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Non-fatal injuries among urban and rural residents: The National Health Interview Survey, 1997–2001

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Objective: Although death rates from injuries are higher in rural areas compared with large metropolitan areas, little is known about how non-fatal injury rates vary by rurality. Data from the 1997–2001 US National Health Interview Surveys were used to explore associations between rurality and non-fatal injury.

Design: A nationally representative survey.

Methods: The annual injury rates per 1000 adults and 95% CIs were computed for medically attended injuries. Counties of residence were coded according to urban influence codes into four categories: large urban, small urban, suburban and rural. A linear-by-linear trend test was used to determine whether injury rates increase monotonically with county rurality. Logistic regression was used to control potential confounders.

Results: Compared with large urban counties, small urban counties experienced 8% higher injury odds (95% CI 1% to 15%); suburban counties 20% higher injury odds (95% CI 10% to 31%); and rural counties 30% higher injury odds (95% CI 17% to 43%) after adjusting for age, gender, marital status, education and health insurance.

Conclusions: Rural residents had higher non-fatal injury rates than urban and suburban residents. Exploring this discrepancy can further contribute to new hypotheses regarding rural injury risk and ultimately lead to better suited interventions for rural residents.

Fatal injuries represent only the top of the injury pyramid—a symbolic way to describe the burden of injury across severity levels. For each injury death in 2004, there were approximately 12 injury hospitalizations and 182 injuries treated in emergency rooms.[1]

Unintentional injury death rates are higher in rural than in urban areas.[2–3] National Center for Health Statistics (NCHS) data showed that in 2001 the most rural counties (those with no city of more than 10 000 people) had unintentional injury death rates twice as high as those in large metropolitan counties.[2] Although studies outside the US have found that non-fatal unintentional injury rates are higher in rural areas, little work of this nature has been performed within the US.[4–6] Several studies present data on specific types of injuries: occupational injuries[7]; injuries to children[8]; sports and recreation-related injuries[9]; or injuries to blue collar workers.[10] There are also several studies that examine rurality and injury mortality.[5 6 11] To our knowledge, the only study examining the association between rurality and overall injury morbidity used data from a single state.[12]

The National Health Interview Survey (NHIS) includes specific questions on medically attended non-fatal injuries. Revisions since 1997 have increased the scope and depth of NHIS injury data. This study explores the association between rurality and injury morbidity in adults, (aged ⩾18 years), using nationally representative data from 5 years of the NHIS.

METHODS

Population

The NHIS is an ongoing, nationally representative survey of the civilian, non-institutionalized population of the US, with data collected through a computer-assisted, face-to-face household interview. Interviewers are employed and trained by the US Bureau of the Census using procedures specified by the NCHS.[13] The NHIS collects detailed information on sociodemographics, health behaviors and health conditions for each family member. Data are collected from an adult representative of the family (aged ⩾18 years) for all injury and poisoning episodes in the previous 3 months for each person in the family.

In the 1997 redesigned NHIS, a greater emphasis was placed on estimating the number of injuries and poisonings.[14] Changes included more detail in the cause and circumstances of injury, an increase in the recall period for injury, and the inclusion of only those injury episodes that were medically attended.[13] County of residence was provided through collaboration between The University of Iowa Injury Prevention Research Center and the NCHS. The county of residence allows urban–rural classification that differentiates isolated rural areas from those with an urban influence.

In this study, we focus on all NHIS participants aged ⩾18 years. Poisonings were excluded from this analysis. To increase the precision of our estimates, we pooled 5 years of data from 1997 through 2001. The total number of households interviewed for the 5 years was 215 926,[13 15–17] the total number of adult respondents ⩾18 years was 500 699 and the average response rate for the 5-year period was 89.6%.[13 15–17]

Variable definitions

An injury episode in the current study refers to a medically attended event in which an adult was injured one or more times from an external cause.[13] Medically attended injury episodes were those events that led to contact with a healthcare professional, either in person for treatment or by telephone for advice.[13]

Urban and rural status was categorized according to Urban Influence Codes (UICs). Developed by the US Department of Agriculture in 1980, the UIC separates all US counties into nine classifications.[18] We combined metropolitan

Abbreviations: NCHS, National Center for Health Statistics; NHIS, National Health Interview Survey; UIC, Urban Influence Code

and non-metropolitan areas into four categories for analysis defined as follows: large urban = metropolitan area with at least 1 million residents (UIC code 1); small urban = metropolitan area with fewer than 1 million residents (UIC code 2); suburban = adjacent to either a large or a small metro area (UIC codes 3–6); and rural = not adjacent to a metro areas (UIC codes 7–9).

We assessed the following variables, found to be confounders in prior studies of rurality and injury, across the urban–rural categories: gender, age (18–29, 30–49, 50–64 and ⩾65 years), ethnicity, (Hispanic and non-Hispanic), family income (<$20 000 and ⩾$20 000), educational status (below high school, high school or some college, or college graduate), and health insurance status (any health insurance coverage such as private, US-sponsored health plan, public assistance, a state-sponsored health plan, other government programs, or a military health plan, and no healthcare coverage at the time of interview).

Analytic strategy

For the rate calculations in tables 1 and 2, the unit of analysis was an injury episode. An injured adult may have had multiple episodes. The estimates were weighted to represent the civilian, non-institutionalized population of the US with weights provided by NHIS. To obtain annual estimates, we calculated the number of injury episodes per 1000 adults per 3 months and multiplied this by four. To account for the complex sampling design, we used SUDAAN software for all analyses.[19] Injury episode rates and rate ratios (RRs) are presented for urban–rural status stratified by gender, ethnicity, income, education and health insurance. We calculated non-fatal injury episode rates per 1000 adults, 95% CIs, and RRs using large urban counties as the reference group. We tested the hypotheses that stratum-specific and overall non-fatal injury episode rates increase as areas become more rural, using a one-sided linear-by-linear test.[20 21] This test is an exact, non-parametric test that can be used to compare the null hypothesis that rates across groups are equal, with the alternative hypothesis that the rates increase monotonically.[20 21]

For the odds ratio (OR) calculations, we used a person-based logistic regression model to adjust estimates for potential confounders reported in the literature, including gender, age, marital status, health insurance coverage and education.

Because over 95% of those reporting injuries reported only one injury episode, we dichotomized our study population into those with one or more injury episodes in the last 3 months and those with no injury episodes during the same period. The logistic regression model compared the odds of having one or more injury episodes among rural residents with the odds of having one or more injury episodes among the residents of large urban counties, which was used as the reference comparison for other county categories.

RESULTS

Over the 5-year period, an estimated annual average of just under 21 million non-fatal injury episodes (weighted) were reported in the US, a rate of 105 per 1000 residents aged ⩾18 years (95% CI 102.3 to 107.7). Large urban counties had the lowest non-fatal injury rates (table 1). As counties became more rural, the non-fatal injury rates increased. Compared with large urban counties, injury rates were 8% (95% CI 5% to 10%) higher in small urban counties, 17% (95% CI 13% to 21%) higher in suburban counties and 26% (95% CI 22% to 31%) higher in rural counties. Using a linear-by-linear test, the trend of increasing injury episode rates from urban to rural counties was statistically significant (p = 0.001).

Table 2 reports the results of linear-by-linear tests of this trend for each of the urban/rural strata for six demographic variables. The trends by rurality were statistically significant at the 0.1 level for all of the strata within the six variables, except for those aged 50–64 years, those aged ⩾65 years and those with education <12 years.

Table 3 shows trends by the leading injury causes, places of occurrence, activities and types. Compared with large urban counties, rural counties had an increased risk for all four leading causes of non-fatal, unintentional injuries. However, there was no consistently increasing injury rate across levels of urban status. Of all injury characteristics, rural residents did not have increased risk for injury for only two: the injury location of street and the injury activity of driving. The highest rural risk occurred for the activity of working at home (RR = 1.84; 95% CI 1.82 to 1.87), and all injury characteristics associated with working showed increases among rural residents.

Table 4 presents the results of a logistic regression analysis. The table compares the crude ORs for having had one or more injury episodes over the last 3 months with the ORs adjusted for the potential confounders via logistic regression: gender, age, marital status, education and health insurance.[7] The point estimates of the adjusted ORs for counties of differing rurality are very similar to the crude ORs. There was no evidence of confounding by gender, age, marital status, education or health insurance. Finally, we note that the increased RRs based on injury episodes in table 1 were similar to the person-based ORs in table 4.

DISCUSSION

To our knowledge, this is the first study examining urban and rural differences in non-fatal injury rates using a nationally representative dataset. The NHIS provides high-quality data with a response rate of nearly 90%. Nationally, rural counties had an overall non-fatal injury rate that was 26% higher than that in large urban counties. The elevated non-fatal injury rates within rural communities persisted when adjusted for gender, age, marital status, education and health insurance. We believe that a 30% increase in the injury odds, controlling for confounders, shows a strong disparate risk to people in rural areas.

The association between rurality and unintentional injury morbidity parallels the established association between rurality and unintentional injury mortality. Increased injury death rates

Table 1 Injury episodes and rate comparisons by urban–rural status, National Health Interview Survey 1997–2001

	Adult population in thousands	Injury episodes in thousands	Rate per 1000 (95% CI)	Rate ratio(95% CI)
Large urban*	97 879	9637	98.5 (94.8 to 102.2)	1.0
Small urban	60 787	6442	106 (100.7 to 111.3)	1.08 (1.05 to 1.10)
Suburban	23 744	2740	115.4 (106.6 to 124.2)	1.17 (1.13 to 1.21)
Rural	17 132	2134	124.5 (113.3 to 135.7)	1.26 (1.22 to 1.31)
Totals	199 542	20 951	105 (102.3 to 107.7)	

*Significant contrast p values between large urban and small urban (p = 0.003), large urban and suburban (p = 0.005), large urban and rural (p = 0.006), small urban and suburban (p = 0.005), small urban and rural (p = 0.006) and suburban and rural (p = 0.007). Each contrast reflects the difference between the two rates. The test assesses whether the contrast is significantly different from zero.

Table 2 Average annual injury rates by urban–rural status and selected demographic variables

Demographics	Large urban injury rate (95% CI)	Small urban injury rate (95% CI)	Suburban injury rate (95% CI)	Rural injury rate (95% CI)	Linear-by-linear test for effect
Age (years)					
18–29	114.7 (105.3 to 124.1)	132.0 (119.1 to 144.9)	144.1 (125.3 to 162.9)	162.0 (140.2 to 183.8)	0.047
30–49	95.2 (90.1 to 100.3)	107.7 (99.7 to 115.7)	115.9 (104.7 to 127.1)	122.8 (109.9 to 135.7)	0.043
50–64	89.5 (81.1 to 97.9)	83.7 (75.5 to 91.9)	85.8 (68.7 to 102.9)	105.9 (87.3 to 124.5)	0.127
⩾65	94.6 (86.0 to 103.2)	94.0 (84.2 to 103.8)	116.0 (97.8 to 134.2)	105.5 (88.4 to 122.6)	0.121
Gender					
Male	105.7 (99.8 to 111.6)	120.4 (112.8 to 128)	133.7 (121.7 to 145.7)	140.5 (123.4 to 157.6)	0.043
Female	91.8 (87.1 to 96.5)	92.8 (86.1 to 99.5)	98.0 (86.4 to 109.6)	109.7 (96.6 to 122.8)	0.054
Ethnicity					
Non-hispanic	60.6 (55.1 to 66.1)	74.9 (65.5 to 84.3)	87.8 (62.5 to 113.1)	102.1 (66.0 to 138.2)	0.042
Hispanic	104.9 (100.8 to 109.0)	108.5 (102.8 to 114.2)	116.5 (107.5 to 125.5)	125.6 (114.0 to 137.2)	0.044
Income					
<$20 000	116.8 (107.4 to 126.2)	126.3 (117.1 to 135.5)	129.0 (98.2 to 146.8)	149.6 (132.0 to 167.2)	0.051
⩾$20 000	99.5 (95.0 to 104.0)	104.0 (97.9 to 110.1)	115.5 (104.7 to 126.3)	118.7 (106.5 to 130.9)	0.046
Education					
Below high school	98.3 (89.1 to 107.5)	99.9 (88.7 to 111.1)	104.0 (88.3 to 119.7)	99.4 (81.4 to 117.4)	0.253
High school or some college	104.6 (98.9 to 110.3)	116.1 (108.8 to 123.4)	119.7 (107.4 to 132.0)	139.2 (125.9 to 152.5)	0.048
College graduate	90.8 (84.5 to 97.1)	92.2 (84.4 to 100)	114.7 (100.4 to 129.0)	111.1 (95.0 to 127.2)	0.067
Health insurance					
No health insurance	79.5 (71.3 to 87.7)	102.8 (91.2 to 113)	114.4 (96.6 to 132.2)	123.8 (101.5 to 146.1)	0.046
Health insurance	102.8 (98.5 to 107.1)	107.1 (101.2 to 113)	116.3 (107.9 to 124.7)	124.9 (112.8 to 136.9)	0.043

in rural populations have been identified in several studies as summarized by Peek-Asa *et al*.[3] In 2001, the NCHS found the age-adjusted unintentional injury death rate increased as counties became less urban.[2] Baker *et al*,[22] using national mortality data from 1980–6, found rural areas to have higher unintentional injury death rates, which persisted when they controlled for income. Of the five US states with the highest overall injury death rates in 2001, three were rural states with fewer than 1 million citizens.[23 24]

Our findings are consistent with a recent study by Leff *et al*[12] that examined differences between urban and rural non-fatal injuries in Colorado. They found that the odds of a non-fatal injury among rural residents were 30% higher than those for urban residents after adjusting for age, gender and marital status (OR = 1.30, 95% CI 1.01 to 1.68). However, their study was carried out in a single state, and urban–rural status was limited to a dichotomous variable.

Reasons for these disparities in injury morbidity rates are not well understood. Although inadequate or poor access to emergency medical services has been offered as an explanation for the disproportionate injury mortality found in rural areas,[22] this explanation does not adequately explain the increase in injury morbidity. In fact, we would expect poor access to medical care to lower the rates for non-fatal, medically attended injuries in rural counties. However, we found non-fatal, medically attended injury rates to be elevated in rural counties, which suggest causal mechanisms beyond delayed care.

There are several possible explanations for these disparities in injury morbidity rates. First, adults in rural areas may have unique injury risks and behaviors that increase their chances for injury—for example, increased use of recreational vehicles and employment in high-risk occupations such as farming. Pediatric studies have suggested that the use of all-terrain

Table 3 Average annual non-fatal injury episode rates and rate ratios and 95% CI per 1000 by selected injury cause, place of occurrence, type of injury and activity when injured by urban–rural status: National Health Interview Survey 1997–2001

	Large urban	Small urban		Suburban		Rural	
Leading injury characteristics	Injury rate and 95% CI per 1000 persons	Injury rate and 95% CI per 1000 persons	RR compared with large urban (95% CI)	Injury rate and 95% CI per 1000 persons	RR compared with large urban (95% CI)	Injury rate and 95% CI per 1000 persons	RR compared with large urban (95% CI)
Injury cause							
transportation	4.0 (3.6 to 4.4)	4.6 (4.0 to 5.2)	1.15 (1.14 to 1.16)	3.8 (3.2 to 4.4)	0.95 (0.94 to 0.96)	4.4 (3.4 to 5.4)	1.10 (1.09 to 1.11)
Fall	7.5 (6.9 to 8.1)	7.6 (6.8 to 8.4)	1.01 (1.01 to 1.02)	9.1 (7.7 to 10.5)	1.21 (1.20 to 1.23)	9.1 (7.5 to 10.7)	1.21 (1.21 to 1.22)
overexertion	3.4 (3.0 to 3.8)	4 (3.4 to 4.6)	1.18 (1.17 to 1.19)	4.7 (3.9 to 5.5)	1.38 (1.37 to 1.40)	5.4 (4.4 to 6.4)	1.59 (1.58 to 1.60)
Struck by	3.3 (2.9 to 3.7)	3.3 (2.9 to 3.7)	1.0 (0.99 to 1.01)	3.6 (2.6 to 4.6)	1.09 (1.08 to 1.10)	3.9 (2.7 to 5.1)	1.18 (1.17 to 1.19)
Place of occurrence							
around home	8.9 (8.3 to 9.5)	10.8 (10.0 to 11.6)	1.21 (1.20 to 1.22)	13.5 (11.5 to 15.5)	1.52 (1.50 to 1.53)	12.9 (10.9 to 14.9)	1.45 (1.43 to 1.47)
Street	4.2 (3.8 to 4.6)	4.2 (3.6 to 4.8)	1.00 (0.99 to 1.01)	3.1 (2.5 to 3.7)	0.74 (0.73 to 0.75)	3.9 (2.9 to 4.9)	0.93 (0.92 to 0.94)
Work locations	7.9 (7.3 to 8.5)	9.1 (8.5 to 9.7)	1.15 (1.14 to 1.16)	10.6 (9.4 to 11.8)	1.34 (1.33 to 1.36)	11.6 (10.2 to 13.0)	1.47 (1.45 to 1.49)
Activity when injured							
Working at paid job	5.3 (4.7 to 5.9)	5.9 (5.3 to 6.5)	1.11 (1.10 to 1.12)	8.5 (7.3 to 9.7)	1.60 (1.59 to 1.62)	7.9 (6.5 to 9.3)	1.49 (1.47 to 1.51)
Driving/riding in MV	3.0 (2.6 to 3.4)	3.4 (2.8 to 4.0)	1.13 (1.12 to 1.14)*	2.4 (1.8 to 3.0)	0.80 (0.79 to 0.81)	3.0 (2.0 to 4.0)	1.00 (0.99 to 1.01)
Leisure activity	4.3 (3.9 to 4.7)	4.7 (4.1 to 5.3)	1.09 (1.08 to 1.10)	4.0 (3.0 to 5.0)	0.93 (0.92 to 0.94)	4.8 (3.6 to 6.0)	1.12 (1.10 to 1.13)
Working at home	3.2 (2.8 to 3.6)	4.1 (3.5 to 4.7)	1.28 (1.27 to 1.29)	5.7 (4.7 to 6.7)	1.78 (1.76 to 1.80)	5.9 (4.5 to 7.3)	1.84 (1.82 to 1.87)
Type of injury							
Fracture	4.3 (3.9 to 4.7)	4.2 (3.6 to 4.8)	0.98 (0.97 to 0.98)	5.4 (4.4 to 6.4)	1.26 (1.24 to 1.27)	4.8 (3.8 to 5.8)	1.12 (1.10 to 1.13)
Sprain	6.9 (6.3 to 7.5)	8.1 (7.3 to 8.9)	1.17 (1.16 to 1.18)	7.7 (6.5 to 8.9)	1.12 (1.10 to 1.13)	9.3 (7.9 to 10.7)	1.35 (1.33 to 1.36)
Wound	4.0 (3.6 to 4.4)	5.0 (4.4 to 5.6)	1.25 (1.24 to 1.26)	5.1 (4.3 to 5.9)	1.28 (1.26 to 1.29)	5.9 (4.7 to 7.1)	1.48 (1.46 to 1.49)

MV, motor vehicle.

Table 4 Crude and adjusted injury odds ratios from a person-based logistic regression analysis by urban–rural status and potential confounders

Risk factors for injury	Crude ORs for reported injury vs none	Adjusted ORs for reported injury vs none*
Population density		
Large urban	1.00	1.00
Small urban	1.08 (1.01 to 1.15)	1.08 (1.01 to 1.15)
Suburban	1.19 (1.09 to 1.30)	1.20 (1.10 to 1.31)
Rural	1.28 (1.16 to 1.42)	1.30 (1.17 to 1.43)
Gender		
Male	1.24 (1.18 to 1.30)	1.31 (1.24 to 1.38)
Female	1.00	1.00
Age (years)		
18–29	1.31 (1.21 to 1.42)	1.54 (1.40 to 1.70)
30–49	1.06 (0.99 to 1.13)	1.25 (1.16 to 1.34)
50–64	0.91 (0.84 to 0.98)	1.02 (0.94 to 1.10)
⩾65	1.00	1.00
Marital status		
Married	1.00	1.00
Separated, divorced, widowed	1.49 (1.40 to 1.58)	1.70 (1.59 to 1.81)
Never married	1.36 (1.28 to 1.45)	1.17 (1.09 to 1.26)
Education		
Less than high school	1.00	1.00
High school or some college	1.15 (1.07 to 1.22)	1.13 (1.05 to 1.20)
College graduate	0.96 (0.89 to 1.03)	0.99 (0.92 to 1.08)
Health insurance		
Health insurance	1.00	1.00
No health insurance	0.88 (0.82 to 0.94)	0.77 (0.72 to 0.83)

*Adjusted for variables shown.

vehicles and other such recreational vehicles in rural areas produce high injury rates.[25 26]

A recent study found rural residence to be a predictor for occupational injury even after controlling for other covariates, including job type.[27] Although farming and farm-related work are often associated with high occupational injury rates in rural areas, rural adults also hold jobs in other high-risk occupations such as mining, forestry and construction.[22] Also, farmers often hold part-time jobs, in addition to their farming responsibilities, which may increase their overall risk for an occupational injury. A study in Iowa showed that 22% of principal operators of Iowa farms had a second, non-agricultural job off the farm.[28]

Second, adults in rural areas may not use protective and safety devices such as bicycle helmets, seatbelts and smoke detectors as frequently as their urban counterparts. Rural bicycle helmet use has been shown to be considerably less frequent than urban helmet use across all ages.[29] A study in Oklahoma showed that rural drivers are less likely to use seat belts than urban drivers.[30] An annual observational survey of driver and child passenger restraint use in Iowa found that the percentage of children appropriately restrained was lower in rural communities compared with urban communities.[31] In communities of <2500 population in Iowa, 65% of children were restrained properly compared with 83% in communities with >50 000 population.[31] A national study of smoke alarm ownership showed that while 93% of urban homes had a smoke detector, only 85% of rural homes did have one.[32] These discrepancies could be due to decreased permeation of safety messages, fewer programs to promote and assist with safety devices, or less stringent enforcement.

The current study has several limitations. First, even though 5 years of data were combined for this analysis, sample sizes were small in rural areas. We calculated relative standard errors, and all were found to be within acceptable levels.

Second, since injury was defined as a medically attended event, which includes phone calls to medical professionals, our study may underestimate injury episode rates for adults with limited or no access to healthcare. Access to healthcare could potentially be related to distance to a medical facility, which may be related to rurality.

A third issue concerns medical care seeking behavior. For instance, rural self-reliance might cause a rural farmer to forego medical attention and self-treat at home.[33] Again, this potential bias would lead to fewer reports of injury in rural areas and would lead to lower injury episode rates in rural areas. Thus, this is not an explanation for increasing injury rates by rurality.

Fourth, the NHIS is based entirely on respondent-reported data without validation from medical records.[34] This raises the possibility of inconsistent reporting of injuries that occurred, although this inconsistency is not likely to vary with rurality.

Finally, 98% of NHIS-reported injuries from 1997 to 2001 were coded as unintentional. Thus, any comparisons must be made with only unintentional injury. Patterns are known to be different for homicide, where injury death rates are higher in urban than in non-urban areas.[22]

Although non-fatal injuries continue to burden both urban and rural residents, this study suggests that they occur at a higher rate in rural areas. Reasons why these differences by rurality exist are, as yet, not well understood. While inadequate or poor access to emergency medical services has been offered as an explanation of the disproportionate injury mortality found in rural areas,[22] this explanation does not adequately explain the similar increase in injury morbidity. If survival is differentially lower in rural areas, a decrease in non-fatal injuries could be expected. However, we found non-fatal rates to be elevated in rural counties. Future studies are needed to explore the possible causal mechanisms.

IMPLICATIONS FOR PREVENTION

We have presented several hypotheses regarding the increase in rural, non-fatal injuries, and exploring these questions in detail can further contribute to new hypotheses and, ultimately lead to better suited interventions for rural residents. At a minimum, this paper suggests that rural injury prevention interventions should not focus solely on reducing fatal injuries, but should also consider the most common causes of non-fatal injuries.

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