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Evaluating adverse rural crash outcomes using the NHTSA State Data System

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Abstract

Introduction—The population-based rate of motor vehicle crash mortality is consistently higher in rural locations, but it is unclear how much of this disparity might be due to geographic barriers or deficiencies in emergency medical services (EMS). We sought to analyze separately factors associated with the occurrence of a severe injury and those associated with death after injury had occurred.

Methods—Data from all police-reported crashes in 11 states from 2005–2007 were obtained through the National Highway Traffic Safety Administration (NHTSA) State Data System (SDS). Logistic regression was used to estimate factors associated with (1) death; (2) severe (incapacitating or fatal) injury; and (3) death given severe injury. Models included covariates related to the person, vehicle, and event; county location was specified using Rural–Urban Continuum Codes (RUCC).

Results—Older age, not wearing a belt, ejection, alcohol involvement, high speed, and early morning times were associated with increased risk of both severe injury and death. Controlling for these factors, and restricting analysis to persons who had suffered a severe injury, the adjusted odds ratio (aOR) associated with death was higher for counties classified rural (RUCC 6–7, aOR 1.23, 95% CI 1.16–1.31) or very rural (RUCC 8–9, aOR 1.31, 95% CI 1.18–1.46).

Conclusions—Persons severely injured in crashes are more likely to die if they are in rural locations, possibly due to EMS constraints. As NHTSA-SDS data become more available and more uniform, they may be useful to explore specific factors contributing to this increased risk.

Keywords

Crash; Injury; Mortality; Rural; NHTSA; State Data System

1. Introduction

The increased risk for rural residents to die from a motor vehicle crash has been recognized for many years (Baker et al., 1987; Brodsky and Hakkert,1983). While this disparity may be

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partly due to an increased incidence of severe crashes, it appears to be attributable more to the difference in outcome for persons who have been injured (Goldstein et al., 2011; Muelleman et al., 2007). This disparity in outcomes may raise questions about the quality of care delivered by emergency medical services (EMS) and emergency departments (ED), as well as the obvious problems of communication, transportation, and scarce resources in more remote locations (Cummings and O'Keefe, 2000). We sought to explore these issues in order to help identify any factors that might be modified to improve outcomes.

The National Highway Traffic Safety Administration (NHTSA) has developed several crash databases and made them available to researchers at no cost. The best known is the Fatality Analysis Reporting System (http://www.nhtsa.gov/FARS), a census of all crashes since 1975 in which at least one person died. A stratified random sample of similar (but less detailed) information about nonfatal crashes has been provided since 1988 by the National Automotive Sampling System (http://www.nhtsa.gov/NASS). These databases have been used extensively by traffic and automotive engineers, and occasionally for epidemiologic or health services research.

A less frequently used NHTSA database is the State Data System (http://www.nhtsa.gov/Data/State+Data+Program+&+CODES), which is a compilation of state based police accident reports from participating states, including information about the event, vehicles, and persons similar to that available in the National Automotive Sampling System (NASS). Studies using the NHTSA State Data System (NHTSA-SDS) have been infrequently published outside of NHTSA (Cheung and McCartt, 2011; Eisenberg and Warner, 2005; Karaca-Mandic and Ridgeway, 2010; Lyon et al., 2012), but it records data from a much larger number of rural counties than the few sampled by the NASS. NHTSA-SDS is therefore a potentially valuable database for EMS research, which could help overcome some of the limitations and complement the findings from the other NHTSA databases.

A primary goal of this study was to investigate further the rural/ urban outcome disparities in traffic crashes and the effects of post-crash factors on outcomes. We were most interested in the person, vehicle, and location factors associated with mortality among persons who had been severely injured in a crash, since this would be the outcome most likely to be affected by EMS or trauma care systems. We also intended to compare findings using NHTSA-SDS to published results based on estimates from the NASS General Estimates System (GES).

2. Methods

NHTSA-SDS data for 2005–2007 were obtained at nominal cost through the NHTSA Office of Data Acquisitions. Access to the data from each state required specific approval of an official in that state, and in some cases there were additional state-specific requirements. At the time, 33 states were participating in NHTSA-SDS, and we attempted to obtain data from 20 of them; seven explicitly denied access except to internal NHTSA researchers, and two others did not respond to repeated requests. The 11 states that agreed to provide data were Arkansas, California, Florida, Kentucky, Maryland, Michigan, Minnesota, New Mexico, South Carolina, Washington, and Wyoming. An institutional review board exempted this study from review because it contained only preexisting and de-identified data.

Data maintenance and analysis was performed using Stata Version 12.1 (StataCorp, College Station, TX). States had independently collected and reported their data, resulting in variability in the completeness and possibly the accuracy of information. Variable names and coding schemes were also inconsistent, and these were renamed and redefined so that they would be uniform across each state database. Each state database included separate person, vehicle, and crash files that were merged to create a single dataset for each state. A multiple-state database was then created by merging all of the state datasets, which included selected person-, vehicle-, and crash-level variables from each of the 11 states.

Persons other than occupants of cars and light trucks were excluded. Person-related variables of interest included age, sex, seating position, safety belt usage, ejection, and police-reported injury severity (no injury, possible injury, non-incapacitating injury, incapacitating injury, fatal injury, injury of unknown severity). Age was categorized as under 15 years, 15–39, 40–64, 65–79, and 80 years or more. Persons were considered unbelted if they were not recorded as wearing a seat belt or if seat belts were not available in the vehicle.

NHTSA-SDS (like NASS-GES) does not contain measures of injury severity ascertained by hospital personnel or medical examiners. However, the definition of “incapacitating injury” used in police reports has been standardized to mean an injury “which prevents the injured person from walking, driving or normally continuing the activities the person was capable of performing before the injury occurred” (National_Safety_Council, 2007). The number of persons with incapacitating injuries determined by police reports has been previously used as a denominator for persons at risk of death after traffic crashes (Brodsky and Hakkert, 1983; Brown, 1979). For this study, we defined a “severe” injury category to include injuries categorized by police as either incapacitating or fatal.

Other variables were selected primarily with a view to comparison with the findings that Travis et al. (2012) had obtained using NASS-GES, but with further detail limited by the comparability of the SDS data from each state. Vehicle-related variables included speed limit, speed estimates, driver alcohol involvement, rollovers, vehicle deformation, and towing information. Most states were missing data on one or more of the variables that might be used to describe vehicle crash damage, so it was not possible to derive a standard categorization. For this study, we classified vehicles as traveling at high speed if the police estimated that it was traveling over 50 miles per hour at the time of the crash, or if its speed was not reported but the posted speed limit was 50 or above. Alcohol was considered involved if the driver had a positive blood alcohol test.

Crash-related variables included time of day, poor visibility, slippery conditions, number of vehicles involved, and occurrence on an interstate highway. The time of the crash was divided into 6-h blocks.

The location of each crash was categorized using county Rural–Urban Continuum Codes, as defined by the U.S. Department of Agriculture (RUCC, http://www.ers.usda.gov/data-products/rural-urban-continuum-codes.aspx). RUCC classifies US counties into nine groups, which we stratified as urban (RUCC 1–3), partly rural (RUCC 4–5), rural (RUCC 6–7), and very rural (RUCC 8–9). The location was specified as southern if the crash occurred in Arkansas, Florida, New Mexico or South Carolina.

Additional county-level demographic, socioeconomic, and medical resource information was obtained from the Area Resource File provided by the U.S. Health Resources and Services Administration (ARF, http://www.arf.hrsa.gov). ARF variables included median age, racial and ethnic proportions, median income, unemployment rates, high school graduation rates, proportion of the population with health insurance, the number of emergency physicians, and the number of neurosurgeons.

After initial data exploration, logistic regression models (limited to occupants of motor vehicles) were used to examine the association of independent variables (person, vehicle, event, and location factors) with three binary outcomes: (1) death overall; (2) severe injury (incapacitating or fatal); and (3) death given severe injury. No attempt was made to impute any missing data, but analyses were repeated after excluding states that were missing data for age, restraint use, or injury severity in more than 25% of cases.

3. Results

The 11 contributing states provided data from a total of 654 counties, distributed over the nine RUCC categories in proportions roughly similar to those seen in the US as a whole (Table 1). For the 11 states over three years, a total of 11,008,057 persons were involved in a motor vehicle crash as an occupant of a car or light truck: Only 187,199 (1.7%) of these had a severe injury, including 127,680 (1.46%) reported by the police to have an incapacitating injury and 26,582 (0.24%) reported by the police to have a fatal injury.

Table 2 summarizes the characteristics of the sample by injury category. The great majority of crash victims were in the most populous counties, although rural counties contributed a disproportionate number of those with severe (incapacitating or fatal) injuries. Severe injuries were also clearly associated with older age, restraint non-use, ejection, alcohol, high speed, early morning, single-car crashes, and Southern location.

Table 3 summarizes the characteristics of the 187,199 persons with a severe (incapacitating or fatal) injury. Among persons with severe injuries, 14.2% died. This proportion was greater the more rural a county was classified. High speed and ejection from the vehicle were more common in rural areas. For persons with complete data, multivariable logistic regression modeling estimated the effect of each characteristic while controlling for the presence of the others, and the results of these models are shown in Table 4: Model 1 evaluated the overall risk of mortality for motor vehicle occupants involved in a crash. As expected, overall mortality was associated with persons who were older, male, sitting in the front seat, unbelted, or ejected from the vehicle; with alcohol involvement, high speed, crashes at times other than noon to 6 PM, involvement of a single vehicle, in conditions of poor visibility, in the absence of slippery roads, on interstate highways, or in southern states. There was no significant association of mortality with being a passenger rather than the driver in the front seat. Controlling for these factors, and compared to urban (RUCC 1–3) crashes, individuals in rural (RUCC 6–7) crashes had an increased adjusted odds ratio for death (aOR 1.51, 95% CI 1.43–1.59) and individuals in very rural (RUCC 8–9) counties were almost twice as likely to die (aOR 1.91, 95% CI 1.73–2.11).

Model 2 evaluated the overall risk of severe (incapacitating or fatal) injury for motor vehicle occupants involved in a crash. Severe injury was also associated with persons who were older, sitting in the front seat, a passenger rather than the driver, unbelted, or ejected from the vehicle; with alcohol involvement, high speed, crashes at times other than noon to 6 PM, involvement of a single vehicle, in conditions of poor visibility, in the absence of slippery roads, on interstate highways, or in southern states. However, severe injury was reported less frequently among men. Controlling for these factors, and compared to urban (RUCC 1–3) crashes, individuals in rural (RUCC 6–7) crashes were more likely to sustain a severe injury (aOR 1.24, 95% CI 1.22–1.27) and individuals in very rural (RUCC 8–9) counties were even more likely to sustain a severe injury (aOR 1.59, 95% CI 1.53–1.66).

Model 3 evaluated the risk of mortality for motor vehicle occupants who had sustained a severe (incapacitating or fatal) injury in a crash. Mortality given severe injury was again associated with persons who were older, unbelted, or ejected from the vehicle; with alcohol involvement, high speed, crashes at times other than noon to 6 PM, involvement of a single vehicle, or on interstate highways. Men with severe injuries were more likely to die than women with severe injuries; persons seated in a front seat with severe injuries were less likely to die than those seated in a rear seat with severe injuries, but there was no significant difference in risk for front-seat passengers compared with drivers. Poor visibility or slippery roads did not affect the mortality risk for persons with severe injuries, and individuals in southern states with severe injuries did not have an increased risk of death compared with those in northern states. Controlling for these factors, and compared to urban (RUCC 1–3) crashes, individuals in rural (RUCC 6–7) crashes with severe injuries had a 23% increased adjusted odds of death (aOR 1.23, 95% CI 1.16–1.31) and individuals in very rural (RUCC 8–9) counties had a 31% increased adjusted odds of death (aOR 1.31, 95% CI 1.18–1.46).

Preliminary models included other characteristics of the county (e.g., demographics, socio-economic variables, medical resource information) but after adjusting for rural location these did not provide evidence of any independent effects on the risk of death, risk of severe (incapacitating or fatal) injury, or risk of death given severe injury. We found that the state of Washington was missing values for age in all of its cases, California was missing restraint status for 69% of its cases, and Michigan was missing injury severity for 34% of its cases. However, exclusion of these states produced no important changes in the modeling results.

4. Discussion

Injury research generally uses the conceptual model proposed by Haddon (1972), separating the analysis both with respect to the timing (before, during, after an event) and the level of observation (host, agent, and environment). While crash prevention is clearly the most cost-effective approach, the post-event, environmental cell of the Haddon Matrix is also important. Part of the increased crash mortality in rural areas may result from reduced access to an effective trauma care system integrated with local EMS (Brodsky, 1993; Muelleman and Mueller, 1996; Mueller et al., 1988). Specifically, this may involve delays in activating

EMS or barriers in the transportation of injured persons to appropriate hospitals, but the relative importance of these systemic factors is difficult to separate from the effects of person-level or event-level factors. While there has been concern about the quality of care in rural hospitals, it has also been difficult to separate this possibility from other factors (Chen et al., 1995; Wadman et al., 2005).

Most of the person-level, vehicle-level, and crash-level factors associated with severe injury and mortality after crashes in our models come as no surprise and have been described many times before, including age, not wearing a safety belt, ejection, alcohol involvement, vehicle damage, and occurrence in the early morning hours (Evans, 2004; Zlatoper, 1991). In some cases, factors known to increase mortality had differing effects on the risk of suffering a severe injury and on the risk of death given that a severe injury had occurred. Factors adversely affecting the latter are the ones most likely to be influenced by EMS or trauma care systems. For example, rear seat passengers might be less likely to be injured (Model 2) but when severely injured might be more difficult to extricate (Model 3). Hypotheses of this sort cannot be tested with NHTSA-SDS alone, but might be of interest to investigate with other EMS data.

Males had a significantly decreased risk of severe injury compared to females, but an increased risk of death, as was also seen in a study using NASS-GES (Travis et al., 2012). It is not possible to determine whether this difference is due to actual biological factors (e.g., body mass, bone density) or whether injury severity is being classified differently by the police or the involved person. This issue has been the subject of some debate in the literature (Croce et al., 2002; George et al., 2003), but has already led to ongoing studies involving administration of female hormones to injured male patients (Wright et al., 2007). Systematic disparity in the emergency management of patients according to their sex does not seem likely.

In all three of the models presented, the risk of an adverse outcome increased as rurality increased, as seen in previous research (Baker et al., 1987; Brown et al., 2000; Gedeborg et al., 2010; Goldstein et al., 2011; Muelleman et al., 2007). In particular, individuals with severe injuries were more likely to die in rural counties, validating previous studies (Brodsky and Hakkert, 1983; Brown, 1979; Muelleman et al., 2007; Travis et al., 2012). One possible explanation is residual confounding despite the effort to control for this using multivariate modeling; “severe” injuries may still be relatively more severe in rural areas. Another possible explanation is that delay or deficiency in the application of EMS or hospital care may be responsible for the rural/urban disparity. The quality of rural medical services could also be a factor, but this cannot be determined from NHDSA-SDS alone.

Several previous studies have noted an increased risk of traffic mortality in southern states (Clark and Cushing, 1999; Travis et al., 2012; Washington et al.,1999; Zlatoper,1991). Similar to a previous study using NASS-GES (Travis et al., 2012), we found that the risk of severe injury (incapacitating or fatal) was higher in the southern states, but that the risk of death given severe injury was not increased. EMS deficiencies therefore would not explain the regional disparity in outcomes. However, only a few southern states were represented in the NASS-GES sample or in the present study, so results must be interpreted with caution.

Further investigation of the reasons for the increased traffic mortality in the southern states is clearly warranted.

In addition to the findings already mentioned, the effects of variables related to the person, vehicle, and event were quite similar in this study to those that had been reported from NASS-GES. Because the data elements contained in NHTSA-SDS are not exactly the same as those in NASS-GES, and because the completeness and definitions of the NHTSA-SDS variables are not uniform for all states, an exact comparison is not possible. However, the present study confirms the relative importance of the variable effects measured in the earlier study, and holds out the possibility that a gradually improved NHTSA-SDS will allow more focused study of rural areas in the future.

4.1. Limitations

Limitations of this study included non-random sampling of states, variability in the quality and completeness of data among states, and the possibility of variability of factors contributing to injury and mortality even within counties. The location of the crash is specified only as a county within the state. Unfortunately, not all states participate in NHTSA-SDS, and not all of those participating make their data available for research purposes outside of NHTSA. Furthermore, NHTSA-SDS does not have uniform reporting requirements, and information and coding schemes vary across states; results might change if different categorizations were used, or if different states were included.

5. Conclusions

This study found that individuals in rural and very rural crashes have a significantly increased risk of death, increased risk of severe injury, and increased risk of death after being severely injured even with models that control for person, vehicle, and crash characteristics. On the whole, these effects were similar to those found in a study using NASS-GES (Travis et al., 2012). As NHTSA-SDS data become available from more states, and become more uniform, they may be even more valuable than NASS-GES by providing a larger variety of geographic locations and a better ability to contrast rural regions. Further research is needed to explore post-crash factors that could contribute to the increased risk in rural areas, and distinguishing the effects of EMS and ED care may require more precise accounting for the distance from medical resources or the actual elapsed times.

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Table 1

Rural–urban continuum codes—definitions and distributions.

RUCC	Definition	US counties n = 3142	US population n = 281,422,000	Sample counties n = 654	Sample persons n = 11,008,057
1	>1 million, metro area	414 (13.2%)	149,224,000 (53.0%)	85 (13.0%)	6,044,182 (54.9%)
2	250,000 to 1 million, metro area	325 (10.3%)	55,514,000 (19.7%)	83 (12.7%)	2,408,260 (21.9%)
3	<250,000, metro area	351 (11.2%)	27,842,000 (9.9%)	73 (11.2%)	1,097,909 (10.0%)
4	≥20,000, adjacent to metro area	218 (6.9%)	14,442,000 (5.1%)	43 (6.6%)	348,967 (3.2%)
5	≥20,000, not adjacent to metro area	105 (3.3%)	5,573,000 (2.0%)	24 (3.7%)	225,258 (2.1%)
6	2500 to 19,999, adjacent to metro area	609 (19.4%)	15,134,000 (5.4%)	128 (19.6%)	390,697 (3.6%)
7	2500 to 19,999, not adjacent to metro area	450 (14.3%)	8,464,000 (3.0%)	112 (17.1%)	356,686 (3.2%)
8	<2500, adjacent to metro area	235 (7.5%)	2,426,000 (0.9%)	42 (6.4%)	46,548 (0.4%)
9	<2500, not adjacent to metro area	435 (13.8%)	2,803,000 (1.0%)	64 (9.8%)	67,947 (0.6%)

21,603 persons in the sample were missing county information.

Table 2

Characteristics of the study population, by injury severity.

Characteristic (%)	Minor injury, no injury, or unknown	"Severe injury"	
	n **= 10,820,858**	**Incapacitating** ***n*** **= 160,617**	**Fatal** ***n*** **= 26,582**
RUCC			
1–3 (non-rural)	9,403,024 (86.9%)	127,680 (79.5%)	19,647 (73.9%)
4–5 (partly rural)	561,454 (5.2%)	10,713 (6.7%)	2058 (7.7%)
6–7 (rural)	726,010 (6.7%)	17,459 (10.9%)	3914 (14.7%)
8–9 (very rural)	110,201 (1.0%)	3458 (2.2%)	836 (3.2%)
Person			
Age			
0–14	670,204 (6.2%)	7817 (4.9%)	1010 (3.8%)
15–39	6,922,430 (64.0%)	95,474 (59.4%)	14,980 (56.4%)
40–64	2,594,745 (24.0%)	44,022 (27.4%)	6879 (25.9%)
65–79	484,018 (4.5%)	9762 (6.1%)	2324 (8.7%)
80+	149,461 (1.4%)	3542 (2.2%)	1389 (5.2%)
Male	5,520,360 (51.0%)	82,807 (51.6%)	17,472 (65.7%)
Driver	6,812,608 (63.0%)	104,296 (64.9%)	16,486 (62.0%)
Front passenger	1,541,440 (14.3%)	32,032 (19.9%)	5001 (18.8%)
Rear passenger	1,505,339 (13.9%)	19,822 (12.3%)	4121 (15.5%)
Unbelted	756,247 (7.0%)	36,153 (22.5%)	12,182 (45.8%)
Ejected from vehicle	20,705 (0.2%)	9385 (5.8%)	5722 (21.5%)
Vehicle/Crash			
Alcohol involved	491,954 (4.6%)	20,454 (12.7%)	7385 (27.8%)
High speed	2,789,313 (25.8%)	52,294 (32.6%)	11,226 (42.2%)
Midnight to 6 AM	760,404 (7.0%)	23,348 (14.5%)	6247 (23.5%)
6 AM to noon	2,656,811 (24.6%)	37,089 (23.1%)	5328 (20.0%)
Noon to 6 PM	4,880,756 (45.1%)	58,580 (36.5%)	7658 (28.8%)
6 PM to midnight	2,488,069 (23.0%)	41,330 (25.7%)	7168 (27.0%)
>1 car collision	7,932,903 (73.3%)	92,011 (57.3%)	12,143 (45.7%)
Poor visibility	3,166,361 (29.3%)	48,077 (29.9%)	7535 (28.4%)
Slippery road	2,070,917 (19.1%)	28,616 (17.8%)	4265 (16.0%)
Interstate highway	1,102,761 (10.2%)	20,382 (12.7%)	3307 (12.4%)
Southern state	3,185,071 (29.4%)	82,634 (51.4%)	10,698 (40.2%)

Table 3

Characteristics of the study population with severe (incapacitating or fatal) injuries, by RUCC category.

Characteristic	RUCC*			
	1–3 *n* = 147,327	**4–5 *n* = 12,771**	**6–7 *n* = 21,373**	**8–9 *n* = 4,294**
Person				
Age				
0–14	6745 (4.6%)	652 (5.1%)	1093 (5.1%)	239 (5.6%)
15–39	87,248 (59.2%)	7631 (59.8%)	12,252 (57.3%)	2487 (57.9%)
40–64	40,095 (27.2%)	3327 (26.1%)	5877 (27.5%)	1199 (27.9%)
65–79	9302 (6.3%)	856 (6.7%)	1577 (7.4%)	270 (6.3%)
80+	3937 (2.7%)	305 (2.4%)	574 (2.7%)	99 (2.3%)
Male	78,427 (53.2%)	7.002 (54.8%)	11.709 (54.8%)	2436 (56.7%)
Driver	96,338 (65.4%)	7701 (60.3%)	13,231 (61.9%)	2577 (60.0%)
Front passenger	28,655 (19.5%)	2644 (20.7%)	4536 (21.2%)	891 (20.8%)
Rear passenger	18,087 (12.3%)	1831 (14.3%)	3114 (14.6%)	719 (16.7%)
Unbelted	34,917 (23.7%)	3751 (29.4%)	7666 (35.9%)	1702 (39.6%)
Ejected from vehicle	10,255 (7.0%)	1290 (10.1%)	2878 (13.5%)	583 (13.6%)
Vehicle/Crash				
Alcohol involved	22,800 (15.5%)	1665 (13.0%)	2654 (12.4%)	561 (13.1%)
High speed	42,447 (28.8%)	5812 (45.5%)	11,889 (55.6%)	2874 (66.9%)
Midnight to 6 AM	24,220 (16.4%)	1878 (14.7%)	2766 (12.9%)	515 (12.0%)
6 AM to noon	33,192 (22.5%)	2921 (22.9%)	4894 (22.9%)	1078 (25.1%)
Noon to 6 PM	51,374 (34.9%)	4581 (35.9%)	8159 (38.2%)	478 (33.3%)
6 PM to midnight	38,177 (25.9%)	3349 (26.2%)	5506 (25.8%)	1059 (24.7%)
>1 car collision	85,617 (58.1%)	6528 (51.1%)	9395 (44.0%)	841 (58.7%)
Poor visibility	43,440 (29.5%)	3753 (29.4%)	6382 (29.9%)	1450 (33.8%)
Slippery road	24,299 (16.5%)	2589 (20.3%)	4695 (22.0%)	1093 (25.5%)
Interstate highway	15,540 (10.6%)	2349 (18.4%)	4836 (22.6%)	825 (19.2%)
Southern state	76,382 (51.9%)	6099 (47.8%)	9737 (45.6%)	1114 (25.9%)
Outcome				
Died	19,647 (13.3%)	2058 (16.1%)	3914 (18.3%)	836 (19.5%)

Table 4

Multivariate logistic regression estimating the adjusted odds for death, the adjusted odds for severe (incapacitating or fatal) injury, and the adjusted odds for death given severe injury.

Covariate	Model 1 (*n* = 4,270,491) Overall death Adjusted OR (95% CI)*	Model 2 (*n* = 4,270,491) Overall severe injury Adjusted OR (95% CI)*	Model 3 (*n* = 102,550) Death given severe injury Adjusted OR (95% CI)*
RUCC			
1–3 urban	Referent	Referent	Referent
4–5 partly rural	1.19 (1.11–1.29)	1.04 (1.01–1.06)	1.09 (1.01–1.19)
6–7 rural	1.51 (1.43–1.59)	1.24 (1.22–1.27)	1.23 (1.16–1.31)
8–9 very rural	1.91 (1.73–2.11)	1.59 (1.53–1.66)	1.31 (1.18–1.46)
Person			
Age			
0–14	0.75 (0.68–0.84)	0.72 (0.70–0.75)	1.06 (0.94–1.19)
15–39	Referent	Referent	Referent
40–64	1.75 (1.67–1.84)	1.20 (1.18–1.21)	1.61 (1.53–1.69)
65–79	4.55 (4.25–4.87)	1.60 (1.56–1.64)	3.63 (3.37–3.92)
≥80	11.06 (10.17–12.04)	2.34 (2.26–2.44)	7.10 (6.45–7.82)
Male	1.09 (1.05–1.14)	0.76 (0.75–0.77)	1.33 (1.27–1.39)
Driver	Referent	Referent	Referent
Front passenger	1.07 (1.02–1.14)	1.16 (1.14–1.19)	1.01 (0.95–1.07)
Rear passenger	0.84 (0.78–0.89)	0.71 (0.69–0.73)	1.12 (1.05–1.21)
Unbelted	11.31 (10.80–11.86)	4.39 (4.31–4.46)	3.20 (3.05–3.36)
Ejected from vehicle	13.69 (12.98–14.44)	10.51 (10.17–10.87)	2.90 (2.74–3.07)
Vehicle/Crash			
Alcohol involved	3.10 (2.94–3.26)	1.92 (1.88–1.97)	2.10 (1.99–2.22)
High speed	2.93 (2.81–3.06)	2.01 (1.99–2.05)	1.72 (1.65–1.80)
Midnight to 6 AM	1.67 (1.57–1.77)	1.30 (1.27–1.33)	1.42 (1.33–1.52)
6 AM to noon	1.23 (1.17–1.30)	1.15 (1.13–1.17)	1.13 (0.07–1.20)
Noon to 6 PM	Referent	Referent	Referent
6 PM to midnight	1.16 (1.10–1.22)	1.06 (1.05–1.08)	1.12 (1.06–1.19)
>1 car collision	0.77 (0.74–0.81)	0.70 (0.69–0.71)	1.06 (1.01–1.11)
Poor visibility	1.14 (1.08–1.20)	1.15 (1.13–1.17)	0.99 (0.94–1.05)
Slippery road	0.82 (0.77–0.87)	0.80 (0.79–0.82)	1.00 (0.93–1.07)
Interstate highway	1.28 (1.21–1.35)	1.07 (1.05–1.09)	1.15 (1.09–1.22)
Southern state	1.75 (1.68–1.82)	2.42 (2.39–2.46)	0.91 (0.87–0.95)
Constant	0.000297	0.0109	0.0225

CI = confidence interval, RUCC = rural–urban continuum code.

*OR = odds ratio.