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Appalachian versus non-Appalachian US traffic fatalities, 2008-2010

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Abstract

Purpose—Though myriad health disparities exist in Appalachia, limited research has examined traffic fatalities in the region. This study compared traffic-fatality rates in Appalachia and the non-Appalachian US.

Methods—Fatality Analysis Reporting System and Census data from 2008-2010 were used to calculate traffic-fatality rates. Poisson models were used to estimate unadjusted (RR) and adjusted rate ratios (aRR), controlling for age, sex, and county-specific population density levels. *Results:* The Appalachian traffic-fatality rate was 45% (95% CI: 1.42, 1.47) higher than the non-Appalachian rate. Though only 29% of fatalities occur in rural counties in non-Appalachia versus 48% in Appalachia, rates in rural counties were similar (RR=0.97; 95% CI: 0.95, 1.00). However, the rate for urban, Appalachian counties was 42% (95% CI: 1.38, 1.45) higher than among urban, non-Appalachian counties. Appalachian rates were higher for passenger-vehicle drivers, motorcyclists, and all-terrain-vehicle riders, regardless of rurality, as well as for passenger-vehicle passengers overall and for urban counties. Conversely, Appalachia experienced lower rates among pedestrians and bicyclists, regardless of rurality.

Conclusions—Disparities in traffic fatality rates exist in Appalachia. Though elevated rates are partially explained by the proportion of residents living in rural settings, overall rates in urban Appalachia were consistently higher than in urban non-Appalachia.

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Contributors: MZ and JC originated and designed the study. MZ participated in data analysis, and led the writing. SZ conducted data analysis and drafted the methods and results sections. SK participated in literature review and article development. KG and JC critically reviewed and substantially revised the manuscript. MZ and JC had full access to all of the data (including statistical reports and tables) in the study and can take responsibility for the integrity of the data and the accuracy of the data analysis.

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Data sharing: No additional data available.

Keywords

Accidents; Appalachia; health disparities

Introduction

Home to 25 million people (8.2% of the US population), the Appalachian region is a 205,000- square-mile stretch along the Appalachian Mountains, including all of West Virginia and designated counties in Alabama, Georgia, Kentucky, Maryland, Mississippi, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, and Virginia (1). Twice as much of the population in Appalachia is rural compared to the US as a whole, and parts of the region are geographically isolated by mountains (1). The unemployment and poverty rates in the region are higher than the nation, and Appalachians often have limited education (2, 3). Appalachians also face myriad public health challenges, including disparities in chronic disease and injury (3, 4). Studies have reported increased rates of heart disease, cancer, mental illness, and substance abuse in the region (5-7). However, limited research has focused on disparities in motor vehicle crashes in Appalachia. Because of the topography and road conditions of Appalachia, we hypothesized that motor vehicle fatality rates would also be higher in the region compared to the US. Thus, the purpose of this study was to compare Appalachian and non-Appalachian traffic fatality rates.

Methods

Data Sources

Traffic fatality data were obtained from the Fatality Analysis Reporting System (FARS) for 2008-2010. FARS, maintained by the National Highway Traffic Safety Administration (NHTSA), is a census of US motor vehicle crashes that result in at least one fatality within 30 days of the crash (8). Data for each case included date of crash, county of crash, age, sex, vehicle type, and person type (passenger-vehicle driver, passenger-vehicle passenger, motorcyclist, all-terrain-vehicle (ATV) rider, pedestrian, or bicyclist). US Bureau of the Census estimates of the resident population by five-year age groups and sex for counties in 2008-2010 were utilized as denominators to calculate traffic fatality rates (9).

Classification of Geographic Region

The Appalachian region includes 420 counties and 8 independent cities in 13 states (10). Counties were categorized as being Appalachian or non-Appalachian (i.e., the rest of the US) according to the Appalachian Regional Commission's classification (10). Each county was further classified as rural or urban using the US Department of Agriculture's (USDA) 2003 urban influence codes (UIC) (11). These codes divide the 3,141 US counties, county equivalents, and independent cities into 12 groups (11). Urban counties were those assigned UIC codes 1 and 2, and rural counties were those assigned UIC codes 3 through 12 (11). The UIC data also included population density per square mile, and the counties were categorized into four categories (less than 10, 10-49.9, 50-249.9, and 250 or more persons per square mile).

Statistical Analysis

Age-adjusted traffic fatality rates for Appalachia and the non-Appalachian US were calculated and stratified by sex, age, and person type. Within each of these strata, rates were further stratified by urban-rural status. Rate ratios (RR) and 95% confidence intervals (CI) were also calculated, using the non-Appalachian US as the referent. Poisson regression was used to estimate adjusted rate ratios (aRR), controlling for age (five-year age groups), sex, and county-specific population density categories. All statistical analyses were conducted using SAS version 9.3 (12).

Results

Of the 104,191 traffic fatalities that occurred in the US in 2008-2010, about one-ninth (11,919) occurred in Appalachia (Table 1). The total traffic fatality rate per 100,000 residents was 15.8 for Appalachia and 10.9 for the rest of the US. The total traffic fatality rate was similar between rural counties in Appalachia and the rest of the rural US (about 21.0 per 100,000 residents), which was much higher than that in urban counties. Nearly half of traffic fatalities in Appalachia occurred in rural counties, while only 29% occurred in rural counties in non-Appalachia. The total traffic fatality rate for urban counties in Appalachia was 45% (95% CI 1.42, 1.47) higher than among non-Appalachian urban counties; whereas, the rates for rural counties were similar in the two regions (RR=0.97; 95% CI: 0.95, 1.00). The elevated traffic fatality rates in urban Appalachia were consistent across sex and age groups, compared to the rest of the US.

For passenger-vehicle drivers, the traffic fatality rate in Appalachia was 39% (95% CI 1.36, 1.43) higher than that in non-Appalachia after controlling for age, sex, and population density (Table 2). In subgroup analyses, the traffic fatality rate among passenger-vehicle drivers in urban, Appalachian counties was higher (aRR=1.48; 95% CI: 1.43, 1.53) than the rate among passenger-vehicle drivers in urban, non-Appalachian US counties; however, the relative differences in the Appalachian and non-Appalachian fatality rates for passenger-vehicle drivers was smaller (aRR=1.16; 95% CI: 1.12, 1.21) for rural counties. The traffic-fatality rate for drivers in rural counties was higher than those in urban counties, regardless of Appalachian status. Rural counties accounted for half of the driver deaths in Appalachia, but about a third of the driver deaths in the rest of the US.

For passenger-vehicle passengers, the traffic fatality rate in Appalachia was about 19% (95% CI: 1.14, 1.25) higher than for passengers in the rest of the US with a larger magnitude of effect found among urban counties (aRR=1.23 urban counties; aRR=1.03 rural counties). The traffic fatality rate for motorcyclists in Appalachia was 23% higher than that for motorcyclists in non-Appalachian US. The magnitude of the effect was larger for urban counties (aRR=1.28 urban counties; aRR=1.10 rural counties).

For ATV riders, the traffic fatality rates were also higher in Appalachian counties than in non-Appalachian counties, with similar magnitudes of effect for urban and rural counties (urban: aRR=2.32; 95% CI: 1.73, 3.11; rural: aRR=2.50; 95% CI: 2.04, 3.06). Conversely, the pedestrian fatality rates were lower in Appalachia than in the rest of the US, also regardless of urban-rural status (urban: aRR=0.72; 95% CI: 0.66, 0.79; rural: aRR=0.79;

95% CI: 0.69, 0.90). The bicyclist fatality rates were also lower in Appalachia than in the rest of the US, also regardless of urban-rural status (urban: aRR=0.49; 95% CI 0.37, 0.64; rural: aRR=0.34; 95% CI 0.23, 0.53).

Discussion

Appalachians had a higher total traffic-fatality rate compared to the rest of the US We uncovered two reasons to explain the difference. First, Appalachia had a higher proportion of rural residents than the rest of the US; rural residents had a much higher traffic fatality rate relative to urban residents regardless of Appalachian status. Rural counties accounted for half of traffic fatalities in Appalachia, but only one-third of traffic fatalities in the rest of the US. In 2009, 23% of the US population lived in rural areas; however, 57% of traffic fatalities occurred in rural areas (16). Secondly, the traffic fatality rate for urban Appalachian counties was higher than for urban counties in the rest of the US. This study is the first, to our knowledge, to calculate fatality rates by urban-rural status for Appalachia and the rest of the US and identify why Appalachians have elevated rates of traffic fatalities.

Comparison with previous studies

We found that the total traffic fatality rate was higher in Appalachia relative to the rest of the US, regardless of age or sex. Our findings are consistent with a previous study that reported a higher traffic fatality rate in Appalachia relative to the whole US using 1990-1997 data (13). Kearney et al reported that death rates from unintentional injury for white males were higher in Appalachian than in non-Appalachian Kentucky, and that the death rates for white females were similar between Appalachian and non-Appalachian Kentucky (14). The possible reasons for our difference for females include: a) Kearney's investigation involved Kentucky and we studied the entire Appalachian region; b) Kearney et al examined all unintentional injuries, and we focused on traffic injuries. Traffic injuries contributed to 53% of deaths in both Appalachian and non-Appalachian Kentucky (14); c) Kearney et al focused on whites and we combined all races.

In our study, the death rates were higher for passenger-vehicle drivers, passenger-vehicle passengers, and motorcyclists in Appalachia, compared with the rest of the US After controlling for age, sex, and population density, rates of fatality for Appalachia were consistently larger than for non-Appalachia, but the relative difference was larger for urban counties than for rural counties. Svenson et al reported that death rates from trauma were higher in Appalachian than in non-Appalachian Kentucky for children younger than 18 years of age (15). They further identified that the death rate for motor vehicle occupants (including both drivers and passengers) was higher in Appalachian than in non-Appalachian Kentucky.

All-terrain vehicle riders, pedestrians, and bicyclists

We found that the traffic fatality rate for ATV riders was higher in Appalachia regardless of urban-rural status. This may be due to that residents in Appalachia drive ATVs at a higher rate than residents in non-Appalachia US due to the popularity of ATVs in Appalachia.

In our study, the pedestrian fatality rate was about 25% lower in Appalachia compared to non-Appalachia regardless of urban-rural status. Residents in Appalachia might walk less than those in non-Appalachia. Limited sidewalks for pedestrians, and streets built solely for vehicles likely deter walking. Furthermore, the topography makes walking difficult. Svenson et al reported that death rates for pedestrians were similar for Appalachian and non-Appalachian Kentucky (15). The potential reasons for our differences for pedestrians include: a) The sample size for pedestrians was too small in Svenson's study to detect a difference; b) Svenson's study population focused on children and ours included all ages.

We found a 56% lower bicyclist fatality rate in Appalachia. We suspect that residents in Appalachia bike less than residents in the rest of the US due in part to the topography of Appalachia. Mountain terrain may affect bicycling more than walking, which may account for an even lower risk for bicyclist deaths than for pedestrian deaths in Appalachia compared to non-Appalachia. In addition, bicyclists in Appalachia may bike on trails for bicyclists only, and do not share the road as much as residents in the rest of the US.

Limitations

Our study has several limitations. Firstly, our analyses were based on the location of fatal crashes rather than the location of residence. Residents in Appalachian counties may be involved in fatal crashes while communing or travelling to non-Appalachian counties. Further analysis revealed that among fatally injured drivers who crashed in Appalachia, 90% resided in Appalachia, 8% resided in non-Appalachian counties in Appalachian states, and 2% resided in non-Appalachian states. Secondly, our classification of urban and rural areas was based on metropolitan classification of counties, which may not reflect the urban or rural environment of each crash location (17). Thirdly, our classification of urban-rural status was based on the USDA 2003 urban influence codes (11), which may not exactly reflect the 2008-2010 status. The UIC codes are expected to be updated in 2013. The US urban population increased modestly from 79% in 2000 to 80.7% in 2010 (9). Fourthly, our analysis considered Appalachian status, urban-rural status, population density, age, and sex, but fatal crashes originate from the interplay of environment, vehicle, driver, and involved persons such as pedestrians, and multiple factors are involved. Although we compared Appalachia with non-Appalachian US, we did not attempt a comprehensive investigation to examine the reasons why Appalachians had a higher traffic fatality rate. For example, we did not examine the mountain terrain and roadway issues such as road width, number of lanes, and the quality of roads. We did not have exposure to different modes of travel such as annual miles driven, walked, or bicycled. Behavioral factors such as seat belt use, helmet use, and alcohol use were not included. We did not control the prevalence of older passenger-vehicles without current safety features between Appalachia and non-Appalachian US. Differences in emergency medical response were not examined.

Conclusions

In summary, the overall rate of traffic fatality was higher in Appalachia than in non-Appalachia. The elevated traffic fatality rate in Appalachia was largely due to the higher proportion of rural residents in Appalachia and the higher fatality rate among urban

Appalachian counties, compared to the non-Appalachian US. Traffic fatality rates were higher for passenger-vehicle drivers and passengers, motorcyclists and ATV riders, but lower for pedestrians and bicyclists in Appalachia, compared to the non-Appalachian US.

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Abbreviations

aRR	adjusted rate ratio
ATV	all-terrain vehicle
CI	confidence interval
FARS	Fatality Analysis Reporting System
NHTSA	National Highway Traffic Safety Administration
RR	unadjusted rate ratio
SAS	Statistical Analysis Software
UIC	urban influence codes
US	United States
USDA	US Department of Agriculture

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Table 1

Incidence of traffic fatality for Non-Appalachian US and Appalachia, 2008-2010

		Non-Appalachian US		Appalachia		
		Number	**Rate/100,000**	**Number**	**Rate/100,000**	**Rate Ratio (95% CI)**
Total	total	92,272	10.92	11,919	15.79	**1.45 (1.42,1.47)**
	urban	65,668	9.12	6,158	12.92	**1.42 (1.38,1.45)**
	rural	26,603	21.30	5,761	20.71	0.97 (0.95,1.00)
Gender						
Male	total	65,049	15.66	8,373	22.60	**1.44 (1.41,1.48)**
	urban	46,603	13.21	4,307	18.50	**1.40 (1.36,1.45)**
	rural	18,445	29.53	4,066	29.54	1.00 (0.97,1.03)
Female	total	27,200	6.33	3,542	9.21	**1.45 (1.40,1.51)**
	ruban	19,048	5.19	1,850	7.59	**1.46 (1.39,1.53)**
	rural	8,152	13.05	1,692	12.03	**0.92 (0.88,0.97)**
Age (years)						
0-14	total	3,501	2.07	379	2.71	**1.31 (1.18,1.46)**
	urban	2,389	1.64	173	1.94	**1.18 (1.01,1.37)**
	rural	1,112	4.63	206	4.06	0.88 (0.76,1.02)
15-24	total	20,648	17.17	2,568	24.88	**1.45 (1.39,1.51)**
	urban	14,836	14.35	1,358	20.57	**1.43 (1.36,1.52)**
	rural	5,812	34.42	1,210	32.54	0.95 (0.89,1.01)
25-64	total	53,565	11.97	7,002	17.57	**1.47 (1.43,1.51)**
	urban	38,257	9.98	3,631	14.36	**1.44 (1.39,1.49)**
	rural	15,307	23.86	3,371	23.13	0.97 (0.93,1.01)
65+	total	14,397	13.39	1,952	17.27	**1.29 (1.23,1.35)**
	ruban	10,058	11.47	985	14.40	**1.26 (1.18,1.34)**
	rural	4,339	21.85	967	21.67	0.99 (0.93,1.06)

Note: Boldface indicates significant difference when compared with the rest of the US.

Table 2

Incidence of traffic fatality by person type and urban-rural status, Non-Appalachian US and Appalachia., 2008-2010

		Non-Appalachian US		Appalachia			
Person type	**Urban-rural status**	**Count**	**Rate/100,000**	**Count**	**Rate/100,000**	**Rate ratio (95% CI)**	**Adjusted rate ratio (95% CI)****
Passenger-vehicle driver*	total	44,164	6.54	6,687	10.88	**1.66 (1.62,1.71)**	**1.39 (1.36, 1.43)**
	urban	29,684	5.17	3,366	8.69	**1.68 (1.62,1.74)**	**1.48 (1.43, 1.53)**
	rural	14,480	14.35	3,321	14.59	1.02 (0.98,1.06)	**1.16 (1.12, 1.21)**
Passenger-vehicle passenger	total	17,955	2.13	2,222	2.94	**1.38 (1.33,1.45)**	**1.19 (1.14, 1.25)**
	urban	12,091	1.68	1,112	2.33	**1.39 (1.31,1.48)**	**1.23 (1.15, 1.31)**
	rural	5,864	4.69	1,110	3.99	**0.85 (0.80,0.91)**	1.03 (0.96, 1.10)
Motorcyclist*	total	11,847	1.75	1,448	2.36	**1.34 (1.27,1.42)**	**1.23 (1.17, 1.30)**
	urban	9,235	1.61	835	2.16	**1.34 (1.25,1.44)**	**1.28 (1.19, 1.37)**
	rural	2,612	2.59	613	2.69	1.04 (0.95,1.14)	**1.10 (1.01, 1.21)**
ATV riders	total	625	0.09	196	0.32	**3.45 (2.93,4.04)**	**2.82 (2.40, 3.31)**
	urban	292	0.05	52	0.13	**2.64 (1.97,3.55)**	**2.32 (1.73, 3.11)**
	rural	333	0.33	144	0.63	**1.92 (1.58,2.33)**	**2.50 (2.04, 3.06)**
Pedestrian	total	12,025	1.42	778	1.03	**0.72 (0.67,0.78)**	**0.73 (0.68, 0.79)**
	urban	10,449	1.45	500	1.05	**0.72 (0.66,0.79)**	**0.72 (0.66, 0.79)**
	rural	1,576	1.26	278	1.00	**0.79 (0.70,0.90)**	**0.79 (0.69, 0.90)**
Bicyclist	total	1,886	0.22	78	0.10	**0.46 (0.37,0.58)**	**0.44 (0.35, 0.55)**
	urban	1,599	0.22	54	0.11	**0.51 (0.39,0.67)**	**0.49 (0.37, 0.64)**
	rural	287	0.23	24	0.09	**0.38 (0.25,0.57)**	**0.34 (0.23, 0.53)**

Note: Boldface indicates significant difference when compared with the rest of the US

*The denominators are residents aged 15 years and over.

**Adjusted for age, sex, and population density.