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All-Terrain Vehicle Injuries in Texas, Mapping the Path to Intervention with a Geographic Information System

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All-Terrain Vehicle Injuries in Texas, Mapping the Path to Intervention with a Geographic Information System

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ABSTRACT. The state of Texas was ranked 10th for all-terrain vehicle-related deaths among all states from 2007–2009. Health Service Region 4/5N of eastern Texas has a statistically significant higher rate of all-terrain vehicle-related injuries in children under the age of 18 than Texas as a whole ($p < 0.001$.) It is unknown why east Texas has a higher all-terrain vehicle-related injury rate. A retrospective analysis of the registry of the Texas Trauma Service Area G, which serves the east Texas area, from the years 2004–2010 was performed. Variations within the region were assessed using a geographic information system and the analysis demonstrated that the highest rates of all-terrain vehicle-related injuries in east Texas are found in two neighboring rural eastern counties. Recording mechanism of injury was an important adjunct to identifying all-terrain vehicle-related injuries. Using E-codes alone underestimated the actual injuries. Other findings demonstrated that children under age 16 had a high rate of injury, one third of those injured sustained a head injury, and helmet use was very low.

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This analysis can be used by the Texas Department of State Health Services in conjunction with key regional partners to direct further investigation in these areas into the role of the rural environment, other factors associated with the high injury rates, and to plan and conduct preventive intervention at the community level.

KEYWORDS. Adolescent, adult, agriculture, all-terrain vehicles, ATV, child, geographic information systems, off-road motor vehicles/statistics & numerical data, rural health, Texas, trauma centers/statistics & numerical data, wounds, injuries

INTRODUCTION

The Consumer Product Safety Commission (CPSC) defines an all-terrain vehicle (ATV) as an off-road, motorized vehicle with three or four low pressure tires, a straddle seat for the operator, and handlebars for steering control.¹ Annually, an average of 113 youth die from a farm-related injury with 19% of these involving motor vehicles including ATVs.²

The CPSC has been tracking ATV-related injuries and deaths since 1982 out of concern for the numbers of deaths and injuries originally associated with three-wheel ATVs. From January 1, 1982 through December 31, 2009 the CPSC has received reports of 10,281 ATV-related deaths, with a peak of 833 deaths occurring in 2006, the most recent year with complete data. It is also estimated, based on the CPSC's National Electronic Injury Surveillance System (NEISS), that from 2001–2009 a total of 1,186,800 injuries presenting to a hospital with an emergency department (ED) occurred with a statistically significant overall increase of 20% from 2001 to 2009 ($p = 0.0037$) and a statistically significant upward trend ($p = 0.0129$). For the years with complete data (1982–2006), Texas had the second highest number of total deaths at 424, second to California at 467. More recent data (2007–2009) shows that the state of Texas was ranked 10th for ATV-related deaths among all states.¹

Of all fatalities reported by the CPSC, 26% occurred in children younger than 16, and 43% of those occurred in children younger than 12. The injury rates for children are similar to the deaths with 46% of the estimated ED treated injuries in children occurring to those under the age of 12.¹ ATV owners have admitted to riding with passengers, with more than half

allowing children younger than 12 to ride or drive ATVs. Protective gear is used inconsistently, especially by youth, and youth admit to risky stunts and showing off. Half of these owners used their ATV for both work and recreation.³

In an analysis of Healthcare Cost and Utilization Project (HCUP) Nationwide Inpatient Sample, the overall hospital admission rate from ATV-related injuries was reported as 4.4 per 100,000. Eighty percent of the cases were male, 30% were under the age of 18, one fifth of the injuries involved the head, and nearly 1% died during their hospitalization.⁴ Unhelmeted riders have been shown to be significantly more likely to sustain traumatic brain injury ($p < 0.001$) and are significantly more likely to die while in the hospital ($p < 0.001$).⁵ The CPSC has also reported that helmets reduce deaths by 42% and nonfatal head injuries by 64%.⁶ It has also been shown that 238 head injuries, including two fatalities per 100,000 drivers, could be prevented with helmet use.⁷

The National Institute for Occupational Safety and Health (NIOSH) recognizes that the farm environment is hazardous to youth not only while working but by merely residing on a farm.⁸ It has been previously demonstrated that 50% of farms have an ATV.⁹ In a survey administered at a National Future Farmers of America (FFA) convention, it was reported that the median age for first riding an ATV was 9 and only 24% always wore a helmet.¹⁰ A survey of students in agricultural education programs demonstrated that a significantly higher percentage of farm youth rode ATVs than those that did not live on a farm (74% versus 41%, $OR = 4.04$, 95% CI, 2.90–5.64), that two thirds of the ATV users were farm youth, and of those

who worked on a farm, 1 in 4 used the ATV for work.¹¹ In an analysis of the 2001 Childhood Agricultural Injury Survey, a farm survey conducted by NIOSH and the U.S. Department of Agriculture, it was reported that 36% of youths living on farms had operated an ATV and youths younger than 16 were more likely to have used an ATV than a tractor.¹² It was also demonstrated that injuries to farm youth related to ATVs had increased when compared to 1998.¹³ A prior study in central Texas conducted using trauma registry data from a Level 1 Comprehensive Trauma center described that 20% of injuries occurring to children on a farm were ATV-related.¹⁴

BACKGROUND

The state of Texas is divided into eight public health service regions, each with a regional office. Texas Department of State Health Services (DSHS) Region 4/5N services 35 counties of East Texas, and is larger than 10 states in population and geography¹⁵ (Figure 1). The region currently comprises 5.9% of the total Texas population and is 68.9% white, non-Hispanic.¹⁶

The Center for Health Statistics at DSHS collects information from a discharge database of state licensed hospitals related to cases where a patient stayed in a facility for more than 24 hours. The Environmental Epidemiology and Disease Registries Section of DSHS

provided aggregate data from this database using ATV-related ICD-9CM E-Codes E821.0, E821.1, E821.8, or E821.9 to identify ATV-related cases in children under the age of 18 recorded in this database during the years 2004–2009.¹⁷ Data from 2010 was not yet available at the time of this study.

In the State of Texas hospital discharge database from 2004–2009, 1442 children under the age of 18 were identified as suffering an ATV-related injury; 210 of these children (14.6%) were from DSHS Region 4/5N. However, on average, during the same time period, the region comprised only 5.5% of the total Texas population.¹⁸ The data demonstrate that there is a statistically significant disproportionate injury rate to children in DSHS Region 4/5N (10.0 per 100,000, average annual incidence rate) when compared to the State of Texas as a whole (3.8 per 100,000 average annual incidence, $p < 0.001$, X^2).

In response to the high numbers of ATV-related injuries to children occurring in DSHS Region 4/5N (Region 4/5N), investigation was initiated through the Region 4/5N Maternal and Child Health Program in conjunction with regional partners including The Southwest Center for Pediatric Environmental Health; The Southwest Center for Agricultural Health, Injury Prevention, and Education; Texas Area Health Education Center, East Northeast Region; and East Texas Medical Center. The goal of this partnership is to reduce ATV-related injuries to youth in the region by assessing and describing regional ATV-related injury and death rates, and using this analysis to assist with identifying pilot areas to target for further investigation of associated factors to plan the implementation of evidence-based interventions.

The State of Texas is also divided into 22 trauma service areas (TSAs), identified alphabetically, each with a Regional Advisory Council (RAC) for the purpose of improving trauma care.¹⁹ Region 4/5N spans four TSAs (F, G, H, and R), but the majority of the counties within the region are in TSA-G (18 of 35, 51.4%) as well as the majority of the Region 4/5N population (60.6%). Like the remainder of Region 4/5N, the population of TSA-G is 68.6%

FIGURE 1. Location of Texas Department of State Health Services, Health Service Region 4/5N within the State of Texas.

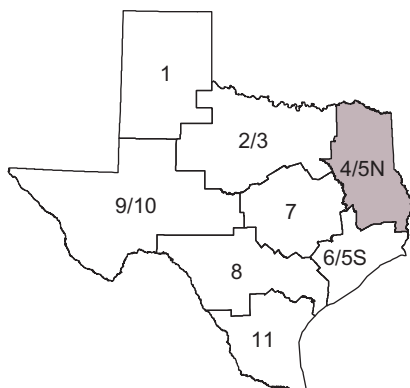
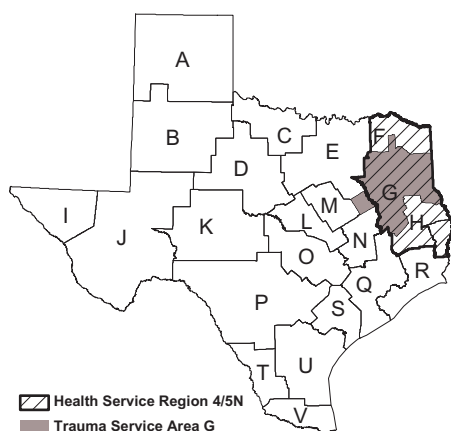


FIGURE 2. Location of Texas Trauma Service Area G relative to Texas Department of State Health Services Health Service Region 4/5N.



white non-Hispanic¹⁶ (Figure 2). There are currently 17 designated Level 1 Comprehensive Trauma facilities in the State of Texas; Region 4/5N contains only one facility, which is located in TSA-G. TSA-G also encompasses the only Level 2 Major Trauma Centers of Region 4/5N.^{19, 20}

Chapter 157 of the Texas Administrative Code and Chapter 29 of the Texas Health and Safety Code require designated trauma facilities to participate in the state EMS/Trauma Registry by reporting all major trauma cases where the patient died or arrived dead, was admitted for more than 48 hours, or was transferred in or out of the facility.²¹ It has been previously suggested that injury prevention programs should be based on objective injury data such as that obtained through trauma registries to identify areas for further study and to guide community injury prevention programs.²²

The purpose of the authors in this study was to describe the regional incidence and outcomes of ATV-related injuries with a geographic information system (GIS) based analysis of registry data and to discuss the use of this analysis as the framework for the Region 4/5N community level assessment and intervention for injury prevention. This study was approved through the Institutional Review Board at the University of Texas Health Science Center at Tyler as exempt research (Exempt 10-011).

METHODS

The trauma registry data of TSA-G was used for analysis as it contains detailed data from the only Level 1 Comprehensive and Level 2 Major Trauma Centers of the region, as well as the data of all other designated trauma centers in the service area, and is representative of the majority of the DSHS Region 4/5N population. The trauma registrar used ICD-9CM E-Codes as well as the described mechanism of injury to identify ATV-related injuries for the most recent 7 years of complete data (2004–2010). The same E-Codes that were used by the Center for Health Statistics at DSHS to identify ATV-related injuries in the discharge database of state licensed hospitals, E821.0, E821.1, E821.8, and E821.9, were used. Those cases that were identified using a mechanism of injury were based on a key word search for ATV, 4 Wheeler, 3 Wheeler, Four Wheeler, or Three Wheeler. To maintain patient confidentiality, the registrar removed all personally identifying information, assigned a case number, and linked transfer cases presenting at multiple facilities through an identifier code. Fields chosen for analysis included demographic data, county level geographic data, conditions surrounding the mechanism of injury, ICD-9 injury codes, helmet use, hospital charges and payer, disposition, and Injury Severity Score (ISS). The ISS is a summary injury classification system that provides an overall score for patients with multiple injuries based on the Abbreviated Injury Scale (AIS), which anatomically scores injury severity.²³ The ISS correlates to mortality and to measures of morbidity including length of stay and cost.²⁴ In a prior study on ATV-related injuries, injuries have been classified as minor (ISS < 9), moderate (ISS 9–15), and major (ISS > 15).²⁵

When a patient appeared in the registry multiple times due to facility transfers within the region, the data recorded at the most advanced facility was used for analysis. As this effort was initiated by DSHS Region 4/5N to identify and target pilot areas for regional prevention programs, unless otherwise stated, cases occurring to residents of Texas DSHS Health Service Region 4/5N based on county of residence were selected for analysis.

For calculation of rates, population data for each year of the 2004–2010 study period was obtained from the Texas Office of the State Demographer, which provides yearly population estimates for intercensal years, for the years 2004–2009¹⁸ and from the U.S. Census Bureau for 2010.¹⁶ Average annual incidence rates were calculated as the average number of cases per year per average total population over the 7 years of the study period. For rates specific to children, the rates were calculated as the average number of cases occurring over the 7 year time period per average total population of children of the age range specified.

Head injuries that may have been prevented by helmet use were defined using ICD-9CM codes 800–804.99 and 850.00–854.99 to include skull fractures, mandible and other facial fractures, intracranial hemorrhage or injury, concussions, and cerebral contusions. Deaths were defined as those recorded either as dead on arrival or as death occurring during the hospital stay.

To protect the identity of patients in the registry, analysis was performed and presented at the county level of aggregation. Rates were compared using a chi square test with Yates Correction where applicable. Means were compared using Student's *t*-test. Statistical analysis was performed using SPSS 19.0. A *p*-value of less than 0.05 was used as the level of significance.

GIS is increasingly becoming an important tool of public health research and communication of results. The WISQARS (Web-based Injury Statistics Query and Reporting System) Fatal Injury Mapping Module, a project of the National Center for Injury Prevention and Control of the Centers for Disease and Control and Prevention, is a model program for the use of GIS to analyze and display maps of injury-related rates. The WISQARS Fatal Mapping Module is capable of generating county level maps of the most recent 7 years of data, which is the amount needed to produce reliable county-level injury-related rates. Maps are becoming an indispensable tool in injury prevention work to rapidly identify geographic patterns in rates in order to tailor interventions to regions of the greatest need, to aid in program planning

activities, and as visual complements to better illustrate injury-related rate information.²⁶ The 7 years of county-level data of this study was thus analyzed and displayed using ArcGIS 9.3.1 to generate and illustrate county-level annual average incidence rate over the 7 year study period of 2004–2010 for prioritization of local intervention planning.

RESULTS

In the TSA-G trauma registry, there were 1,169 total registry entries that met selection criteria reflecting 1,071 patients with ATV-related injuries. Eight hundred ninety-two entries (76.3%) were identified through E-Codes. The remaining 277 (23.7%) were identified by a mechanism of injury that described the involvement of a 4-wheeler, a 3-wheeler, or an ATV. Of these, 821 (821/1071, 76.7%) were residents of DSHS 4/5N and 733 (733/1071, 68.4%) were residents of TSA-G. Most of those injured were white (708/821, 86.2%) and male (603/821, 73.4%). (Table 1.)

The median age was 22. Over one third (290/821, 35.3%) were children under the age of 18 and over one fourth were children under the age of 16 (221/821, 26.9%). Of the children under the age of 16, just under one half were under the age of 12 (101/221, 45.7%). For children under the age of 18, the mean age was 12.28 (11.82–12.74 95% CI) and half of the injuries occurred to children between the ages of 14 and 17 (Figure 3). The percentage of total injuries occurring in children under the age of 16 was not significantly different from those reported at the national level by the CPSC ($p = 0.55$, X^2) nor was the percentage of injuries occurring in children under the age of 12 ($p = 0.45$, X^2).

The mean ISS for all injured was 9.4 (8.9–9.9, 95% CI, Student's *t*), and for children under the age of 16, the mean ISS was 7.3 (6.6–8.0). Of those injured, 2.3% died as a result of their injury (23/821), with 35% (8/23) of the deaths occurring to children under the age of 16. No one who died was wearing a helmet.

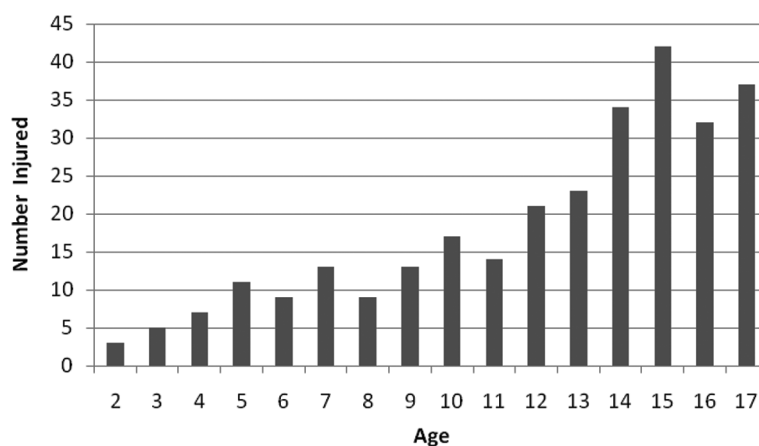
Over one third of adults (183/531, 34.5%) and nearly one third of children under the age of 16 (67/221, 30.3%) suffered a head injury.

TABLE 1. Selected Demographics of Residents of 4/5N Presenting to Trauma Service Area G Facilities with ATV-Related Injuries, 2004–2010 ($n = 821$)

	All ($n = 821$)	Children under the age of 18* ($n = 290$)	Children under the age of 16 ($n = 221$)
Gender			
Male	603 (73.4%)	198 (68.3%)	153 (69.2%)
Female	218 (26.6%)	92 (31.7%)	68 (30.8%)
Race			
White	708 (86.2%)	252 (86.9%)	190 (86.0%)
Black	62 (7.6%)	19 (6.6%)	16 (7.2%)
Hispanic	41 (5.0%)	12 (4.1%)	9 (4.1%)
Other	10 (1.2%)	7 (2.4%)	6 (2.7%)
Average injury severity score (95% CI, student's t)	9.38 (8.87–9.89)	7.77 (7.06–8.48)	7.286 (6.57–8.01)
Any head injury	278 (33.9%)	95 (32.8%)	67 (30.3%)
Intracranial bleed or injury	62/278 (22.3%)	25/95 (26.3%)	19/67 (28.4%)
Skull fracture with or without intracranial bleed	76/278 (27.3%)	22/73 (23.2%)	18/67 (26.9%)
Facial bone fracture	86/278 (30.9%)	31/95 (32.6%)	22/67 (32.8%)
Mandible fracture	25/278 (9.0%)	7/95 (7.4%)	5/67 (7.5%)
Concussion	92/278 (33.1%)	31/95 (32.6%)	18/67 (26.9%)
Cerebral contusion	34/278 (12.2%)	9/95 (9.5%)	7/67 (10.4%)
Helmet used	28 (3.4%)	21 (7.2%)	17 (7.7%)

Note. *Includes all children under the age of 18.

**Percentages are rounded and may not sum to 100%.

FIGURE 3. Age distribution of children under age 18 who resided in Texas DSHS Region 4/5N and presented to Trauma Service Area G facilities with ATV-related Injuries, 2004–2010 ($n = 290$)

Of those with a head injury, the most common injury in adults was a concussion (61/183, 33.3%) and in children under the age of 16 a facial fracture (22/67, 32.8%). Nearly half of adults with a head injury (91/183, 49.7%) and over two thirds (37/55, 67.3%) of children under the age of 16 with a head injury suffered a skull fracture or intracranial hemorrhage or both. (Table 1.) Only 1.3% of the adults

(7/531) wore a helmet. Helmet use was higher in children younger than 16, but was still very low at 7.7% (17/221).

Over two thirds of the injuries occurred on a Friday, Saturday, or Sunday (569/821, 69.3%). The most common months of injury were September (91/821, 11.1%), March (84/821, 10.2%), and May (82/821, 9.9%). For children under 16, the most common months of injury

were March and April (24/21, 10.9% each), September (23/221, 10.4%), and December (21/221, 9.5%).

For all injuries to Region 4/5N residents, the total hospital charges over the 7-year period were \$31.3 million. The most common payment sources were private health insurance (\$13.6 million, 43%), self pay (\$6.6 million, 21%), and auto insurance (\$3.8 million, 12%). The burden to Medicaid was \$3.0 million and to Medicare \$1.9 million. The TSA-G registry records work-relatedness, industry, and occupation, information required to be reported to the National Trauma Databank (NTDB), but not to the State of Texas. None of the cases specified industry or occupation. Only six cases were identified as work-related, five of these were residents of Region 4/5N, but these cases were not paid for by Workers' Compensation. There were 10 cases not recorded as work-related that were paid for by Workers' Compensation with a total cost of \$111,906; seven of these were Region 4/5N residents with a total cost of \$74,199.

Variations within the region based on average annual incidence rate at the county level show the highest rates of ATV-related injury occurring in the far eastern edge of the service area (Figure 4). The county with the highest number of injuries was Gregg County, a metropolitan area which contains the city of Longview with a population of around 80,000,¹⁶ with a total of 99 injured; of these 21 were children under the age of 16. The next highest county, Henderson County, a micropolitan area which contains the city of Athens with a population of around 13,000,¹⁶ had 74 cases. Despite comprising only 3.4% of the Region 4/5N population, 11.2% of the injuries occurred to residents of the two eastern rural counties of Panola and Shelby with average annual injury incidence rates of 31.3/100,000 and 22.7/100,000 respectively. For children under the age of 16, the average annual injury incidence rates for Panola and Shelby Counties were 44.8/100,000 and 45.7/100,000, respectively. Camp County, a small rural county, also showed a high annual rate for children under the age of 16 at 44.0/100,000; however, this calculation is based on only nine cases over the 7-year period.

DISCUSSION

Trauma registry data have been used previously to describe ATV-related injuries in children younger than 16. At a level 1 trauma center in Kentucky, data from 1996–2000 demonstrated a mean ISS of 12.3, 4% helmet use, an average driver age of 13.3 and passenger age of 9.3, with total charges over \$2.1 million (\$420k/year).²⁷ A study conducted at a level 1 trauma center in the State of Oklahoma, which borders Texas, similarly demonstrated an average age of 9.9, with an average ISS of 10.3, and four deaths (5.4%), all due to head injury.²⁸

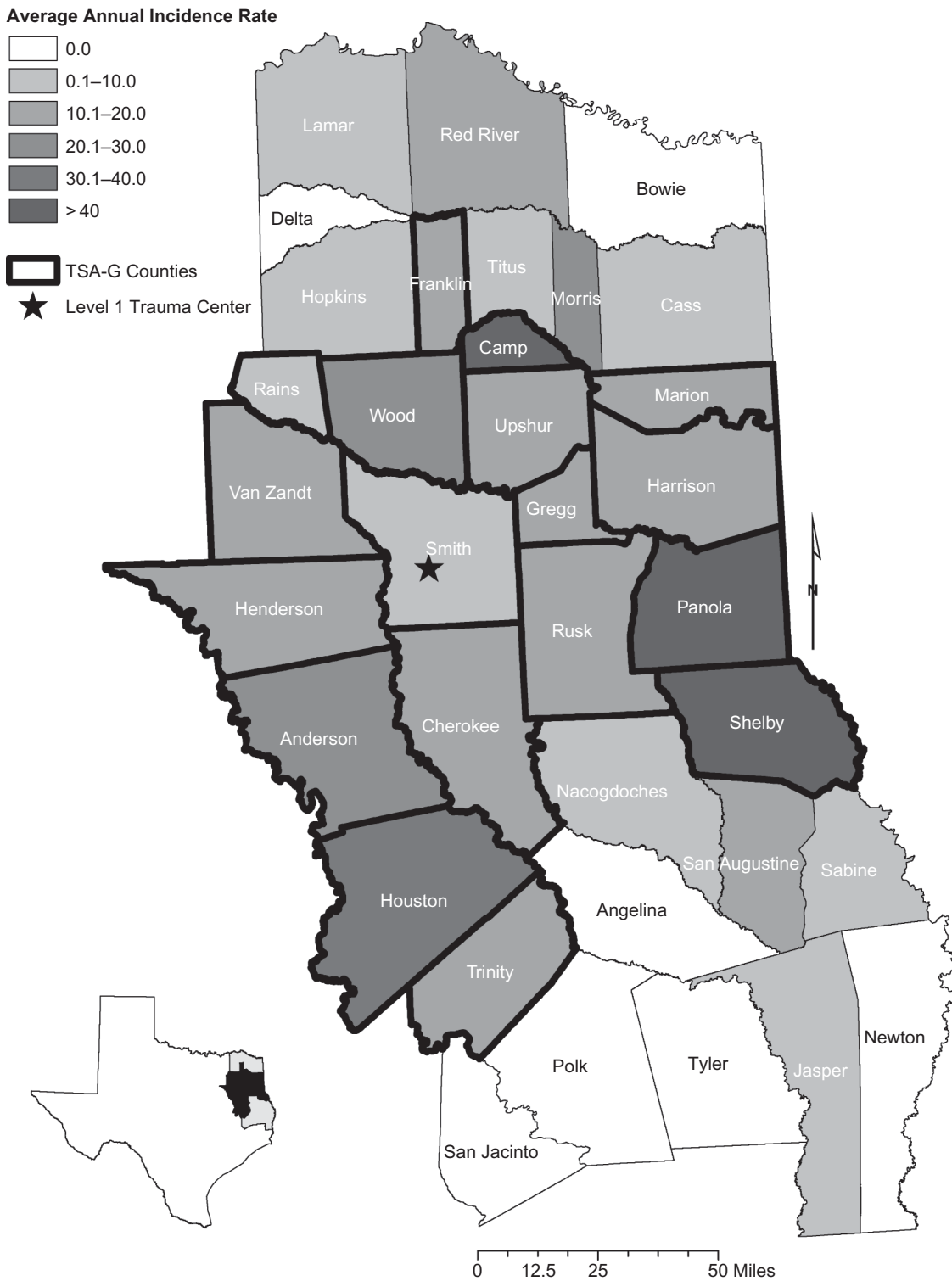
When compared to these prior studies, our findings demonstrated that for children under the age of 16, there was a lower ISS at 7.3 (6.6–8.0), a higher average age of 10.9 (10.5–11.4, 95% CI), higher rate of helmet use at 7.2%, and eight deaths (8/221, 3.6%). While an ISS > 15 can be used to define a significant injury²⁹ the ISS may underestimate the morbidity and mortality of a severe head injury and may not adequately predict potential loss of quality of life.²⁴ However, it is useful for comparing with other studies because of its widespread use.

The higher average annual hospital charges of \$1.1 million/year may reflect the more recent time period of the study. The present study results of 2.3% in hospital deaths does not differ from in hospital deaths reported in the literature based on similar trauma registry analysis, which have varied from 1%³⁰ to 5.5%.²⁸ In the present study, other demographics of gender, age, and race were not dissimilar from those reported in prior studies.^{1, 4, 22, 27, 29, 31, 32, 33}

Data from the Texas hospital discharge database and trauma service area registry likely underestimate the actual ATV-related injuries and deaths. The State of Texas does not have an emergency department database, so those treated and released would not be captured. Additionally, ATV-related injuries which were dead on scene would not be captured nor would minor injuries which may have been treated at an urgent care center, private physician's office, or did not seek treatment.

The population for rate calculation is an estimate based on average population over the study time period as estimated by the

FIGURE 4. Average annual incidence rate (per 100,000) of ATV-related injuries to children under age 16 in Texas Health Service Region 4/5N who presented to Trauma Service Area G, 2004–2010 ($n = 221$)

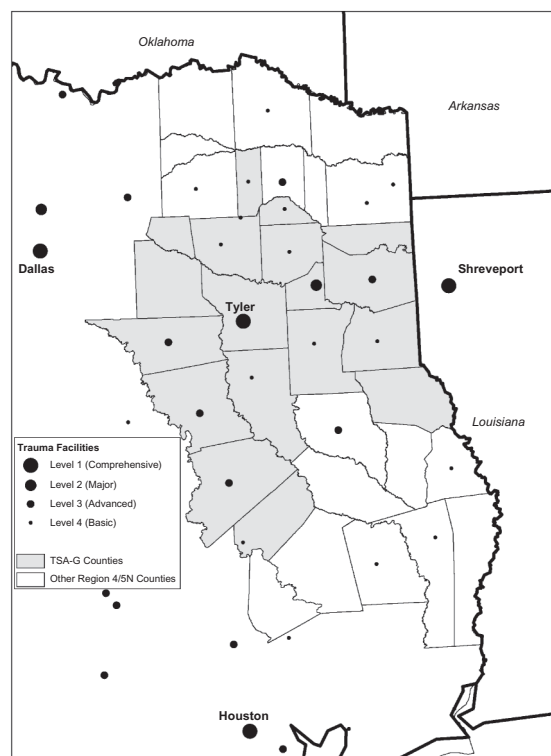


state demographer and as determined by the 2010 U.S. Census. It is limited by population mobility and changes in demographics or age distribution over time. This method does not account for ATV ownership or usage and thus does not reflect those that may actually be at risk for an ATV-related injury. In counties with low populations, the rate can be changed dramatically with small changes in the numbers of cases. It is unclear how this plays a role in the interpretation of the rate for Camp County. Knowledge of ATV ridership in this and other counties would be helpful but was not studied. A prior study which estimated ATV ridership of youth in the farm environment demonstrated an ATV-related injury rate to youths on farms of 4.3 per 1,000 youths who operated ATV's.¹²

Other factors related to exposure and risk such as hours of use, terrain variations, safety practices, and usage patterns of individuals were not assessed. Actual injury rates of counties outside TSA-G, but included for analysis because they fall within the Region 4/5N service area, may have been underestimated because the registries serving those areas were not included. While these areas do contain only level 3 and 4 centers, transfer may have occurred to level 1 or 2 facilities outside of TSA-G, and injuries treated at the level 3 or 4 centers would not have been captured. (Figure 5)

Injury rates may also be underestimated in counties within TSA-G that are near level 1 facilities in Shreveport and Dallas which may have served as the primary facility for those severely injured. However, a report from a pediatric level 1 trauma center in Dallas from the years 2002–2007 described that the only ATV-related injuries presenting from rural counties were not from counties of Region 4/5N, which suggests that pediatric cases are not lost from capture in the TSA-G registry by transport to Dallas.³⁴ Because of the proximity to neighboring level 1 facilities in Shreveport and Houston, the actual rates of nearby counties may have been underestimated. It has been previously published that a level 1 pediatric trauma center in Houston receives referrals for ATV-related injuries that originate from eastern Texas,³⁵ but the exact counties of origin of cases presenting to this facility was unknown at the time of

FIGURE 5. Trauma service delivery environment of Texas DSHS Region 4/5N



this publication. There may also be other transport decision factors not measured in this study but affecting results. An example includes transportation out of the area because of the nature of injury and services and specialties available at other facilities.

CONCLUSIONS

The State of Texas has a high number of fatalities from ATV-related injuries when compared with other states,¹ and east Texas, defined as DSHS Health Service Region 4/5N, has a statistically significant higher ATV-related injury rate (10.0 per 100,000, average annual incidence rate) when compared to the State of Texas as a whole (3.8 per 100,000 average annual incidence rate, $p < 0.001$, X^2). The highest average annual incidence rate of ATV-related injuries, including those of children under the age of 16, is concentrated in the two neighboring rural eastern counties of Panola and Shelby.

While it has been previously and independently suggested that trauma registry analysis²² and GIS²⁶ should be used to guide prevention programs, this project is unique in that GIS analysis of a trauma registry was used and successfully identified the key communities most affected by ATV-related injuries to efficiently target pilot efforts at further investigation and intervention. This GIS-based analysis suggests that future pilot efforts concentrated in a specific geographic region may have the best results.

Through this study the authors further illustrate that the use of E-codes alone underestimates the actual injuries, and that Mechanism of Injury, which is recorded at TSA-G but is not required to be reported to either the State of Texas registry or to the National Trauma Database, is an important adjunct to identifying ATV-related injuries.

The authors also suggest in this study that adults may be serving as poor role models due to the lack of helmet use. Safety messages delivered just prior to months of peak injury rates may have the best impact.

The evidence of this and other studies suggests that preventive strategies should be directed at youth.³ The American Academy of Orthopedic Surgeons states that children under the age of 12 generally do not yet possess the body size, strength, motor skills, and coordination for safe handling of an ATV.³⁶ Multiple professional organizations recommend that children under the age of 16 and who are not licensed to drive an automobile should not operate ATVs, including the American Academy of Pediatrics,³⁷ the American Pediatric Surgical Association,³⁸ the American College of Surgeons,³⁹ and the American Academy of Orthopedic Surgeons.³⁶ It is agreed by both the American Academy of Pediatrics and the American Pediatric Surgical Association that children under 16 lack both the necessary physical skills and judgment to safely operate ATVs.^{37,38} The American College of Surgeons calls for national priority to be given to protection of riders under the age of 16.³⁹

The CPSC has issued a mandatory standard effective April 2009 which prohibits importing or distributing three-wheel ATVs and also requires other safety standards through required

action plans.⁴⁰ In the State of Texas, the Department of Public Safety regulates ATVs through Chapter 663 of the Texas Transportation Code⁴¹ which requires a title if sold or disposed. Additionally, registration is required and there are other safety rules such as no passengers and a safety certificate if operated on public property. Operation is prohibited on public streets except for crossing or for agricultural purposes, and there is required lighting when dark. Operators under 14 are to be accompanied by a parent or guardian, but there is currently no rule regarding helmet use.

It has been previously suggested by the Centers for Disease Control and Prevention that community and school-based programs targeting adolescents and emphasizing ATV safety might reduce deaths, and incentive-based prevention such as reduced insurance premiums or extended warranty coverage for safety training and helmet use may also help reduce the public health burden.³¹

Due to the high numbers of injuries in children under the age of 16, the age distribution reported, and the highest incidence rate occurring in two rural counties in this study, important potential community and school-based partners may include rural youth-oriented groups such as FFA, Vocational Agriculture Teachers, and 4H, a youth development organization that engages rural youth. Due to the regulatory environment of Texas, the Department of Public Safety may also be an important partner.

The ATV Safety Institute is a not-for-profit division of the Specialty Vehicle Institute of America, formed to implement an expanded national program of ATV safety and awareness with the primary goal to promote safe and responsible use of ATVs. The ATV Safety Institute promotes guidelines for ridership which include promotion of the use of Department of Transportation compliant helmets, avoidance of paved roads, and no passengers. The ATV Safety Institute offers hands-on safety training courses as well as a free online course available at <http://www.atvsafety.org>.

The North American Guidelines for Children's Agricultural Tasks (NAGCAT) is a collection of guidelines created by the

National Children's Center for Rural and Agricultural Health and Safety based on child development principles to match a child's physical, mental, and psychosocial abilities with specific tasks. The ATV-related guidelines include those for helmet use and appropriate clothing, communication and supervision by an adult, an assessment of the child's physical ability, emotional maturity and judgment, adult modeling, and an age guideline of use set at 16 years old. The efficacy of the active dissemination of the NAGCAT at delaying initiation of ATV use has been previously demonstrated.⁹

The rural communities identified in this study as having the highest regional average annual incidence rates of ATV-related injuries to youth should be targeted for further investigation to determine actual ATV use and ownership and factors and behaviors associated with ATV-related injuries. Future efforts should focus on clarification of risk factors in the most affected communities. The trauma registry lacks sufficient information to determine the role of the agricultural environment of these rural areas. As it has been shown that the farm environment contributes to youth ridership of ATVs,¹¹ including within the State of Texas,¹⁴ further investigation is needed to understand the role of the agricultural environment in these rural counties and to determine the portion of injuries related to agricultural use.

More work is needed to determine what methodologies of intervention and safety education messages would be most effective. Potential options for youth education may include that provided by the ATV Safety Institute and the NAGCAT.

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