Original Articles

Rural vs Urban Motor Vehicle Crash Death Rates: 20 Years of FARS Data

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Abstract

Objectives. Historically, motor vehicle crash (MVC)-related mortality is higher in rural areas than in urban areas. The authors evaluated whether the difference in rural and urban MVC deaths is persisting, and whether the frequency of patients being found dead at the scene, particularly in rural areas, is increasing. **Methods.** Fatal Accident Reporting System (FARS) data for 1977 through 1996 were reviewed. The authors determined the frequency with which crash deaths occurred, and calculated population-based and vehicle-miles-traveled-based crash death rates. They compared rates for urban and rural areas. **Results.** A total of 875,405 crash deaths were included in the analysis. Both population-based and vehicle-miles-traveled-based MVC deaths have decreased over the last 20 years, but rural rates remain significantly higher than urban rates. Dead-at-scene rates may be increasing, and the rural dead-at-scene rate is higher than the urban rate. **Conclusion.** While MVC death rates are declining, the rural MVC death rate is still higher than the urban rate. Although these data may indicate some positive movement in the area of MVC-related deaths, differences in the rural and urban rates and the number of patients found dead on-scene remain as issues that require attention. **Key words:** accidents; traffic; mortality; rural population; urban population; risk factors.

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Injury remains a leading cause of death among all Americans, and motor vehicle crashes (MVCs) are the largest single cause of injury-related death among younger Americans.[1–3] Mortality related to MVCs has consistently been shown to be higher in rural areas than in urban areas. This is true for national data,[4–7] for state-specific data,[1–3,7–12] for special populations,[10,11,13,14] and even in some other countries.[15–20]

In 1966, Congress passed the Highway Safety Act and established the National Highway Traffic Safety Administration (NHTSA) within the U.S. Department of Transportation. One of the administration's charges is to address MVC-related injury and death. The NHTSA maintains the Fatal Accident Reporting System (FARS), which contains data from fatal MVCs that occur in all 50 states and the District of Columbia. Historically, FARS data have confirmed that deaths from MVCs are more common in rural areas, and demonstrated that a certain percentage of victims will be found dead at the scene. A 1995 briefing to the NHTSA administrator suggested that the difference between rural and urban MVC deaths was persisting, and that the frequency with which patients were being found dead at the scene, particularly in rural areas, was increasing.[21] Based on these cursory findings, we decided to make a more in-depth analysis of the FARS data. We reviewed the data from FARS, U.S. Census Bureau statistics, and NHTSA highway statistics in order to address eight questions about MVC death rates.

Four of the study questions related to overall MVC death rates: 1) Is the rural MVC death rate higher than the urban rate? 2) Has the rural MVC death rate changed over the past 20 years? 3) Has the urban MVC death rate changed over the past 20 years? 4) Has the combined (rural and urban) MVC death rate changed over the past 20 years?

Four other study questions related specifically to patients being found dead at the scene: 1) Is the rural dead-at-scene rate higher than the urban dead-at-scene rate? 2) Has the rural dead-at-scene rate changed over the past 20 years? 3) Has the urban dead-at-scene rate changed over the past 20 years? 4) Has the combined (rural and urban) dead-at-scene rate changed over the past 20 years?

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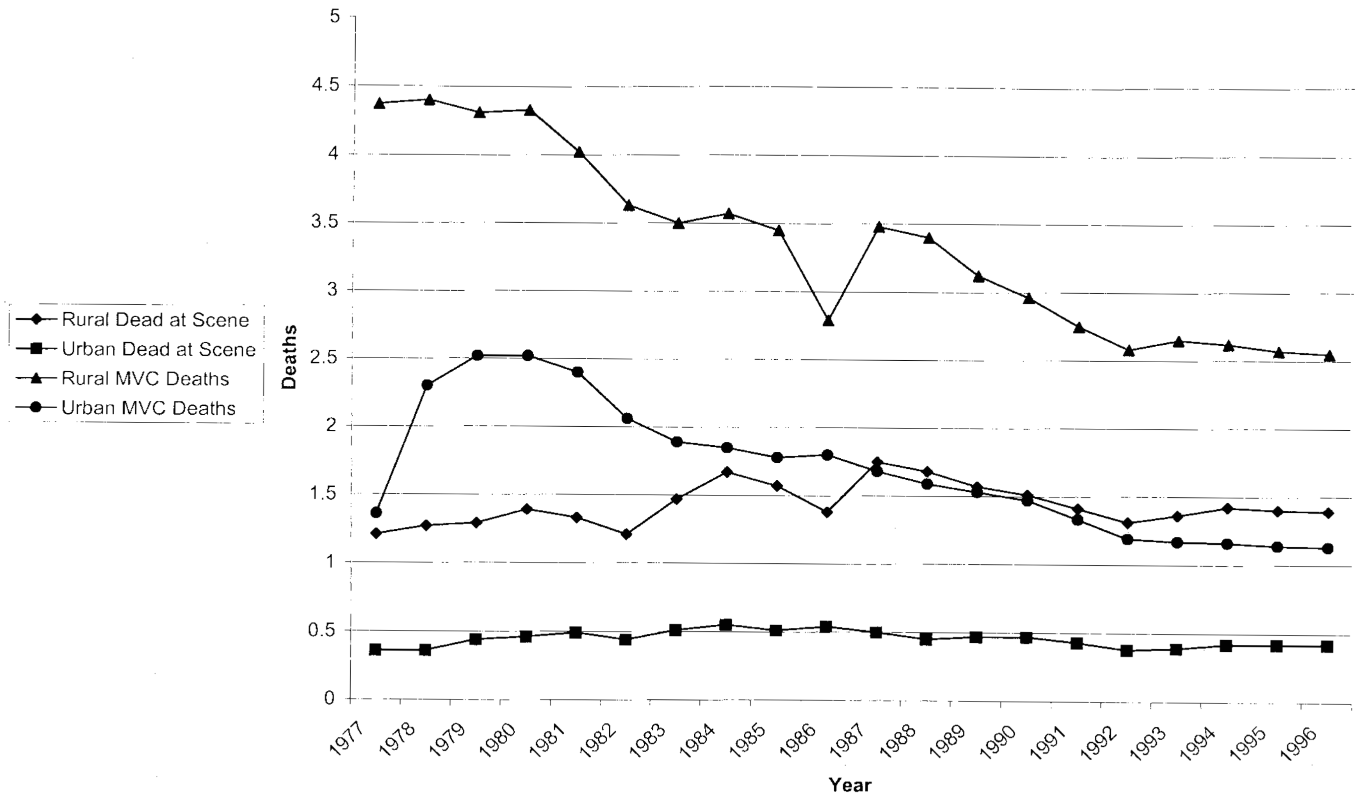

FIGURE 1. Motor vehicle crash (MVC) death rates per 100 million vehicle miles traveled (MVMT).

METHODS

Summary data from FARS were reviewed for the years 1977 through 1996. Data from FARS have been described elsewhere, and used in other studies of MVC mortality.[4,6,22] The summary reports the total number of crash deaths for each year, the number transported to a medical facility, the number not transported (dead at the scene), and the number for which transport or nontransport is unknown. The summary further divides these data for crashes occurring in urban, rural, and unknown areas. We excluded the data for those crash deaths in which location and transportation were unknown.

Data from the U.S. Census Bureau were used to determine the total population, and the percentage of the population living in rural and urban areas, for each year. The Census Bureau provides population estimates for each calendar year. The percentages of the population living in rural and urban areas are reported for each census year. We used the 1980 and 1990 census data to establish the proportion of the population living in rural and urban areas for those two years. The U.S. Census Bureau does not provide rural/urban population estimates for noncensus years. For the noncensus years, we assumed equal growth from year to year, and estimated the rural and urban populations based on that growth. From 1980 to 1990, the proportion of the population living in urban areas increased from 73.7% to 75.2%. This approximates a 0.15% increase in the urban population for each year.

Estimates of annual vehicle miles traveled were obtained from U.S. Department of Transportation/NHTSA Highway Statistic Summaries. These summaries list estimates of the number of vehicle miles traveled for each year from 1936 through 1996. Estimates for various types of vehicles, as well as for rural and urban roads, are included. The NHTSA estimates are published in units of million-vehicle-miles-traveled (MVMT). However, we converted those estimates into units of 100-million-vehicle-miles-traveled (100 MVMT), which is a more common denominator in the MVC literature.[4,23]

Based on these data, we calculated crash death rates in three forms: 1) population-based crash death rates, reported as deaths per 100,000 population; 2) vehicle-miles-traveled (VMT)-based crash death rates, reported as deaths per 100 MVMT; and 3) the frequency with which crash deaths occur. We compared the overall MVC death rates and the dead-at-scene rates for urban and rural areas, and we compared the rates for the first half of the 20-year period (1977–1986) with the rates for the second half (1987–1996). For the overall MVC death rates, we examined both population-based and VMT-based death rates. For dead-at-scene rates, we also examined the frequency with which victims were transported or declared dead at the scene.

Mean annual population-based and VMT-based

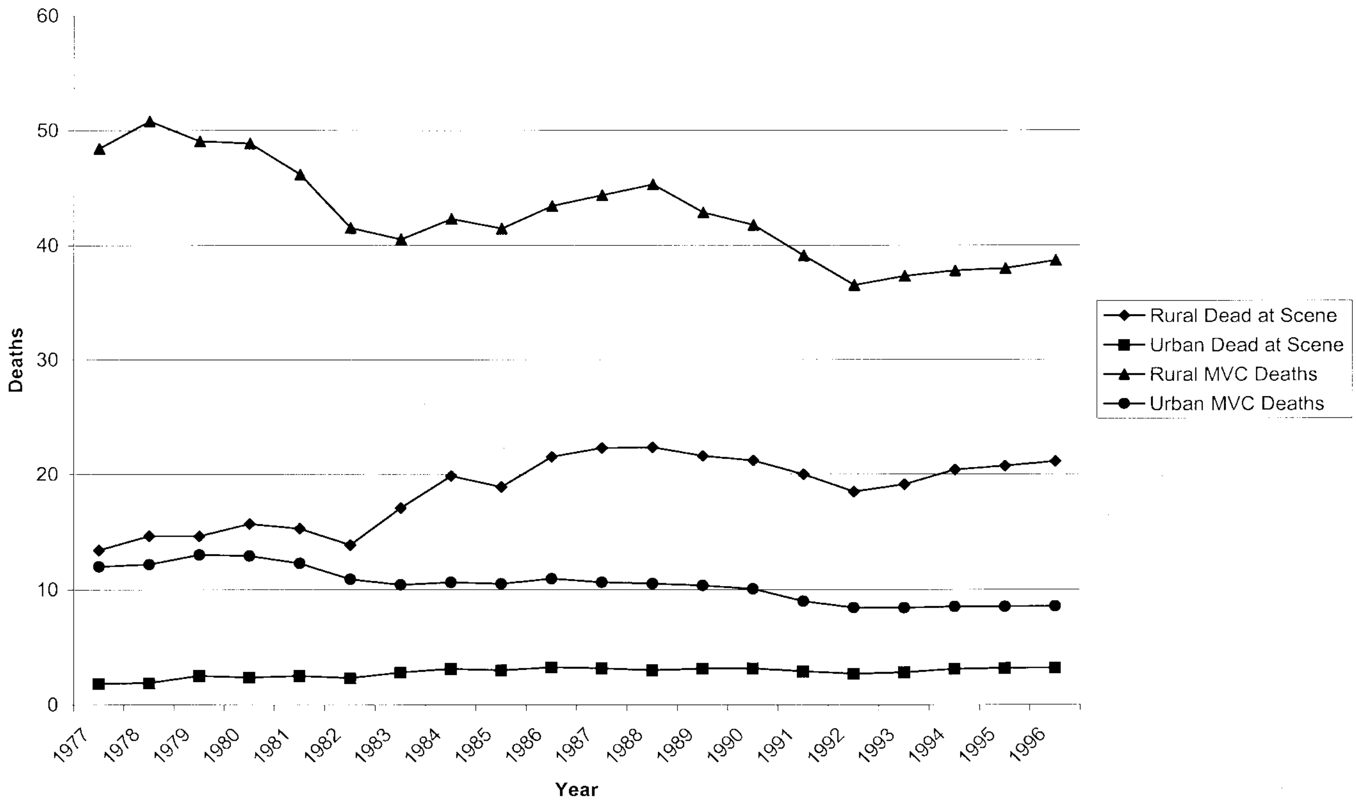

FIGURE 2. Motor vehicle crash (MVC) death rates per 100,000 population.

crash death rates were compared using a *t*-test. Frequencies were compared using chi-square. Odds ratios (ORs) and their approximate 95% confidence intervals (95% CIs) were calculated for the rural vs urban comparisons. All tests were two-tailed, and an alpha value of 0.05 was used to establish statistical significance. All statistical analyses were conducted using SAS statistical analysis software (SAS Institute, Cary, NC) or EPI-Info software (Centers for Disease Control and Prevention, Atlanta, GA).

This study was approved as an exempt study by the institutional review board.

RESULTS

During the 20-year period, there were 889,403 deaths reported in the FARS data. Of these, the location of the crash was not known for 4,400, and whether the patient was transported was not known for another 19,598. These 23,998 victims were excluded from the analysis. Of the 875,405 crash deaths included in the analysis, 366,895 (41.9%) occurred in urban areas, and 508,510 (58.1%) occurred in rural areas. There were 545,638 (62.3%) victims transported to a hospital, and 329,767 (37.7%) declared dead at the scene.

Figure 1 shows the rural and urban VMT-based death rates for the entire 20-year period. Figure 2 shows the rural and urban population-based death rates for the entire 20-year period.

Is the Rural MVC Death Rate Higher than the Urban Rate?

During the entire 20-year period, the mean VMT-based rural MVC death rate was 3.35 ± 0.66 per 100 MVMT, while the urban rate was 1.75 ± 0.49 per 100 MVMT ($p = 0.0001$; OR = 1.95, 95% CI: 1.61–2.35). The significant difference in VMT-based death rates was present in both the first ten-year period ($p < 0.0001$; OR = 1.82, 95% CI: 1.53–2.16) and the second ten-year period ($p < 0.0001$, OR = 2.18, 95% CI: 1.76–2.69).

The mean population-based rural MVC death rate for the entire 20-year period was 42.71 ± 4.30 per 100,000 population, while the urban rate was 10.43 ± 1.51 per 100,000 population ($p = 0.0001$; OR = 4.10, 95% CI: 3.83–4.39). The significant difference in population-based death rates was also present in both the first ten-year period ($p = 0.0001$; OR = 3.91, 95% CI: 3.67–4.18) and the second ten-year period ($p = 0.0001$; OR = 4.32, 95% CI: 4.02–4.65).

Has the Rural MVC Death Rate Changed over the Past 20 Years?

Between the first and second ten-year periods, the mean VMT-based rural MVC death rate decreased from 3.84 ± 0.54 per 100 MVMT to 2.87 ± 0.35 per 100 MVMT ($p = 0.0001$). The mean population-based rural MVC death rate decreased from 45.25 ± 3.83 per

TABLE 1. Motor Vehicle Crash (MVC) Death Rates

Years	Rural	Urban	Combined
All years (1977–1996)			
VMT-based*	3.35 ± 0.66	1.75 ± 0.49	2.55 ± 0.99
Population-based†	42.71 ± 4.30	10.43 ± 1.51	26.57 ± 16.65
First ten years (1977–1986)			
VMT-based	3.84 ± 0.54	2.15 ± 0.30	2.99 ± 0.96
Population-based	45.25 ± 3.83	11.57 ± 1.01	28.41 ± 17.49
Second ten years (1987–1996)			
VMT-based	2.87 ± 0.35	1.34 ± 0.21	2.10 ± 0.83
Population-based	40.16 ± 3.15	9.29 ± 0.96	24.73 ± 15.99

*VMT-based = deaths per 100 million vehicle miles traveled.
†Population-based = deaths per 100,000 population.

100,000 population to 40.16 ± 3.15 per 100,000 population ($p = 0.0045$).

Has the Urban MVC Death Rate Changed over the Past 20 Years?

Between the first and second ten-year periods, the mean VMT-based urban MVC death rate decreased from 2.15 ± 0.30 per 100 MVMT to 1.34 ± 0.21 per 100 MVMT ($p < 0.0001$). The mean population-based urban MVC death rate decreased from 11.57 ± 1.01 per 100,000 population to 9.29 ± 0.96 per 100,000 population ($p = 0.0001$).

Has the Combined (Rural and Urban) MVC Death Rate Changed over the Past 20 Years?

Between the first and second ten-year periods, the mean VMT-based MVC death rate decreased from 2.99 ± 0.96 per 100 MVMT to 2.10 ± 0.83 per 100 MVMT ($p = 0.0034$). The mean population-based combined MVC death rate decreased from 28.41 ± 17.49 per 100,000 to 24.73 ± 15.99 per 100,000 population, but that decrease was not statistically significant ($p = 0.4911$).

The data for the four questions relating to total death rates from MVC are shown in Table 1.

Is the Rural Dead-at-scene Rate Higher than the Urban Dead-at-scene Rate?

For the entire 20-year period, 44.9% of rural deaths occurred at the scene, while 27.7% of urban deaths occurred at the scene. Rural crash victims were significantly more likely than urban victims to be declared dead at the scene ($p < 0.0001$; OR = 2.12, 95% CI: 2.10–2.14). The significant difference in rural and urban dead-at-scene rates was present in both the first ten-year period ($p < 0.0001$; OR = 2.07, 95% CI: 2.04–2.10) and the second ten-year period ($p < 0.0001$; OR = 2.21, 95% CI: 2.18–2.24).

The mean VMT-based rural dead-at-scene rate for the entire 20-year period was 1.43 ± 0.15 deaths per 100 MVMT, while the urban rate was 0.45 ± 0.06 deaths per 100 MVMT ($p = 0.0001$; OR = 3.21, 05% CI: 2.27–4.56). The significant difference in VMT-based rural and urban dead-at-scene rates was present in both the first ten-year period ($p = 0.0001$; OR = 2.96, 95% CI: 2.10–4.19) and the second ten-year period ($p = 0.0001$; OR = 3.40, 95% CI: 2.40–4.83).

The mean population-based rural dead-at-scene rate for the entire 20 years was 18.3 ± 3.01 per 100,000 population, while the urban rate was 2.79 ± 0.44 per 100,00 population ($p = 0.0001$; OR = 6.56, 95% CI: 5.77–7.46). The significant difference in population-based rural and urban dead-at-scene rates was present in both the first ten-year period ($p = 0.0001$; OR = 6.49, 95% CI: 5.67–7.42) and the second ten-year period ($p = 0.0001$; OR = 6.82, 95% CI: 6.03–7.70).

Has the Rural Dead-at-scene Rate Changed over the Past 20 Years?

Between the first and second ten-year periods, the frequency of rural deaths occurring at the scene increased from 37.9% to 52.1% ($p < 0.0001$). The mean VMT-based rural dead-at-scene rate remained relatively constant: 1.38 ± 0.15 per 100 MVMT during the first ten years compared with 1.48 ± 0.14 per 100 MVMT during the second ten years ($p = 0.1582$). The mean population-based rural dead-at-scene rate increased from 16.48 ± 2.74 per 100,000 population to 20.72 ± 1.27 per 100,000 population ($p = 0.0007$).

Has the Urban Dead-at-scene Rate Changed over the Past 20 Years?

Between the first and second ten-year periods, the frequency of urban deaths occurring at the scene increased from 22.8% to 33.1% ($p < 0.0001$). The mean VMT-based urban dead-at-scene rate remained relatively constant: 0.47 ± 0.07 per 100 MVMT during the first ten-year period compared with 0.44 ± 0.04 per 100 MVMT during the second ten-year period ($p = 0.2363$). The mean population-based urban dead-at-scene rate increased from 2.54 ± 0.50 per 100,000 population to 3.04 ± 0.17 per 100,000 ($p = 0.0126$).

Has the Combined (Rural and Urban) Dead-at-scene Rate Changed over the Past 20 Years?

During the first ten-year period, 31.5% of all MVC-related deaths occurred at the scene. During the second ten-year period, 44.2% of all MVC-related deaths occurred at the scene. Deaths at the scene were more likely to occur in the second ten-year period than in the first ($p < 0.0001$). However, the VMT-based and population-based dead-at-scene rates for the combined data remained relatively constant. The mean VMT-based combined dead-at-scene rate was 0.86 ± 0.74 per 100 MVMT during the first ten-year period, compared with 0.85 ± 0.75 per 100 MVMT during the second ten-year period ($p = 0.7314$). The mean population-based combined dead-at-scene rate was 9.51 ± 7.40 per 100,000 population during the first ten-year period, compared with 11.88 ± 9.11 per 100,000 population during the second ten-year period ($p = 0.3727$).

The data for the four questions relating to dead-at-scene rates are shown in Table 2.

TABLE 2. Motor Vehicle Crash (MVC) Dead-At-scene Rates

Years	Rural	Urban	Combined
All years (1977–1996)			
Frequency	44.9%	27.7%	37.7%
VMT-based*	1.43 ± 0.15	0.45 ± 0.06	0.86 ± 0.09
Population-based†	18.30 ± 3.01	2.79 ± 0.44	10.70 ± 8.28
First ten years (1977–1986)			
Frequency	37.9%	22.8%	31.5%
VMT-based	1.38 ± 0.15	0.47 ± 0.07	0.86 ± 0.74
Population-based	16.48 ± 2.74	2.54 ± 0.50	9.51 ± 7.40
Second ten years (1987–1996)			
Frequency	52.1%	33.1%	44.2%
VMT-based	1.48 ± 0.14	0.44 ± 0.04	0.85 ± 0.75
Population-based	20.72 ± 1.27	3.04 ± 0.17	11.88 ± 9.11

*VMT-based = deaths per 100 million vehicle miles traveled.
†Population-based = deaths per 100,000 population.

DISCUSSION

There are two widely accepted methods for tracking MVC death rates, one based on population and one based on vehicle miles traveled.[2,4,10,12,17,23,24] The results from one method can often be confirmatory of results from the other. Sometimes, however, these two methods yield differing results, as seen in the current analysis.

For some of our questions, the data provide us with clear answers. While both the rural and urban MVC death rates are declining, the rural MVC death rate is higher than the urban rate, and that is consistently true over the 20 years of data. This finding is in keeping with the existing literature about rural death rates. A 1989 report from NHTSA indicated that 57% of all fatal crashes occurred in rural settings,[4] and others have estimated that number to be as high as 65%.[6] However, only about one-third of the vehicle miles traveled in the United States are on rural roads.[5] Indeed, the MVC fatality rate in rural areas could be as much as 60% higher than the urban rate.[7] Studies conducted at the state and local levels in Arkansas,[1] Nebraska,[2] Texas,[7] Washington,[8,11] New Mexico,[9] Nevada,[10] and Michigan[3] echo these findings. Rural crashes are also known to have a higher death rate among certain subgroups of the population, such as pregnant women,[9] children,[10] and Native Americans.[13,14]

The difference in rural and urban MVC death rates is not unique to the United States. The United Kingdom,[15] Australia,[16,17] Canada,[18] Taiwan,[19] and Japan[20] have all reported similar data. It is interesting, though, that the urban and rural MVC death rates in China are nearly identical (8.4 vs 8.6 per 100,000 population).[24]

Several authors have explored or hypothesized about the reasons for the differences in rural and urban MVC death rates. Rural crashes may be more severe than urban crashes, either as a result of increased speeds or poorer road conditions.[2,6,13,19] Raising the speed limit to 65 mph in rural areas may have contributed to the higher death rate.[22,23] However, some have questioned the association between increasing the speed limit and increasing crash deaths,[25] and at least one study found that, even after controlling for vehicle speed, pedestrians struck in rural areas are still twice as likely to die than those struck in urban areas.[8]

There are other possible factors. Discovery of the crash may be delayed in the rural setting, and notification of the EMS system may be hampered if one must travel some distance to find a telephone or emergency callbox.[2,5,6,26,27] Both response and transport times are prolonged in rural areas,[2,5,6,8,15,28] and prehospital care is often less sophisticated.[2,5–8,26,27,29] Hospital care can be a factor, too. Rural areas are less likely to have established trauma systems or trauma centers, and the medical professionals in rural areas are likely to have less experience in managing major trauma.[2,6,8,26]

The rural dead-at-scene rate is higher than the urban rate, and that, too, is consistently true over the 20 years of data. The reasons for the dead-at-scene rate's being greater in rural areas are less clear. Some of the reasons may parallel the reasons for the generally higher MVC death rate in rural areas. Perhaps some patients die as they await EMS, which is slowed by delayed access and prolonged response.[2,5,6,8,15,28] In the United Kingdom, physician members of the Mid-Anglia General Practitioner Accident Service (MAGPAS) began responding to crash scenes in 1972. Reports from this service indicate that physicians arrive at the crash scene before an ambulance 42% of the time, and that as many as 60% of severely injured patients require immediate attention to open their airways.[28,30] Preventable MVC deaths in rural areas have been associated with issues of discovery and response delays[7,8,31] and hospital care.[27,32,33] A South Carolina study indicated that prehospital advanced life support may be beneficial for rural multisystem trauma victims,[34] and the development of regionalized trauma systems is believed to improve trauma care in rural areas.[2,11,33,35] However, some question whether rural and urban preventable death rates truly differ.[3,6]

Another possible explanation for the difference in urban and rural dead-at-scene rates may be that EMS responders in urban areas, having short response and transport times, are more likely to attempt the resuscitation of trauma arrest patients. Thus, those patients are transported to the hospital before they are pronounced dead. Although one study has reported that resuscitation may be beneficial for rural multisystem trauma victims,[34] other authors studying preventable deaths have judged MVC patients undergoing prehospital cardiopulmonary resuscitation to have no potential for survival.[32]

For other questions, our data have produced contradictory results. Whether total MVC death rates have changed significantly depends on the denominator used to evaluate the data. The population-based combined (rural and urban) MVC death rates do not differ for the two ten-year periods, but the VMT-based rate is lower in the second ten-year period. The converse is true of the dead-at-scene rates. Both the raw numbers and population-based dead-at-scene rates have increased for both the rural and urban crashes, while the VMT-based dead-at-scene rates have remained effectively unchanged. Further, when analyzing the combined rural and urban data, only the frequency of dead-at-scene MVCs is significantly higher in the second ten-year period; both population-based and VMT-based rates remain essentially constant.

In these areas of conflicting data, there is no clear answer. Both of these methods for tracking death rates have inherent weaknesses. Population-based rates use the entire population. They do not take into account the number of people who actually drive a motor vehicle, nor the likelihood that people from urban areas often travel in rural areas, and vice-versa. Vehicle-miles-traveled-based rates do not consider population density, traffic congestion, highway speeds, and other important variables. The reader is cautioned to consider all of the data in their entirety. Neither of these two methods can be touted as the "best" measurement technique. The implications of our data depend largely on whether one views the glass as half-empty or half-full. Although some may be reassured by the decreasing MVC death rates, rural residents are still at higher risk than urban residents, dead-at-scene rates are higher in rural areas, and dead-at-scene rates may be increasing.

LIMITATIONS AND FUTURE STUDIES

Whichever denominator is used, the crash death data themselves may be confounded by many variables. Highway construction techniques and automobile designs have evolved over the 20 years for which we have data, as have EMS systems and medical care practices. Changes and differences in MVC death rates may be affected by these evolutions, and by differences in the extent to which they have penetrated rural and urban areas. Similarly, seat belt usage and air bags are much more common today than in 1977, and it is reasonable to expect that both have affected crash death rates. Law enforcement activities, public awareness campaigns (such as Mothers Against Drunk Driving), and the proliferation of cellular telephones are all variables that may affect crash death rates, and that may differ between rural and urban areas. Finally, the reporting of crashes and MVC-related deaths is likely to be more complete and more accurate today. Unfortunately, there is no reasonable way to control for all of these variables.

This study was further limited by its retrospective nature, and the dependence on various data sources for the death, population, and vehicle miles traveled data. As our data show, some of the results vary for the different denominators. There may be other denominators that would produce different results. Also, both the census and vehicle-miles-traveled data are government estimates, and may not accurately reflect the true values for these variables. For example, we had to estimate the percentage of the population living in urban and rural areas for all but two years of the data. The U.S. Census Bureau does not report the urban and rural populations for noncensus years, and there are no official estimates for those years. We chose to assume equal growth in the urban population from year to year. While it is unlikely that the growth was truly equal, it is even more unlikely that the percentage of the population living in urban areas remained constant throughout the 1980s, and then suddenly increased 1.5% in 1990.

Clearly, these are areas in need of further evaluation and intervention. The impact of seat belts, air bags, law enforcement, public awareness, road construction techniques, and automobile crash-worthiness on MVC crash deaths, and specifically on differences between rural and urban crash death rates, must be explored. Additionally, there are two new initiatives, automatic crash notification and location identification technology for cellular 911 calls, that are intended to reduce the discovery and response delays associated with rural crashes. These data support the need for exploring those technologies, as well.

CONCLUSION

Although the overall MVC death rate has decreased in both, significant differences remain in the death rates for urban and rural areas. The dead-at-scene rate may be increasing for both rural and urban crash victims, and the rural rate is significantly higher than the urban rate. Although these data may indicate some positive movement in the area of MVC-related deaths, differences in the rural and urban death rates and on-scene trauma care for critically injured victims remain as issues that require attention.

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