic men, African-American men, and American Indian men and women.
- African-Americans and Hispanics did not have raised total rates of motor vehicle crash fatalities compared with non-Hispanic whites and actually had lower rates in rural areas.
- Motor vehicle fatality rates are declining among all racial/ethnic groups but at a slower rate among American-Indians leading to increasing relative risks for this population.

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