

# Acute Traumatic Injuries in Rural Populations

In the United States, injuries are the leading cause of death among individuals aged 1 to 45 years and the fourth leading cause of death overall. Rural populations exhibit disproportionately high injury mortality rates. Deaths resulting from motor vehicle crashes, traumatic occupational injuries, drowning, residential fires, and suicide all increase with increasing rurality.

We describe differences in rates and patterns of injury among rural and urban populations and discuss factors that contribute to these differences. (*Am J Public Health*. 2004;94:1689–1693)

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**TRAUMATIC INJURIES ARE A** major public health problem in the United States. Injuries are the leading cause of death among those aged 1 to 45 years and the fourth leading cause among individuals of all ages. They account for 29% of all years of potential life lost among individuals aged younger than 65 years, representing the largest percentage associated with any cause of death. Injuries create an annual economic burden of more than \$260 billion in the United States and are a leading contributor to disability and loss of quality of life.<sup>1</sup>

Rural populations have been shown to have disproportionately high injury mortality rates, and decreasing population density is the strongest predictor of county-specific trauma death rates in the United States.<sup>2,3</sup> Rural fatality rates are more than twice as high as urban rates in the case of a wide variety of injuries, including motor vehicle crashes, traumatic occupational injuries, drowning, unintentional firearm injuries, residential fires, electrocutions, and suicides.<sup>2,4,5</sup>

Rural and urban environments are very different, and many factors may be related to disparities in injury rates. In the sections to follow, we describe differences in rates and patterns of injuries among rural and urban populations and discuss some of the contributing factors.

## RURAL DISPARITIES IN INJURY RATES

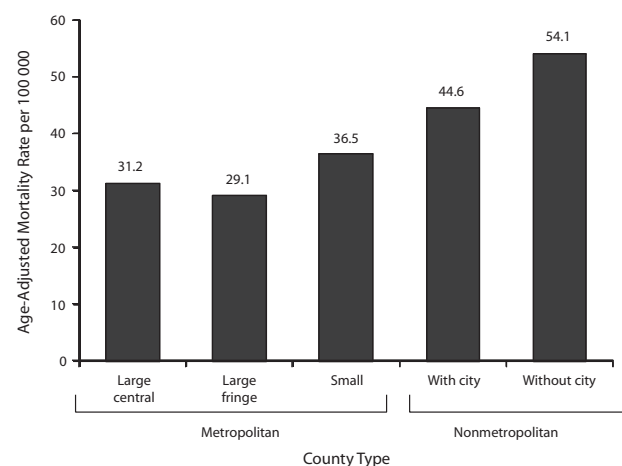
The National Center for Health Statistics published county-level

injury rates in the 2001 *Urban and Rural Health Chartbook*, in which counties were classified according to their urbanization level.<sup>2</sup> The unintentional injury mortality rate for the most rural counties was 54.1 per 100 000 population, a rate almost 2 times higher than that observed in large metropolitan counties. Among rural areas with a small city (population below 10 000), the rate was nearly 1.5 times higher (Figure 1).

The *Urban and Rural Health Chartbook* revealed similar trends in the case of suicide deaths (Figure 2). Relative to large fringe metropolitan counties, suicide death rates were 31% and 43% higher, respectively, in nonmetropolitan counties adjacent and not adjacent to small cities. Disparities were greatest among male residents of the western

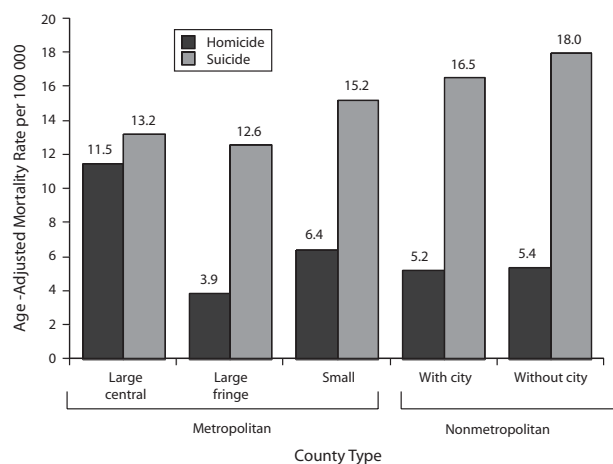
United States, whose suicide rate was 80% higher in rural areas than in metropolitan areas.<sup>2</sup> Homicide rates are highest in large metropolitan counties and are similar in smaller metropolitan and rural counties (Figure 2).

Much less has been documented about disparities in non-fatal injuries according to rurality. For example, national injury incidence rates from the National Health Interview Survey have not been published by rurality (M. Warner, National Center for Health Statistics, written communication, November 2003). Rural trends in violent victimization have been reported by the Bureau of Justice Statistics via the National Crime Victimization Survey. Data derived from this survey indicate that rural residents are less likely than urban or suburban residents to be vic-



Source. Data are adapted from *Urban and Rural Health Chartbook*.<sup>2</sup>

**FIGURE 1—Unintentional traumatic injury death rates, by urbanization level: United States, 1996–1998.**



Source. Data are adapted from *Urban and Rural Health Chartbook*.<sup>2</sup>

**FIGURE 2—Homicide and suicide death rates, by urbanization level: United States, 1996–1998.**

tims of violent crimes,<sup>6</sup> a finding consistent with results indicating lower homicide rates among rural populations.

However, although rates of both violent and property crime victimization decreased from 1993 to 1998, this decrease occurred at a greater rate in urban and suburban than in rural areas.<sup>6</sup> This trend could indicate that prevention programs designed for urban populations have not been applied or have not been effective in rural areas. In 1998, urban and suburban residents were more likely than rural residents to be victims of simple and aggravated assaults, although rape and sexual assault rates were similar in all areas.

Individual studies examining different types and mechanisms of nonfatal injury provide some information regarding rural disparities. An analysis of data from the Colorado Behavioral Risk Factor Surveillance System showed that the odds of a self-reported nonfatal injury were 30% higher among rural than among urban

residents.<sup>7</sup> In the case of rural residents living in remote areas, the odds increased to 64%. Traumatic brain injury rates were shown to be higher in rural than in urban populations.<sup>8</sup>

However, other studies that examined types of injuries, including overall fractures and hip fractures, showed rates to be lower in rural than in urban populations.<sup>9,10</sup> Studies have indicated that overall rates of serious firearm injuries are consistently higher in urban areas<sup>11,12</sup> but that unintentional firearm injury rates are higher among rural populations, perhaps driven by higher proportions of gun ownership.<sup>12</sup> At least one study has shown that safe storage of firearms in the home does not differ according to urban/rural status.<sup>13</sup>

In addition to limited knowledge about nonfatal injury incidence rates according to rurality, there is also limited information about variation within rural areas. For example, farmers are less likely to wear seat belts and use alcohol but more likely to

own a gun than rural townspeople, and these risk factors have been strongly tied to injury incidence rates.<sup>14</sup>

## RURAL DISPARITIES IN SELECTED TYPES OF INJURY

### Motor Vehicle Injuries

Much of the increase in rural injury death rates is related to motor vehicle crashes. According to the National Highway Traffic Safety Administration, rural fatal crashes account for 61% of all traffic fatalities but only 39% of vehicle miles traveled, and the rural–urban difference is increasing over time.<sup>15</sup> Crash-related mortality is inversely associated with population density and per capita income.<sup>16</sup> Analyses of motor vehicle crashes in several states have shown that fatality rates in the most rural counties are almost double those observed in urban counties.<sup>17,18</sup>

Many factors may contribute to the increased motor vehicle crash fatality rates observed in rural areas. For example, environmental factors may contribute to increased rates of crash occurrence both among rural residents and among urban residents driving on rural roads. Unlike interstate roads, rural highways are typically composed of 2 narrow lanes and do not have crash reduction features such as divided traffic streams, controlled vehicle entrances and exits, graded curves, skid-reducing surfaces, large lane and median widths, and lighted traffic signs.<sup>19,20</sup> In comparison with urban primary roads, rural roads have fewer traffic control devices, and speeds are often higher because of the presence of uninterrupted segments of roadway.

Certain types of crashes, such as those involving motor vehicle collisions with farm machinery, are unique to rural environments.<sup>21</sup> These crashes most frequently involve slow-moving tractors and are exacerbated by the high speeds at which vehicles often travel on rural roadways. In addition, other types of crashes, such as those involving all-terrain vehicles and snowmobiles, are more common in rural areas.

Environmental factors may also contribute to increased crash severity. Head-on collisions, which most frequently occur when traffic streams are not separated and which are the most likely of all crash types to cause fatality and severe injury, account for 17% of fatal rural crashes and 9% of fatal urban crashes.<sup>16</sup>

Behavioral factors also differ according to population density. Rural residents are less likely than urban residents to wear seat belts or to use child safety seats,<sup>14,22,23</sup> and they are more likely to consume alcohol.<sup>24</sup> In addition, enforcement of traffic safety laws, such as laws against drunk driving and speeding, may be limited in some rural areas because of the reduced density of traffic enforcement officials.

### Traumatic Occupational and Agricultural Injuries

Traumatic occupational fatality rates are higher among rural than urban populations. For example, in comparison with the national average, injury mortality rates in the construction industry are 40% higher in predominantly rural states.<sup>25</sup> Many of the most dangerous occupations are found in rural areas, most notably mining and agriculture.<sup>26–29</sup> In 2002, the mining industry had the highest occupational fatality

rate, 29.1 per 100 000 workers, followed by agriculture, at 21.0.<sup>30</sup> Mining workers suffered approximately 10 000 disabling injuries, and agricultural workers experienced approximately 150 000 such injuries.<sup>30</sup> Each year, approximately 10% of farmers are injured while working.<sup>31</sup>

Major initiatives established by the National Institute for Occupational Safety and Health have identified agricultural risks and potential approaches to prevention.<sup>32,33</sup> Research on agricultural injuries indicates that major injury risks are linked to working with animals and machinery, especially tractors.<sup>29,34–37</sup> Injuries are often multiple and severe, resulting in substantial disability, and compensation is less available for farm injuries than for non-farm-related occupational injuries.<sup>29,35,38–40</sup>

In addition to agricultural work, farms involve hazards for the entire family, because work areas and work tasks are so closely tied to living and play areas. Farm injury risks are similar among men and women when number of hours of exposure to farm tasks is controlled,<sup>41</sup> and children and elderly farm residents are at especially high risk for farm-related injuries.<sup>33,42–45</sup> Occupational hazards on farms, such as animals and machinery, pose risks to children whether they are working or playing.<sup>43,44</sup> In 2003, the National Children's Center for Agricultural Health and Safety led an effort to establish consensus development initiatives and generate work guidelines (work guidelines available at: <http://www.nagcat.org>) and play guidelines (play guidelines available at: <http://research.marshfieldclinic.org/children/safeplay.pdf>) to protect children from agricultural trauma.

### Residential Fire Injuries

Fires and burns are the seventh leading cause of overall injury deaths and the fourth leading cause of unintentional injury deaths in the United States.<sup>46</sup> In 1998, an estimated 381 500 residential structure fires resulted in 3250 nonfirefighter deaths, 17 175 injuries, and approximately \$4.4 billion in property loss.<sup>47</sup> Residential fires accounted for 74% of all structure fires, 81% of all fire-related deaths, and 74% of injuries resulting from fires.<sup>47</sup>

Fire death rates per capita are 36% higher in rural than in urban areas,<sup>48</sup> and there are many causes of this increased risk among rural inhabitants. Residential fires may be more common in rural homes because of older home construction and use of more risky heating sources. Heating is the leading cause (36%) of rural home fires,<sup>48</sup> followed by cooking (13%). In urban areas, the situation is reversed, with cooking the leading cause of home fires (25%) and heating the second leading cause (16%).

Residents of rural areas may be less likely to escape from a fire once it has started because of poor home fire protection. Smoke alarms reduce the risk of dying in a fire by half<sup>49,50</sup> and reduce the risk of having a reportable fire by three fourths.<sup>50</sup> However, 73% of rural home fires occur in homes without operational smoke detectors.<sup>48</sup> In the United States, the percentage of urban homes with smoke detectors is 92.9%, while the corresponding percentage of rural homes is 85.8%.<sup>51</sup> Furthermore, the percentage of homes that experience a fire and have a working smoke alarm is 41.8% in urban areas but only 20.8% in rural areas.<sup>52</sup> The isolation of rural homes may also cause delayed de-

tection and longer response times on the part of fire and emergency service personnel.<sup>48</sup>

### Emergency Medical Services and Trauma Care

Delay in receiving trauma care is one of the major factors contributing to risk of traumatic injury death in rural environments.<sup>53</sup> On average, trauma deaths occurring in rural environments involve less severe injuries than those occurring in urban environments, which indicates potentially preventable deaths.<sup>54</sup> Rural trauma victims are also more likely to be pronounced dead at the injury scene, which can be attributed to longer discovery and transport times.<sup>53,54</sup> Access to care and presence of personnel with advanced life support training who provide prehospital care are associated with lower death rates,<sup>55</sup> while higher trauma death rates in rural areas have been correlated with lower per capita numbers of board-certified surgeons.<sup>56</sup>

Challenges to trauma systems in rural areas include the longer distances required for emergency medical service personnel to reach injured individuals, the longer distances required to reach advanced trauma care facilities, the predominance of volunteer emergency medical service providers (who may be less likely to have undergone advanced training or to have equipment for advanced field life support), and, often, a lack of protocols for triage and transfer decisions.<sup>53,54</sup> The costs of expanding trauma services in rural areas are prohibitive because of sparse populations, and lack of local services results in rural trauma personnel facing different challenges than urban personnel.

For example, most studies of trauma care support the practice

of stabilizing severe injuries at a local hospital followed by transfer to a trauma hospital.<sup>57–61</sup> However, these studies have largely been conducted in urban areas. Delays in receiving definitive care owing to prolonged pretransfer stays in small community hospitals have been described,<sup>57,62</sup> and the findings of one trauma care study conducted in a rural area support direct transport of patients to the nearest trauma hospital.<sup>63</sup>

The development and adoption of organized trauma systems have had measurable effects in terms of reducing deaths and improving outcomes among trauma patients.<sup>64–68</sup> Trauma systems integrate decisions about field care, triage, and transport to allow provision of the necessary level of care with minimal delay. Trauma systems were developed and have been tested in mostly urban settings; much less is known about the need for and delivery of trauma care in rural settings.<sup>69</sup> Regional trauma systems that integrate wider geographic areas have been found to be most effective, but many systems include limited areas or only major trauma centers.<sup>70,71</sup> This is an especially important factor in regard to rural areas, most of which do not have trauma hospitals.

## DISCUSSION

Many factors are possible contributors to the increased mortality and injury incidence rates observed among rural populations. Some injury mechanisms may occur more frequently in rural than urban populations; for example, motor vehicle crashes may occur more frequently on rural roadways because of their design. Other

injury mechanisms may be present only in rural environments, an example being injury risks posed by agricultural work.

In addition to being more frequent, rural injuries may also be more severe. For example, one study of motor vehicle crashes showed that rural crash victims were twice as likely to die as their nonrural counterparts.<sup>18</sup> Behavioral data indicate that rural residents are less likely to engage in secondary prevention strategies that reduce injury severity, such as wearing seat belts or bicycle helmets or using child safety seats.<sup>14,23,72</sup> Moreover, prevention programs that provide safety equipment and programs that promote the use of such equipment (e.g., safety seat installation checks) may be less available in rural areas.

Inadequate access to emergency medical services may increase the likelihood of a fatal outcome among individuals injured in rural areas. As discussed earlier, problems involving access to such services probably represent one of the most important factors contributing to increased injury death rates among rural populations. Finally, lack of rehabilitation services in rural areas may hinder full recovery once an injury has occurred.<sup>73</sup> For example, it has been shown that patients in a rural setting with traumatic brain injuries are more likely to be functionally dependent and to report impaired health status than their urban counterparts.<sup>74</sup> Rural residents have limited access to psychological services as well, which might also hinder recovery from a traumatic event.

Several national prevention initiatives have been designed for urban populations. However, differences in rural and urban envi-

ronments suggest that prevention strategies developed for urban populations may not translate well to rural populations. For example, it is more challenging to establish designated driver programs intended to reduce drunk driving collisions in rural environments given the distances between homes. In addition, pool fencing legislation aimed at prevention of drowning is less applicable to rural areas where open bodies of water are more frequent sites for drowning. Safe walk-to-school programs are less applicable to rural households and communities because most rural children live far away from their schools and ride the bus.

Challenges for prevention in rural environments include sparse populations, greater geographic areas, different injury risks, isolation, increased behavioral risk factors, and lack of access to care. These factors probably contribute to the lack of rural injury prevention research. However, despite the challenges involved there is a clear need to identify differences in patterns of injuries and injury risks in rural and urban areas and to better translate and evaluate prevention and intervention programs in rural communities. ■

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