

PEDIATRICS®

OFFICIAL JOURNAL OF THE AMERICAN ACADEMY OF PEDIATRICS

Variation in Pediatric and Adolescent Firearm Mortality Rates in Rural and Urban US Counties

Michael L. Nance, Brendan G. Carr, Michael J. Kallan, Charles C. Branas and Douglas J. Wiebe

Pediatrics published online May 24, 2010;

DOI: 10.1542/peds.2009-3219

The online version of this article, along with updated information and services, is located on the World Wide Web at:

<http://www.pediatrics.org>

PEDIATRICS is the official journal of the American Academy of Pediatrics. A monthly publication, it has been published continuously since 1948. PEDIATRICS is owned, published, and trademarked by the American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, Illinois, 60007. Copyright © 2010 by the American Academy of Pediatrics. All rights reserved. Print ISSN: 0031-4005. Online ISSN: 1098-4275.

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN™



Variation in Pediatric and Adolescent Firearm Mortality Rates in Rural and Urban US Counties



WHAT'S KNOWN ON THIS SUBJECT: Firearm mortality rates in the adult population vary along a rural-urban continuum. Firearms represent a leading cause of death in the pediatric population.



WHAT THIS STUDY ADDS: This study documents that the risks of firearm-related death for children and adolescents in the United States are statistically indistinguishable between the most-rural counties and the most-urban counties.

abstract

OBJECTIVE: We examined whether firearm mortality rates among children varied across US counties along a rural-urban continuum.

METHODS: US vital statistics data were accessed for all pediatric (age: 0–19 years) firearm deaths from 1999 through 2006. Deaths were analyzed according to a modified rural-urban continuum code (based on population size and proximity to metropolitan areas) assigned to each county (3141 counties).

RESULTS: In the 8-year study period, there were 23 649 pediatric firearm deaths (15 190 homicides, 7082 suicides, and 1377 unintentional deaths). Pediatric nonfirearm mortality rates were significantly higher in the most-rural counties (adjusted rate ratio: 1.36 [95% confidence interval [CI]: 1.13–1.64]), compared with the most-urban counties. The most-rural counties demonstrated virtually identical pediatric firearm mortality rates (adjusted rate ratio: 0.91 [95% CI: 0.63–1.32]), compared with the most-urban counties. The most-rural counties had higher rates of pediatric firearm suicide (adjusted rate ratio: 2.01 [95% CI: 1.43–2.83]) and unintentional firearm death (adjusted rate ratio: 2.19 [95% CI: 1.27–3.77]), compared with the most-urban counties. Pediatric firearm homicides rates were significantly higher in the most-urban counties (adjusted rate ratio: 3.69 [95% CI: 2.00–6.80]), compared with the most-rural counties.

CONCLUSIONS: Children in the most-rural US counties had firearm mortality rates that were statistically indistinguishable from those for children in the most-urban counties. This finding reflects a greater homicide rate in urban counties counterbalanced by greater suicide and unintentional firearm death rates in rural counties. Nonfirearm mortality rates were significantly greater outside the most-urban US counties. *Pediatrics* 2010;125:1112–1118

AUTHORS: Michael L. Nance, MD,^a Brendan G. Carr, MD, MS,^{b,c} Michael J. Kallan, MS,^b Charles C. Branas, PhD,^b and Douglas J. Wiebe, PhD^b

^aDepartment of Surgery, Children's Hospital of Philadelphia, Philadelphia, Pennsylvania; and Departments of ^bBiostatistics and Epidemiology and ^cEmergency Medicine, School of Medicine, University of Pennsylvania, Philadelphia, Pennsylvania

KEY WORDS

pediatric, firearm, epidemiology, rural, fatality

ABBREVIATION

CI—confidence interval

www.pediatrics.org/cgi/doi/10.1542/peds.2009-3219

doi:10.1542/peds.2009-3219

Accepted for publication Feb 24, 2010

Address correspondence to Michael L. Nance, MD, Children's Hospital of Philadelphia, Department of Surgery, 34th Street and Civic Center Boulevard, Philadelphia, PA 19104-4227. E-mail: nance@email.chop.edu

PEDIATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275).

Copyright © 2010 by the American Academy of Pediatrics

FINANCIAL DISCLOSURE: *The authors have indicated they have no financial relationships relevant to this article to disclose.*

From 1999 through 2006, firearms claimed the lives of nearly 24 000 children and adolescents in the United States.¹ Research that focused on pediatric and adolescent populations found that firearm injury and mortality rates varied across large geographic units (eg, regions of the country) according to gender, race, firearm availability, and injury intent.^{2–5} Research in the adult population studied firearm mortality rates at the county level and, at this much-finer geographic unit of analysis, found that firearm mortality rates varied systematically according to a county's position along the rural-urban continuum.⁶ Similar county-level analyses have not been reported for US pediatric and adolescent populations.

The effectiveness of firearm injury prevention initiatives presumably should be related to the type of firearm injuries encountered. For example, a prevention program designed to decrease rates of firearm-related youth homicides in an urban setting likely would be less effective if applied in a community in which unintentional firearm-related injuries predominated. To design and to implement prevention strategies most effectively, such programs must be tailored specifically to the community situation for which the program is intended. Given the evidence of variability in firearm deaths along a rural-urban continuum among adults, the present study analyzed firearm mortality rates at the county level along a rural-urban continuum, to determine whether and to what extent variation existed in the pediatric and adolescent populations.

METHODS

Participants and Data Sources

We accessed multiple cause of death data files from the National Center for Health Statistics National Vital Statistics System from 1999 through 2006.

These data files are created through the uniform registration of death certificates at the state level. We included pediatric and adolescent decedents 0 to 19 years of age (19 years is the upper age of adolescence reported by the Centers for Disease Control and Prevention for injury surveillance).⁷ Among all US deaths, we analyzed suicides, homicides, and unintentional injury deaths on the basis of International Classification of Diseases, 10th Revision, external-cause codes V01 to X59, Y85 to Y86, W32 to W34, X60 to X84, Y87.0, X72 to X74, X85 to Y09, Y87.1, and X93 to X95. For our analyses, these deaths were separated into those involving firearms and those not involving firearms. Although we focused on firearm deaths, the comparative analysis of nonfirearm deaths was included as a reference for our findings on firearm deaths, as performed previously.⁴

We excluded injury deaths classified as having occurred through unspecified means or through late effects because they could not be categorized as either involving or not involving firearms. Finally, we excluded deaths attributable to police, on-duty military personnel, or judiciary executions. These legal intervention deaths, although intentional, were committed with motives distinct from those of the intentional injury deaths we analyzed. A total of 206 legal intervention firearm deaths and 348 firearm deaths of undetermined intent were excluded.

Each death was assigned to the US county in which the injury occurred. County assignments were based on Federal Information Processing Standards geographic codes and included suicides and homicides that occurred in counties with <100 000 persons, according to a special data request approved by the Division of Vital Statistics at the National Center for Health Statistics. We chose county of occur-

rence rather than county of residence because injuries may occur outside the home and we sought to understand the immediate context within which deaths occurred and not necessarily their residential context, which might or might not have been influential at the time of injury. Aside from states, counties (known as parishes, boroughs, and independent cities in some states) are the major, legally defined, political and administrative units in the United States.⁸ All 3141 US counties were included in our analysis. Because counties are primary governmental divisions, county boundaries and names rarely change.⁸ Our county list included the District of Columbia as a county equivalent. We also tracked and accounted for any county names or Federal Information Processing Standards codes that changed during the study period.

For each year of the 8-year study period, 8 main outcome variables were analyzed, namely, total unintentional firearm injury deaths, total intentional firearm injury deaths, firearm suicides, firearm homicides, total unintentional nonfirearm injury deaths, total intentional nonfirearm injury deaths, nonfirearm suicides, and nonfirearm homicides. In addition, an age-stratified analysis (ages of 0–4 years, 5–9 years, 10–14 years, or 15–19 years) was performed for firearm deaths according to intent (homicide, suicide, or unintentional) for the years 1999–2006 in aggregate.⁹ These variables were analyzed relative to a 10-category ordinal variable that was assigned to each county for each year of the study. This ordinal variable distinguished counties by considering both population size and proximity to metropolitan areas (Table 1). Therefore, it provided different information than simple categorization of counties on the basis of population size, land area, proximity to metropolitan areas, or

TABLE 1 Descriptions of Urban-Rural County Classification Codes (From 2000 Census)

County Code	Description	Proportion of US Counties, %	Proportion of US Population, %
0	Counties with ≥ 1 million population in metropolitan areas of ≥ 1 million population	1.1	25.3
1	Counties with < 1 million population in metropolitan areas of ≥ 1 million population	12.0	27.7
2	Counties in metropolitan areas of 250 000 to 1 million population	10.3	19.7
3	Counties in metropolitan areas of < 250 000 population	11.2	9.9
4	Urban population of ≥ 20 000, adjacent to metropolitan area	6.9	5.1
5	Urban population of ≥ 20 000, not adjacent to metropolitan area	3.3	2.0
6	Urban population of 2500 to 19 999, adjacent to metropolitan area	19.4	5.4
7	Urban population of 2500 to 19 999, not adjacent to metropolitan area	14.3	3.0
8	Completely rural or < 2500 urban population, adjacent to metropolitan area	7.5	0.9
9	Completely rural or < 2500 urban population, not adjacent to metropolitan area	13.8	1.0

population density, each as singular variables.

The 10-category, county classification variable that we used is equivalent to the widely recognized, 9-category, rural-urban continuum codes from the US Department of Agriculture except for the addition of a category of central counties of ≥ 1 million population.¹⁰ Metropolitan areas of > 1 million population often are composed of multiple counties but may contain 1 or 2 counties that are unusually distinct “nuclear” counties, surpassing the other counties in the metropolitan area in terms of population and possibly the risk of firearm-related deaths.^{11,12} Our 10-category, county classification code was used successfully as the independent variable of primary interest in previous analyses of intentional injury deaths.⁶

We also accounted for changes in several other, county-level, independent variables that were hypothesized to have affected the occurrence of injury-related deaths during the study period. These independent variables included county measures of the total population of 0- to 19-year-old youths,

average age, proportion of black individuals, proportion of Hispanic individuals, proportion of boys, per-capita income, proportion of the civilian labor force unemployed, proportion of households headed by women, proportion of persons > 16 years of age living alone, and proportion of persons > 18 years of age with college education. All independent variables were obtained from the US Census Bureau and the Area Resource File.¹³ With the exception of county measures of total population (estimates were measured annually, by using Census proportions of 0- to 19-year-old individuals in the overall county-level populations) and rural-urban county classification codes (taken from the 2003 classification), independent variables were taken from 2000 Census data.¹⁴

Statistical Analyses

Basic descriptive analyses of the outcome variables (described above) as both total counts per county and rates per 100 000 persons per county were completed. After those analyses, unadjusted comparative analyses of the outcome variables (both counts and

rates) relative to the urban-rural county classification codes were completed. SAS for Windows 9.2 (SAS Institute, Cary, NC) was used for all analyses.

We then tested the rural-urban county codes (as separate indicator variables for each code) along with the other independent variables as part of more-detailed multivariate regression analyses, by using a Poisson probability distribution model.¹⁵ Excessively collinear independent variables, determined on the basis of variance inflation factors equal to 10, were excluded from our final regression models.¹⁶ The logarithm of the population was treated as an offset term with a coefficient of 1, so that rate ratios could be calculated.

RESULTS

During the 8-year period of review, there were 136 665 pediatric and adolescent injury deaths in the United States, including 23 649 firearm-related deaths and 113 016 non-firearm-related deaths. Of the firearm-related deaths, 15 190 were homicides, 7082 were suicides, and 1377 were unintentional deaths. The majority of firearm deaths attributable to suicide (84.3%), homicide (86.7%), and unintentional causes (70.1%) occurred inside the decedent’s county of residence. The variability in firearm mortality rates according to age and intent is presented in Fig 1. The variation in age along the rural-urban continuum according to mechanism and intent is presented in Table 2. Table 2 shows that the median ages of children who died as a result of firearm injuries were concentrated at the older end of the age range (ie, ≥ 16 years of age) quite uniformly across the rural-urban continuum, with unintentional firearm-related death being one exception (eg, median age of 14 years in the most-rural counties). Homicides stood out among the deaths attributable to nonfirearm mechanisms, with median

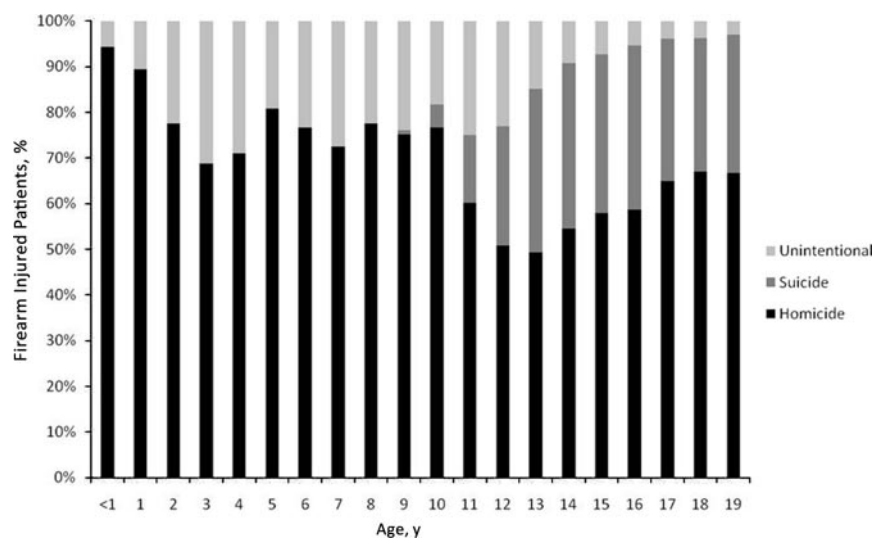


FIGURE 1
Proportions of firearm deaths according to intent and age of decedent.

ages being low (ie, 2–3 years) in most of the county groupings.

Figure 2 shows that, for the period from 1999 through 2006, the mortality

rates for firearm-related injuries demonstrated modest variability along the modified rural-urban continuum. There was no statistical difference in

firearm mortality rates in the most-rural counties (adjusted rate ratio: 0.91 [95% confidence interval [CI]: 0.63–1.32]), compared with the most-urban counties. However, the rates of child and adolescent deaths attributable to all methods of nonfirearm injuries were significantly higher in the most-rural counties (adjusted rate ratio: 1.37 [95% CI: 1.13–1.64]), compared with the most-urban counties.

Mortality rates varied along the rural-urban continuum according to injury intent. The more-rural counties experienced generally higher child and adolescent suicide rates through both firearm and nonfirearm means. Figure 3 shows that the rates of firearm and nonfirearm suicides were 2.01 times (95% CI: 1.43–2.83 times) and 1.89 times (95% CI: 1.35–2.65 times) higher, respectively, in the most-rural coun-

TABLE 2 Crude Mortality Rates and Median Ages for Decedents According to Rural-Urban Continuum Code and Mechanism/Intent of Injury

Mechanism and Intent	County Code									
	0	1	2	3	4	5	6	7	8	9
Firearm										
All										
Crude mortality rate, deaths per 100 000	4.64	3.52	3.18	2.98	2.51	3.20	2.85	3.16	3.08	4.04
Age, median, y	18	18	17	17	17	17	17	17	17	17
Intentional										
Crude mortality rate, deaths per 100 000	4.53	3.36	2.95	2.67	2.23	2.88	2.47	2.74	2.55	3.52
Age, median, y	18	18	18	17	17	18	17	18	17	17
Suicide										
Crude mortality rate, deaths per 100 000	0.70	0.86	1.17	1.48	1.34	1.69	1.61	1.94	1.62	2.75
Age, median, y	18	18	18	17	17	17	17	17	17	16
Homicide										
Crude mortality rate, deaths per 100 000	3.83	2.51	1.78	1.19	0.89	1.19	0.86	0.80	0.93	0.78
Age, median, y	18	18	18	18	17.5	18	17	17	17	15
Unintentional										
Crude mortality rate, deaths per 100 000	0.11	0.16	0.23	0.31	0.28	0.33	0.38	0.42	0.53	0.51
Age, median, y	16	16	16	16	15	15	15	14.5	13	14
Nonfirearm										
All										
Crude mortality rate, deaths per 100 000	13.03	14.21	19.04	21.22	20.17	21.23	24.90	25.69	26.58	28.66
Age, median, y	14	15	16	16	16	16	16	16	16	16
Intentional										
Crude mortality rate, deaths per 100 000	2.67	2.57	2.87	2.65	2.21	2.28	2.05	2.31	1.88	2.28
Age, median, y	15	15	15	15	16	16	16	16	16	17
Suicide										
Crude mortality rate, deaths per 100 000	1.00	1.11	1.34	1.32	1.26	1.18	1.11	1.47	1.33	1.72
Age, median, y	17	17	17	17	17	17	17	17	17	17
Homicide										
Crude mortality rate, deaths per 100 000	1.68	1.46	1.53	1.33	0.95	1.11	0.93	0.84	0.55	0.56
Age, median, y	3	3	2	3	9	2	6	2	8	13.5
Unintentional										
Crude mortality rate, deaths per 100 000	10.35	11.63	16.18	18.57	17.96	18.95	22.85	23.39	24.69	26.38
Age, median, y	14	16	16	16	16	16	16	16	16	16

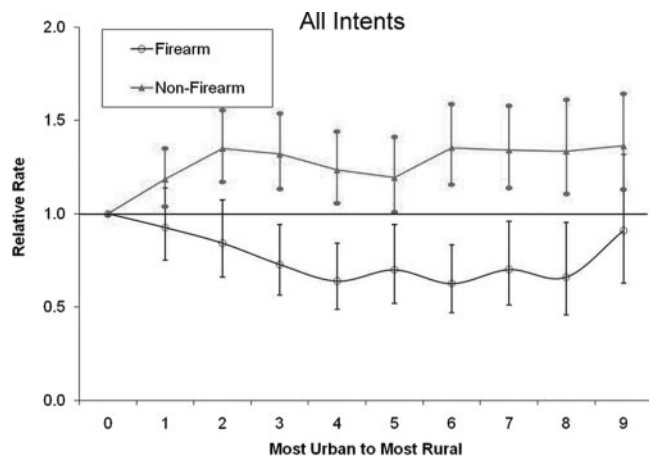


FIGURE 2

Adjusted relative rates and 95% CIs according to county type for all homicide, suicide, and unintentional pediatric deaths.

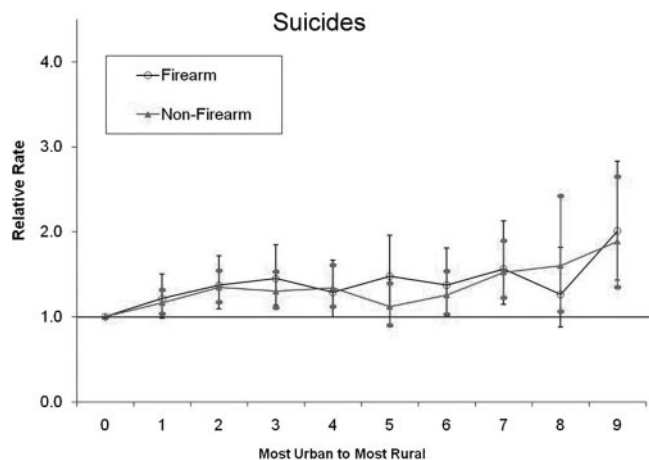


FIGURE 3

Adjusted relative rates and 95% CIs according to county type for suicides.

ties, compared with the most-urban counties, and rates varied along the continuum in a systematic (ie, monotonic) manner. The rates of homicides demonstrated the opposite trend, with firearm (adjusted rate ratio: 3.69 [95% CI: 2.00–6.80]) and nonfirearm (adjusted rate ratio: 2.35 [95% CI: 1.56–3.53]) homicide rates being significantly higher in the most-urban counties than in the most-rural counties (Fig 4). Relative rates of death attributable to unintentional causes are shown in Fig 5. Rates of unintentional deaths attributable to firearm (adjusted rate ratio: 2.19 [95% CI: 1.27–

3.77]) and nonfirearm (adjusted rate ratio: 1.37 [95% CI: 1.12–1.66]) causes followed parallel trends, were significantly higher in the more-rural counties than in the more-urban counties, and generally varied systematically along the rural-urban continuum.

Mortality rates also varied along the rural-urban continuum according to age group (0–4 years, 5–9 years, 10–14 years, or 15–19 years of age) (data not shown). For firearm homicide rates, there was systematic variation across the rural-urban continuum only for the 15- to 19-year-old age group, with the rates in the most-urban counties being >5 times higher (adjusted rate ratio: 5.57 [95% CI: 2.85–10.89]) than the rates in the most-rural counties. For the other age groups, the variation was not statistically significant.

During the 8-year study period, no children <5 years of age committed suicide and only 33 children between the ages of 5 and 9 years committed suicide (1 by firearm and 32 by nonfirearm means). Relative rates of death were not calculated for these age groups. Rates of suicide among 10- to 14-year-old youths were generally

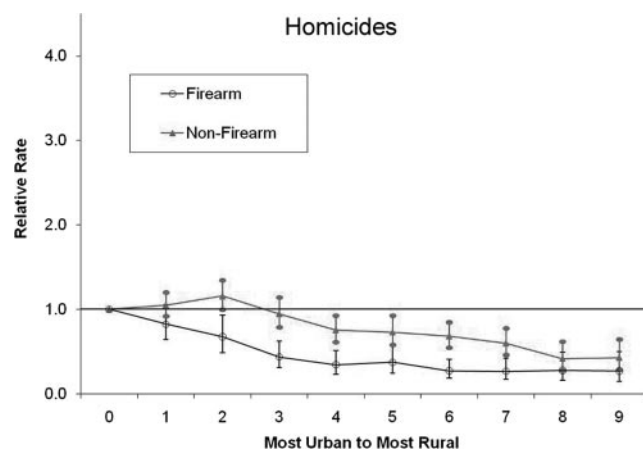


FIGURE 4

Adjusted relative rates and 95% CIs according to county type for homicides.

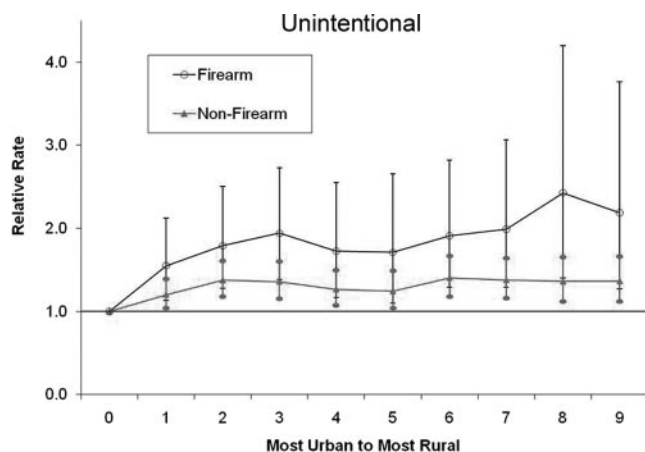


FIGURE 5
Adjusted relative rates and 95% CIs according to county type for unintentional deaths.

similar to rates of suicide among 15- to 19-year-old youths across the rural-urban continuum and, for each of these age groups, the rates of suicide in the most-rural counties were significantly higher than those in the most-urban counties (10–14 years of age, adjusted rate ratio: 2.58 [95% CI: 1.34–4.96]; 15–19 years of age, adjusted rate ratio: 1.94 [95% CI: 1.36–2.78]).

Rates of death resulting from firearm-related, unintentional injuries among both 5- to 9-year-old children (adjusted rate ratio: 3.77 [95% CI: 1.01–13.98]) and 10- to 14-year-old children (adjusted rate ratio: 4.24 [95% CI: 1.68–10.69]) were higher in the most-rural counties, compared with the most-urban counties. For the oldest group (15–19 years of age), rates of death did not vary significantly across the rural-urban continuum in a systematic manner. However, all other county types had slightly higher rates of death resulting from firearm-related, unintentional injuries, compared with the most-urban counties (ie, county classification codes 1 through 9 in comparison with code 0).

DISCUSSION

Controlling for a variety of social, demographic, and economic factors, we found that there was remarkably little

variation in firearm-related mortality rates across the entire rural-urban continuum for children and adolescents in the United States. That is, children in the most-rural US counties were as likely to die by means of firearms as were children in the most-urban US counties. Therefore, reduction of the death toll attributable to firearms among children and adolescents should be a priority for policymakers in all types of communities across the United States. These findings mirror the previously reported, rural-urban mortality rate variation for intentional firearm injuries in the US population as a whole and highlight the need for adult and pediatric firearm mortality rate reduction measures as a national (and not just urban) priority.⁶

There was significant variation in the intent associated with the firearm deaths across the rural-urban continuum, however. The urban counties experienced disproportionately high rates of firearm homicide, whereas the most-rural counties experienced disproportionately high rates of firearm suicide and unintentional firearm-related death. To affect these mortality burdens effectively, prevention strategies should be optimized for the type

of firearm injury problems existing within the community of interest. Although there is a national need to reduce pediatric firearm injury rates, specific counties should understand their own, distinctive profiles of firearm injury and death and should tailor their prevention activities according to their specific situations.

In comparisons of nonfirearm and firearm deaths according to intent, similar trends were noted across the rural-urban continuum for suicide and unintentional deaths, with rates of both increasing in more-rural counties. Firearm homicide rates by contrast were significantly greater than nonfirearm homicide rates as one moved from the more-rural counties to the more-urban counties. This suggests that in the child and adolescent population, for homicides occurring in more-urban counties or for suicides occurring in more-rural counties, the firearm is a potentially modifiable risk factor. This concept was supported by previous work that suggested that firearm prevalence predicted 47% of state-to-state variability in youth firearm mortality rates.¹⁷ The presence of a firearm in the home has been linked to higher rates of firearm suicide.^{18,19} In the pediatric and adolescent population specifically, gun storage practices have been correlated with higher risk of suicide and safe storage practices with lower risk of death.²⁰ In comparison, prevention efforts aimed at modifying the behavior of either adults or children have had limited success in reducing gun violence.²¹

Grouping the child and adolescent population according to age revealed differences in terms of firearm homicides. Specifically, homicide victims in the 10- to 14-year and 15- to 19-year age groups, but not those in younger age groups, demonstrated significantly higher firearm mortality rates in the most-urban re-

gions, compared with the most-rural regions. This finding is in agreement with overall national firearm mortality statistics that demonstrate one of the highest mortality burdens in the adolescent population.¹

We used county-level data rather than data aggregated at a higher level, and our analysis thus yielded a more geographically specific picture of pediatric firearm mortality rates in the United States than did previous studies. However, our findings have limitations. We used administrative death certificate data, and we recognize the potential for misclassification bias. The intent assigned was based on the final interpretation of the official certifying the death certificate. It is possible that cases of suicide were misclassified as unintentional death (or possibly homicide) and vice versa. Although

this might have occurred, a previous review of potential misclassification of suicides in the adolescent population found that “despite misclassification, the true direction of trends in adolescent suicide is reflected in recent official data.”²² We recognize that, despite our small units of geographical analysis, we are unable to represent the mortality risk faced by any single individual residing in a county of a given type. Although our results are less vulnerable to this type of ecologic bias than are those of studies using data aggregated into larger geographic units (such as states or regions of the United States), the aggregate nature of our data should not be overlooked in interpretations of the results for individuals.

These findings advance our understanding of firearm-related deaths

among children and adolescents in the United States. Firearm-related mortality rates vary systematically at the county level across the rural-urban continuum, with the nature and extent of that variability being dependent on injury intent. This information may be used to help direct injury prevention initiatives on the basis of county type. In this way, scarce prevention resources may be allocated to maximize their potential for one of the nation’s priority public health problems among its most vulnerable residents, children.

ACKNOWLEDGMENT

This study was supported through funds made available by the Josephine J. and John M. Templeton, Jr Endowed Chair in Pediatric Trauma at The Children’s Hospital of Philadelphia.

REFERENCES

- Centers for Disease Control and Prevention. WISQARS Injury Mortality Reports, 1999–2006. Available at: http://webappa.cdc.gov/sasweb/ncipc/mortrate10_sy.html. Accessed July 6, 2009
- Miller M, Azrael D, Hemenway D. Firearm availability and unintentional firearm deaths, suicide, and homicide among 5–14 year olds. *J Trauma*. 2002;52(2):267–275
- Fingerhut LA, Ingram DD, Feldman JJ. Firearm and non-firearm homicide among persons 15 through 19 years of age: differences by level of urbanization, United States, 1979 through 1989. *JAMA*. 1992; 267(22):3048–3053
- Fingerhut LA, Ingram DD, Feldman JJ. Homicide rates among US teenagers and young adults: differences by mechanism, level of urbanization, race and sex, 1987 through 1995. *JAMA*. 1998;280(5):423–427
- Nance ML, Denysenko L, Durbin DR, et al. The rural-urban continuum: variability in statewide serious pediatric and adolescent firearm injuries. *Arch Pediatr Adolesc Med*. 2002;156(8):781–785
- Branas CC, Nance ML, Elliott MR, et al. Urban-rural shifts in intentional firearm death: different causes, same results. *Am J Public Health*. 2004;94(10):1750–1755
- MacKay AP, Duran C. *Adolescent Health in the United States, 2007*. Hyattsville, MD: National Center for Health Statistics; 2007
- US Census Bureau. *Geographic Areas Reference Manual*. Washington, DC: US Census Bureau; 2001. Available at: www.census.gov/geo/www/garm.html. Accessed December 24, 2002
- Centers for Disease Control and Prevention. Recommended framework for presenting injury mortality data. *MMWR Recomm Rep*. 1997;46(RR-14):1–30
- US Department of Agriculture. Measuring rurality: rural-urban continuum codes. Available at: www.ers.usda.gov/Briefing/Rurality/RuralUrbCon. Accessed June 1, 2009
- US Census Bureau. Current Population Survey (CPS): definitions and explanations. Available at: www.census.gov/population/www/cps/cpsdef.html. Accessed June 1, 2009
- Sing RF, Branas CC, MacKenzie EJ, et al. Geographic variation in serious nonfatal firearm injuries in Pennsylvania. *J Trauma*. 1997;43(5):825–830
- Health Resources and Services Administration. Area Resource File. Available at: www.arfys.com. Accessed June 1, 2009
- Butler MA, Beale CL. *Rural-Urban Continuum Codes for Metro and Nonmetro Counties, 1993*. Washington, DC: US Department of Agriculture, Economic Research Service; 1994. Report AGES 9425
- Cameron AC, Trivedi PK. *Regression Analysis of Count Data*. New York, NY: Cambridge University Press; 1998. Econometric Society Monograph 30
- Gujarati DN. Multicollinearity. Chapter 10. In: Gujarati DN, ed. *Basic Econometrics*. 2nd ed. New York, NY: McGraw-Hill; 1988: 283–315
- Murnan J, Dake JA, Price JH. Association of selected risk factors with variation in child and adolescent firearm mortality by state. *J Sch Health*. 2004;74(8):335–340
- Miller M, Hemenway D, Azrael D. Firearms and suicide in the northeast. *J Trauma*. 2004;57(3):626–632
- Miller M, Azrael D, Hemenway D. Household firearm ownership and suicide rates in the United States. *Epidemiology*. 2002;13(5): 517–524
- Grossman DC, Mueller BA, Riedy C, et al. Gun storage practices and risk of youth suicide and unintentional firearm injuries. *JAMA*. 2005;293(6):707–714
- Hardy MS. Behavior-oriented approaches to reducing youth gun violence. *Future Child*. 2002;12(2):101–117
- Mohler B, Earls F. Trends in adolescent suicide: misclassification bias? *Am J Public Health*. 2001;91(1):150–153

Variation in Pediatric and Adolescent Firearm Mortality Rates in Rural and Urban US Counties

Michael L. Nance, Brendan G. Carr, Michael J. Kallan, Charles C. Branas and Douglas J. Wiebe

Pediatrics published online May 24, 2010;

DOI: 10.1542/peds.2009-3219

Updated Information & Services

including high-resolution figures, can be found at:
<http://www.pediatrics.org>

Permissions & Licensing

Information about reproducing this article in parts (figures, tables) or in its entirety can be found online at:
<http://www.pediatrics.org/misc/Permissions.shtml>

Reprints

Information about ordering reprints can be found online:
<http://www.pediatrics.org/misc/reprints.shtml>

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN™

