ATV and Bicycle Deaths and Associated Costs in the United States, 2000–2005

James C. Helmkamp, PhD, MS[a]
Mary E. Aitken, MD, MPH[b]
Bruce A. Lawrence, PhD[c]

SYNOPSIS

Objective. We determined the rate and costs of recent U.S. all-terrain vehicle (ATV) and bicycle deaths.

Methods. Fatalities were identified from the National Center for Health Statistics Multiple Cause-of-Death public-access file. ATV and bicycle deaths were defined by International Classification of Diseases, 10th Revision codes V86.0–V86.9 and V10–V19, respectively. Lifetime costs were estimated using standard methods such as those used by the National Highway Traffic Safety Administration.

Results. From 2000 through 2005, 5,204 people died from ATV crashes and 4,924 from bicycle mishaps. A mean of 694 adults and 174 children died annually from ATV injuries, while 666 adults and 155 children died from bicycle injuries. Death rates increased among adult ATV and bike riders and child ATV riders. Males had higher fatality rates for both ATVs and bicycles. Among children, total costs increased 15% for ATV deaths and decreased 23% for bicycle deaths. In adults, ATV costs increased 45% and bike costs increased 39%.

Conclusions. Bicycle- and ATV-related deaths and associated costs are high and, for the most part, increasing. Promotion of proven prevention strategies, including helmet use, is indicated. However, enforcement of helmet laws is problematic, which may contribute to observed trends.

[a]Injury Control Research Center and Department of Community Medicine, West Virginia University, Morgantown, WV

[b]Department of Pediatrics, University of Arkansas for Medical Sciences, College of Medicine and Pediatric Injury Prevention Center, Arkansas Children's Hospital, Little Rock, AR

[c]Pacific Institute for Research and Evaluation, Calverton, MD

Address correspondence to: James C. Helmkamp, PhD, MS, Injury Control Research Center and Department of Community Medicine, West Virginia University, PO Box 9151, Morgantown, WV 26506-9151; tel. 304-293-6682; fax 304-293-0265; e-mail <jhelmkamp@hsc.wvu.edu>.

©2009 Association of Schools of Public Health

All-terrain vehicles (ATVs) are a popular form of motorized recreation, with an estimated eight million four-wheelers in use in 2005 and nearly 24 million riders.[1,2] About 800,000 new ATVs were sold in the U.S. in 2006.[3] ATVs are also used in a variety of occupational settings, including agriculture, construction, oil production, and law enforcement.[4] Larger, more powerful, and faster ATVs have increased exposure and contributed to rising fatal and nonfatal injuries.[1,2,5] In fact, the U.S. Consumer Product Safety Commission (CPSC) reports that the estimated number of deaths associated with ATVs has risen nearly 60%, from 552 in 2000 to 870 in 2005. Similarly, estimated nonfatal injuries requiring emergency department (ED) treatment rose 48%, from 92,200 in 2000 to 136,700 in 2005.[1] Children <16 years of age accounted for about one-quarter of deaths and about one-third of ED-treated injuries during this period. Helmkamp et al.[5] reported that estimated hospitalizations for ATV-related injuries increased 90%, from 8,232 in 2000 to 15,630 in 2004. Total hospital charges for these injuries increased 243%, from $109 million in 2000 to $374 million in 2004. Helmkamp and Lawrence[6] compared the reported frequency and cost of child (age ≤15 years) and adult (age ≥16 years) ATV deaths in the U.S. from 1999 to 2003 and concluded that, despite federal efforts and strong recommendations from consumer groups, little had changed in regard to ATV safety in 20 years.

Bicycling is more popular than ATV riding, with about 100 million bicycle owners in the U.S. in 2004[7] and nearly 20 million new bikes sold annually.[8] From 2000 through 2005, the Centers for Disease Control and Prevention reported an annual mean of about 800 deaths from bicycle injuries, increasing 25% from 738 in 2000 to 926 in 2005. Estimated nonfatal injuries requiring ED treatment decreased 27%, from 660,403 in 2000 to 479,963 in 2005. Children <16 years of age constituted about 19% of deaths and nearly 60% of ED-treated injuries.[9]

Numerous U.S. studies of bicycle injuries and deaths have been conducted during the past two decades. Some studies have described the epidemiology of bike injuries,[10–12] while many have focused on fatal and nonfatal injury patterns and trends among child and adult populations of states, regions, or the entire nation.[13–25] Only a few have provided cost information related to nonfatal injuries[21] and deaths.[18,19]

Schulman estimated that in the U.S. in 1997, approximately 327 fatal, 6,900 hospitalized, and 100,000 ED cases of bicycle-related head injuries could have been avoided with universal use of bicycle helmets. These preventable cases were associated with nearly $2.4 billion in health-care costs.[18] More recently, Miller reported total lifetime costs of $2.3 billion resulting from 866 confirmed bicycle deaths in the U.S. in 2000.[19]

The epidemiology of ATV injuries and deaths has been well-described in various states, regions, and individual trauma centers, but few studies have reported on the entire U.S. population.[6,26–31] During the past 20 years, numerous U.S. studies have compared four-wheeled ATV injuries with those resulting from three-wheeled ATVs, snowmobiles, dirt bikes, dune buggies, motorcycles, and other motor vehicles,[32–44] but we identified only one study that included bicycles: Brown reviewed ATV and bicycle injuries seen at an Ohio pediatric trauma center.[45] To our knowledge, no national study has focused specifically on ATV and bicycle deaths and resulting costs.

The objectives of our study were to (*1*) calculate fatality rates and describe national trends of reported ATV and bicycle fatalities during 2000–2005, (*2*) calculate and compare the estimated total lifetime costs resulting from these deaths, and (*3*) discuss results in the context of the public health approach to injury prevention, including strategies such as helmet use and regulatory approaches.

METHODS

Populations of interest and case definition

ATV and bicycle deaths for children (aged ≤15 years) and adults (aged ≥16 years) for 2000–2005 were identified from the National Center for Health Statistics (NCHS) Multiple Cause-of-Death (MCOD) public-access file.[46] The MCOD data, which are drawn from official death certificates, include a record of every death that occurred in the U.S. in a given year. The age range for children follows the definition used by the CPSC for its standard presentation of ATV fatality statistics.[1] ATV and bicycle deaths were identified by searching all diagnosis fields for International Classification of Diseases, 10th Revision external cause codes V86.0–V86.9 and V10–V19, respectively.[47] Searching all fields results in slightly higher case counts than looking only at the underlying cause of death, as coded by NCHS.

Fatality rates

We used a population-based approach to calculate fatality rates. While this approach is methodologically sound and previously published for ATV deaths,[30,31,48] it would have been preferable to use a registration-based rate. This latter approach was not feasible, however, because most ATVs in use are unregistered.[1] In 2005, only 16 states required ATV registration with

a motor vehicle registration agency.[49] Furthermore, there are no consistent or reasonably accurate counts of bicycles in use, and bikes typically are not required to be registered.

Cost estimates

Total lifetime costs resulting from ATV and bicycle deaths were estimated using a comprehensive approach that incorporated medical, work loss, and quality of life (QOL) components. Conceptually, these components encompass all costs that might be reasonably incurred by society as a result of injury. This approach has been used previously to estimate costs of ATV deaths for children and adults.[6,50]

Medical costs were computed separately for the places of death identified in the MCOD data: on-scene, on hospital arrival, in the emergency room, at the hospital after admission, and at a nursing home. The medical costs incurred, depending on place of death, might include coroner/medical examiner, emergency medical transport, ED, inpatient hospital, and nursing home costs.

Estimates of work losses follow the approach of Rice et al.[51] For a victim of a given age and sex, we summed the probability of surviving to each subsequent year of age[52] times sex-specific expected earnings (including the value of fringe benefits) for someone of that age, as reported in Haddix et al.[53] Parallel calculations were used to value lost household work. Earnings at future ages were adjusted upwards to account for a historical 1% productivity growth rate.[53] Growth in household production, on the other hand, has been historically negligible, so we did not adjust for it. Both earnings and household production were discounted to present value using a 3% discount rate—the discount rate recommended for reference case comparisons worldwide by the U.S. Panel on Cost-effectiveness in Health and Medicine.[54]

Lost QOL resulting from a fatality depends only on the victim's life expectancy. Each year of expected life lost was valued at $98,851 (in 2000 dollars) and discounted to present value using a 3% discount rate. This value is based on a value of statistical life of $3.4 million (in 2000 dollars), which was derived from a systematic review[55] and is used in regulatory analyses at the Department of Transportation and the U.S. Department of Justice. The value of a statistical life (the amount that people are collectively willing to pay—and actually do pay—to save one life) is divided by the present value of the expected number of years of life saved.

National cost estimates for all years were inflated to 2005 dollars to facilitate comparisons between years. Medical costs were inflated by an index of medical expenditures per capita, while work loss and QOL costs were inflated by the real employment cost index, as calculated by the U.S. Bureau of Labor Statistics.

RESULTS

During the six-year study period, 5,204 people died from ATV crashes, compared with 4,924 who died from bicycle mishaps. A mean of 694 adults and 174 children died annually from ATV injuries, while 666 adults and 155 children died from bicycle injuries. This translates, in 2005 for example, to 17 adults and four children dying weekly in ATV crashes, as compared with 15 adults and three children dying weekly in bicycle incidents. The high-risk group of 16- and 17-year-olds accounted for 6% of all ATV deaths and 3% of all bicycle deaths. Forty-five percent of the ATV deaths had a first diagnosis of head injury; 50% among children, 43% among adults, 48% among females, and 44% among males. For bicycle deaths, 48% were due to head injury; 58% among children, 46% among adults, 47% among females, and 48% among males.

Counts and fatality rates

Children. Overall, children accounted for 20% of all ATV deaths and 19% of all bicycle deaths, with little proportional variation by year. The mean age of both ATV and bike victims was about 11 years. Among adolescent ATV victims, 75% were male, compared with 82% of bike victims (Table 1). ATV and bicycle fatality rates for children were similar during the six-year period (0.27 deaths per 100,000 and 0.24 deaths per 100,000, respectively), with ATV rates consistently exceeding bicycle rates after 2000. ATV rates increased 15% during the period, while bicycle rates decreased 22%. As shown in Table 1 and Figure 1, notable gender differences in the childhood fatality rates included:

- The male ATV rate (0.39) was about 2.8 times the female ATV rate (0.14).
- Female ATV rates were consistently higher than female bicycle rates.
- Male ATV rates were lower than male bike rates for 2000 and 2001, the same in 2002, and then consistently higher from 2003 on.
- The male bicycle rate (0.38) was approximately four times the female bicycle rate (0.09).
- The highest rate during the period was for male bicycle deaths in 2000 (0.49).

Adults. Adults accounted for 80% of both ATV and bicycle deaths, and nearly 90% were male (Table 1).

Table 1. Trends in the number and rate[a] of reported ATV- and bicycle-related deaths in the U.S. by age group and gender, 2000–2005

Vehicle	2000 Number (rate)	2001 Number (rate)	2002 Number (rate)	2003 Number (rate)	2004 Number (rate)	2005 Number (rate)	Total Number (rate)
Children (≤15 years of age)							
ATV							
Male	119 (0.36)	123 (0.37)	122 (0.37)	130 (0.39)	153 (0.46)	138 (0.41)	785 (0.39)
Female	43 (0.14)	36 (0.11)	39 (0.12)	44 (0.14)	48 (0.15)	48 (0.15)	258 (0.14)
Total	162 (0.25)	159 (0.25)	161 (0.25)	174 (0.27)	201 (0.31)	186 (0.29)	1,043 (0.27)
Bicycle							
Male	161 (0.49)	127 (0.38)	121 (0.37)	120 (0.36)	119 (0.36)	118 (0.35)	766 (0.38)
Female	25 (0.08)	26 (0.08)	25 (0.08)	28 (0.09)	33 (0.10)	27 (0.08)	164 (0.09)
Total	186 (0.29)	153 (0.24)	146 (0.23)	148 (0.23)	152 (0.23)	145 (0.22)	930 (0.24)
Adults (≥16 years of age)							
ATV							
Male	500 (0.48)	543 (0.51)	544 (0.50)	659 (0.60)	669 (0.60)	779 (0.69)	3,694 (0.56)
Female	61 (0.05)	59 (0.05)	77 (0.07)	84 (0.07)	91 (0.08)	95 (0.08)	467 (0.07)
Total	561 (0.26)	602 (0.27)	621 (0.28)	743 (0.33)	760 (0.33)	874 (0.38)	4,161 (0.31)
Bicycle							
Male	510 (0.49)	605 (0.57)	579 (0.53)	562 (0.51)	625 (0.56)	716 (0.64)	3,597 (0.55)
Female	62 (0.05)	50 (0.04)	54 (0.05)	66 (0.06)	80 (0.07)	85 (0.07)	397 (0.06)
Total	572 (0.26)	655 (0.30)	633 (0.28)	628 (0.28)	705 (0.31)	801 (0.35)	3,994 (0.30)

[a]Rates per 100,000 population; annual denominators obtained from the Census Bureau

ATV = all-terrain vehicle

The number of adult ATV deaths and resulting fatality rates were lower than those observed for adults dying in bicycle crashes from 2000 to 2002, with the trend reversing from 2003 through 2005. Although the six-year adult fatality rates were virtually the same for ATVs (0.31) and bicycles (0.30), the overall fatality rate increased 56% for adult ATV victims as compared with 40% for adult bicycle victims. As shown in Table 1 and Figure 2, there were several notable gender differences among the adult rates, including:

- The male ATV rate (0.56) was eight times the female ATV rate (0.07).
- The male bicycle rate (0.55) was nine times the female bicycle rate (0.06).
- Male ATV rates were lower than male bicycle rates for 2000 to 2002 and then consistently higher from 2003 on.
- The highest rate during the period was for male ATV deaths in 2005 (0.69).
- The largest rate differential among adults occurred in 2001 between male (0.57) and female (0.04) bicycle victims.

Lifetime costs of fatalities

The lifetime economic costs associated with ATV deaths among children increased 15% (from $805 million in 2000 to $924 million in 2005); the highest annual cost, a little more than $1 billion, occurred in 2004 (Table 2). For children killed in bicycle mishaps, total costs decreased nearly 23%, from $929 million in 2000 to $719 million in 2005. Among adults killed in ATV crashes, lifetime costs increased 45%, from $2.4 billion in 2000 to $3.5 billion in 2005. This compares to a 39% increase observed for adult bicycle victims, from $2.0 billion in 2000 to $2.8 billion in 2005. Interestingly, while child ATV deaths generally increased during the period and child bicycle deaths decreased, the mean value of the real total lifetime cost held constant at a little less than $5 million and was, moreover, remarkably similar for both causes; the mean difference was a mere $387 (Table 2). However, among adults, while both ATV and bike deaths increased, the mean value of the lifetime costs was consistently about $0.5 million higher for ATV victims. The mean value of lifetime costs was consistently higher among children compared with adults for both ATVs (about 22% and $0.9 million annually) compared with bicycles (about 41% and $1.5 million annually).

Overall, the QOL component accounted for more than 64% of the total lifetime costs, the work loss component for about 35%, and the medical component for less than 1%. These proportions varied only slightly by ATV or bicycle, age group, or year. As shown in Table 2, while QOL and work loss accounted for the significant dollar changes noted previously, the most notable proportional cost changes between 2000 and 2005 occurred in the medical component:

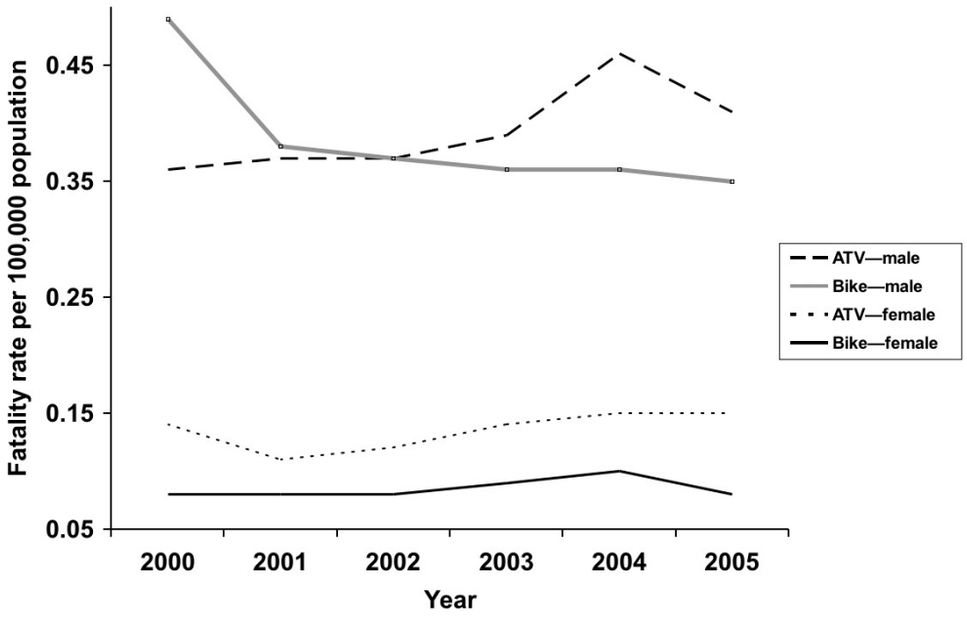
- Adult ATV medical costs increased 112%, from $5.6 million to $11.8 million.
- Adult bicycle medical costs increased 60%, from $10.5 million to $16.8 million.
- Child ATV medical costs increased 21%, from $1.8 million to $2.2 million.
- Child bicycle medical costs decreased 43%, from $4.1 million to $2.4 million.

DISCUSSION

Our results demonstrate a steady increase in the number and rate of ATV and bicycle deaths for both children and adults during the study period. The only positive outcomes were the decreasing trends observed among child bicycle victims. Males are at a higher risk of death than females for both ATVs and bicycles. The male preponderance is likely explained by differences in both exposure and behavior.[2,14,56,57] Both recreational activities are typically male dominated, particularly in older age groups.[14,27] In addition, males may be more likely than females to take risks, such as carrying an ATV passenger, given similar exposures.[27]

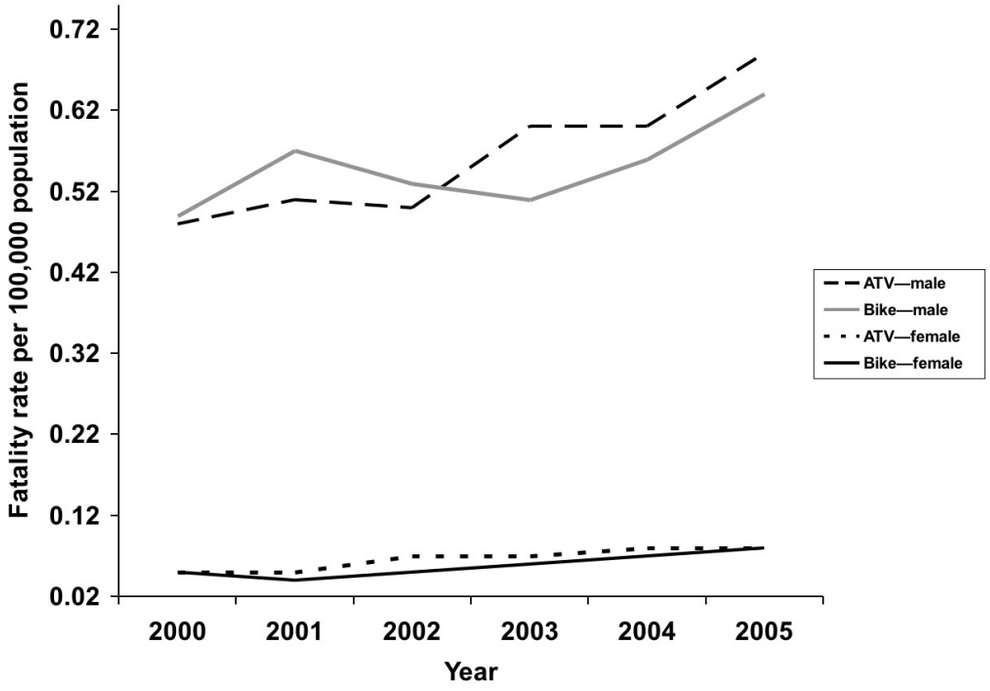
Costs continued to escalate in other high-risk groups, as well. Total costs rose 15% for children's ATV deaths and decreased 23% for children's bike deaths, in both cases closely tracking the changes in incidence. The mean real cost per child victim was practically constant across the six years and nearly identical between ATVs and bikes. This reflects the demographic consistency across years and between transport modes: in every case, the fatal population had a mean age of 11 and was at least 73% male. Thus, life expectancies and expected lifetime incomes were fairly constant, resulting in very little variation in costs. Among adults, while total annual costs for both ATV and bicycle deaths increased in about the same proportion overall, the mean cost per victim displayed notable annual differences. This, again, was the result of demographic differences. The mean age of bicycle fatalities was fairly constant at 45 to 47, while the mean age of ATV fatalities rose steadily from 35 in 2000 to nearly 40 in 2005. Work loss decreases with age because older victims lose fewer years of expected working life.

Figure 1. ATV- and bicycle-related fatality rates, by gender, for people ≤15 years of age



ATV = all-terrain vehicle

Figure 2. ATV- and bicycle-related fatality rates, by gender, for people ≥16 years of age



ATV = all-terrain vehicle

These trends in both bicycle and ATV deaths are troubling and deserve further discussion, including an analysis of potential strategies that might mitigate the increasing fatalities and rates. Applying the public health approach to ATV and bicycle injuries and death,[58] the collective body of work on surveillance and the identification of risk factors has been comprehensive and unequivocal. The intervention evaluation and implementation components have been more uniformly addressed within the bicycle community compared with ATVs, and may explain some of the variation in the death rates across the different population subgroups. One strategy that has been demonstrated to reduce injuries and deaths for both bicycles and ATVs is helmet use. We therefore focus our discussion on helmet use and effectiveness, and on helmet laws and their potential influence on the trends noted previously.

Use and effectiveness of helmets and helmet laws

Rodgers reported in 1998 that about 43% of bicyclists said they always or almost always used a helmet. This proportion was higher in the youngest riders, for those with college educations, and for those whose riding time exceeded 100 hours/year.[56] The 2005 Youth Risk Behavior Survey reported that more than 83% of high school students rarely or never wore a bicycle helmet and that helmet use was lower among males and black people.[57] In a 2003 review of research relating to bicycle helmet use in children,[59] Coffman identified several barriers to helmet use, including lack of peer support, discomfort of helmets, poor role modeling by parents and other adults, negative parental pressure, and helmet cost. Effectiveness of bicycle helmets in reducing the severity of injury has been well-established.[60–69] Thompson and colleagues reported that helmets, regardless of type, provide substantial protection (e.g., a 69% to 74% protective effect) against head injuries in people of all ages involved in crashes, including those involving motor vehicles.[62] Rivara et al. found that children whose helmets fit poorly had nearly a twofold increased risk of head injury.[63] Rodgers, in a 1998 national telephone survey,[67] and Karkhaneh and colleagues' recent systematic review of bicycle helmet laws,[69] opined that legislation significantly increased helmet use, particularly among younger age groups. They further emphasized that state helmet laws must be an important component of any strategy to increase usage.

Multiple studies have been conducted on ATV helmet use and injuries, mortality rates, and results of legislative efforts.[26,27,30,31,40,48,70–73] In a 1997 national ATV exposure survey, Rodgers estimated about 52% of ATV drivers frequently wore helmets.[27] Rodgers also

showed that, given an ATV accident resulting in injury, helmet use reduced the risk of death 42% and could reduce the likelihood that a nonfatal injury involved the head by about 64%.[26] Helmkamp also reported that states with ATV helmet laws had 1990–1999 population-based fatality rates that were half that of states with no safety legislation.[30] Recently, Rodgers explored population-based state ATV mortality rates for the same decade and concluded that state rate variations were in large part related to ATV usage rates and several demographic characteristics, including the proportion of the state's population that was male, young, rural, college educated, and white.[31] Rodgers added that state and local governments with large rural populations and high ATV usage rates should consider enacting safety requirements to address the mortality risk directly. Safety measures could include age restrictions, hands-on training, and use of safety equipment (i.e., helmets and eye protection).

States and localities began adopting bicycle laws in the late 1980s, mostly limited to children younger than age 16.[74] In 1994, Congress passed the Children's Bicycle Helmet Safety Act, requiring the CPSC to establish a bicycle helmet standard. Provisions of this act included adequately protecting the head and having chinstraps strong enough to prevent helmets from coming off riders in a crash, collision, or fall. Currently, an omnibus federal law does not mandate bicycle riders to wear helmets. Healthy People 2010, however, set a goal for all states to have a bicycle helmet law for riders younger than 16 years of age by 2010.[75] In 2005, 20 states had laws and more than 150 localities in

Table 2. Trends in the real costs of ATV- and bicycle-related deaths in the U.S. by age group and cost components, 2000–2005[a]

Component	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*Overall change (percent)*
			Children (≤15 years of age)				
ATV (number of deaths)	162	159	161	174	201	186	
Quality of life	545.92	535.84	541.72	587.51	676.14	628.27	+15.1
Work loss	257.56	254.91	258.53	275.43	323.19	293.81	+14.1
Medical	1.83	1.55	2.13	2.34	2.31	2.21	+20.8
Total	805.31	792.30	802.37	865.27	1,001.65	924.28	+14.8
Mean	4.97	4.98	4.98	4.97	4.98	4.97	
Bicycle (number of deaths)	186	153	146	148	152	145	
Quality of life	622.30	509.15	489.28	496.23	512.42	483.53	−22.3
Work loss	302.14	244.32	236.55	238.56	244.06	233.12	−22.8
Medical	4.15	3.14	3.14	1.96	2.52	2.37	−42.9
Total	928.59	756.07	728.97	736.74	759.00	719.02	−22.6
Mean	4.99	4.94	4.99	4.98	4.99	4.96	
			Adults (≥16 years of age)				
ATV (number of deaths)	561	602	621	743	760	874	
Quality of life	1,486.37	1,577.43	1,580.63	1,887.60	1,937.08	2,177.83	+46.5
Work loss	885.86	946.00	925.13	1,113.60	1,134.06	1,263.34	+42.6
Medical	5.60	7.16	8.31	10.59	10.04	11.85	+111.6
Total	2,377.82	2,530.59	2,514.06	3,011.79	3,081.18	3,453.01	+45.2
Mean	4.24	4.20	4.05	4.05	4.05	3.95	
Bicycle (number of deaths)	572	655	633	628	705	801	
Quality of life	1,285.82	1,511.95	1,450.03	1,410.85	1,567.64	1,786.88	+39.0
Work loss	708.34	857.48	822.46	777.09	852.13	980.87	+38.5
Medical	10.49	12.57	12.88	11.80	13.94	16.78	+60.0
Total	2,004.65	2,382.00	2,285.37	2,199.74	2,433.72	2,784.53	+38.9
Mean	3.50	3.64	3.61	3.50	3.45	3.48	

[a]In millions of 2005 dollars

ATV = all-terrain vehicle

these states and in 15 additional states had ordinances requiring minors to wear helmets. Fifteen states had no state or local helmet laws.

Similarly, there are no federal laws requiring helmets for ATV riders. The 10-year consent decree between the CPSC and major ATV manufacturers required that manufacturers affix a permanent warning label on all ATVs sold in the U.S. beginning in 1988. One of the specific safety precautions listed on each label recommended that ATV operators always wear an approved motorcycle helmet, eye protection, and protective clothing.[76] After the consent decree expired in 1998, most major ATV manufacturers voluntarily continued to place these labels on new ATVs. Professional organizations such as the Consumer Federation of America, the American Academy of Pediatrics, and the American Academy of Orthopaedic Surgeons strongly recommend the use of safety equipment, including helmets, and stress that helmets should be those used by motorcyclists and not those typically worn by bicyclists.[77–79] A parallel Healthy People 2010 objective for state ATV laws was not developed. In 2005, 27 states required helmets for young ATV riders; 13 of these states also required helmets for adults, and 15 states required helmets on both drivers and passengers. The ATV helmet law in nine states was specific for public property or defined designated areas such as state parks. Two of the state laws pertained only to three-wheeled ATVs.[49,80]

Many of the aforementioned studies have shown that universal helmet use by ATV and bicycle riders reduces the likelihood and severity of injuries. While helmet laws are in place in many states, the effectiveness of the laws is often problematic if they cannot be enforced.[31,48,69] While we do not know the proportion of ATV and bike victims who wore a helmet, the high proportion of fatal head injuries that we observed should give us pause and suggest that helmets probably were not worn. We feel the enforcement paradox has contributed to the continuing increase in ATV and bike deaths and associated costs in both adults and children. Ehrlich and colleagues conducted a matched analysis of parents' and children's self-reported attitudes toward bicycle safety and concluded that (*1*) parents don't always know if their kids are riding safely, (*2*) simply owning a helmet does not ensure its use, and (*3*) a parent's behavior will impact a child's safety practices; simply riding helmeted with your family may be an intervention itself.[81] We suspect these findings might very well be operating among ATV riders as well, but a similar analysis has not been conducted.

Limitation

We acknowledge a limitation in the cost portion of our study. The magnitude of the QOL component, which accounted for 64% of total costs, depends on the assumed value of a statistical life (VSL), which can easily vary by one-third in either direction. The VSL that we used is consistent with National Highway Traffic Safety Administration practice, but other government agencies have different policies.

CONCLUSIONS

Our study demonstrated that prevention solutions for both ATV and bicycle injuries have not yet met their historical promises to reduce fatalities and injuries. While exposure to bicycles was much higher than to ATVs, population-based death rates were comparable and increasing for adults. The decrease in children's fatalities may be related to increased use of helmets in this subpopulation. No corresponding trend in ATV deaths for children was demonstrated, unfortunately, and may reflect poorer penetration of helmet use among ATV users. Further study, including more in-depth analysis of attitudes toward safety strategies among parents and children, the potential impact of increased enforcement of existing laws regulating bicycle and ATV safety, and more universal education about effective safety measures, is warranted.

This study was funded by the Arabella Legacy Fund and Concerned Families for ATV Safety.

The findings and conclusions in this article are those of the authors and do not necessarily represent the views of the Arabella Legacy Fund or Concerned Families for ATV Safety.

REFERENCES

1. Consumer Product Safety Commission (US). 2006 annual report of ATV-related deaths and injuries. Bethesda (MD): CPSC (US); February 2008.
2. Levenson MS. All-terrain vehicle 2001 injury and exposure studies. Bethesda (MD): Consumer Product Safety Commission (US); January 2003.
3. Specialty Vehicle Institute of America. Special report. Irvine (CA): SVIA; 2007. Also available from: URL: http://www.atvsafety.org/sviapressreleases/SVIA_Special_Report.pdf [cited 2008 May 14].
4. Department of Labor (US). Hazards associated with all-terrain vehicles (ATVs) in the workplace. Safety and Health Information Bulletin 08-03-2006. Washington: Occupational Safety and Health Administration (US); 2006. Also available from: URL: http://www.osha.gov/dts/shib/shib080306.html [cited 2008 Apr 23].
5. Helmkamp JC, Furbee PM, Coben JH, Tadros A. All-terrain vehicle-related hospitalizations in the United States, 2000–2004. Am J Prev Med 2008;34:39-45.
6. Helmkamp JC, Lawrence BA. The economic burden of all-terrain vehicle-related pediatric deaths in the United States. Pediatrics 2007;119:223-5.
7. Bicycle Helmet Safety Institute. Helmet related statistics from many sources [cited 2008 Apr 23]. Available from: URL: http://www.helmets.org/stats.htm

8. National Bicycle Dealers Association. Industry overview 2007—a look at the bicycle industry's vital statistics [cited 2008 Apr 24]. Available from: URL: http://nbda.com/page.cfm?pageID=34
9. Centers for Disease Control and Prevention (US). Web-based Injury Statistics Query and Reporting System (WISQARS): leading causes of death reports, 1999–2005 [cited 2008 Apr 24]. Available from: URL: http://webappa.cdc.gov/sasweb/ncipc/leadcaus10.html
10. Baker SP, Li G, Fowler C, Dannenberg AL. Injuries to bicyclists: a national perspective. Baltimore: The Johns Hopkins Injury Prevention Center; 1993.
11. Thompson MJ, Rivara FP. Bicycle-related injuries. Am Family Phys 2001;63:2007-17.
12. Collins J. Letter from the editor: the trauma of cycling. Semin Roentgenol 2006;41:153-4.
13. Sacks JJ, Holgrem P, Smith SM, Sosin DM. Bicycle-associated head injuries and deaths in the United States from 1984 through 1988. How many are preventable? JAMA 1991;266:3016-8.
14. Rodgers GB. Bicyclist deaths and fatality risk patterns. Accid Anal Prev 1995;27:215-23.
15. Sosin DM, Sacks JJ, Webb KW. Pediatric head injuries and deaths from bicycling in the United States. Pediatrics 1996;98:868-70.
16. Powell EC, Tanz RR, DiScala C. Bicycle-related injuries among preschool children. Ann Emerg Med 1997;30:260-5.
17. Powell EC, Tanz RR. Cycling injuries treated in emergency departments: need for bicycle helmets among preschoolers. Arch Pediatr Adolesc Med 2000;154:1096-100.
18. Schulman J, Sacks J, Provenzano G. State level estimates of the incidence and economic burden of head injuries stemming from non-universal use of bicycle helmets. Inj Prev 2002;8:47-52.
19. Miller TR, Zaloshnja E, Lawrence BA, Crandall J, Ivarsson J, Finkelstein AE. Pedestrian and pedalcyclist injury costs in the United States by age and injury severity. Annu Proc Assoc Adv Automot Med 2004;48:265-84.
20. Xiang H, Zhu M, Sinclair SA, Stallones L, Wilkins JR III, Smith GA. Risk of vehicle-pedestrian and vehicle-bicyclist collisions among children with disabilities. Accid Anal Prev 2006;38:1064-70.
21. Shah S, Sinclair SA, Smith GA, Xiang H. Pediatric hospitalizations for bicycle-related injuries. Inj Prev 2007;13:316-21.
22. Stutts JC, Hunter WW. Motor vehicle and roadway factors in pedestrian and bicyclist injuries: an examination based on emergency department data. Accid Anal Prev 1999;31:505-14.
23. Ortega HW, Shields BJ, Smith GA. Bicycle-related injuries in children and parental attitudes regarding bicycle safety. Clin Pediatr (Phila) 2004;43:251-9.
24. Kim JK, Kim S, Ulfarsson GF, Porrello LA. Bicyclist injury severities in bicycle-motor vehicle accidents. Accid Anal Prev 2007;39:238-51.
25. Abdel-Aty M, Chundi SS, Lee C. Geo-spatial and log-linear analysis of pedestrian and bicyclist crashes involving school-aged children. J Safety Res 2007;38:571-9.
26. Rodgers GB. The effectiveness of helmets in reducing all-terrain vehicle injuries and death. Accid Anal Prev 1990;22:47-58.
27. Rodgers GB. The characteristics and use patterns of all-terrain vehicle drivers in the United States. Accid Anal Prev 1999;31:409-19.
28. Helmkamp JC. Injuries and deaths and the use of all-terrain vehicles. N Engl J Med 2000;343:1733-4.
29. Rodgers GB, Adler P. Risk factors for all-terrain vehicle injuries: a national case-control study. Am J Epidemiol 2001;153:1112-8.
30. Helmkamp JC. A comparison of state-specific all-terrain vehicle-related death rates, 1990–1999. Am J Public Health 2001;91:1792-5.
31. Rodgers GB. Factors associated with the all-terrain vehicle mortality rate in the United States: an analysis of state-level data. Accid Anal Prev 2008;40:725-32.
32. Ganos D, Crady S, Poortenga S, Hoffman G, Mann R. Trauma associated with three-and four-wheeled all-terrain vehicles: is the four-wheeler an unrecognized health hazard? Am Surg 1988;54:429-33.
33. Greene MA, Metzler MH. Trauma associated with three and four-wheeled all-terrain vehicles. J Trauma 1988;28:391-4.
34. Dolan MA, Knapp JF, Andres J. Three-wheel and four-wheel all-terrain vehicle injuries in children. Pediatrics 1989;84:694-8.
35. Vasilakis A, Vargish T, Apelgren KN, Moran WH Jr. All-terrain vehicles (ATVs). A recreational gamble. Am Surg 1989;55:142-4.
36. Pollack CV, Pollack SB. Injury severity scores in desert recreational all-terrain vehicle trauma. J Trauma 1990;30:888-92.
37. Mangus RS, Simons CJ, Jacobson LE, Streib EW, Gomez GA. Current helmet and protective equipment usage among previously injured ATV and motorcycle riders. Inj Prev 2004;10:56-8.
38. Holmes PJ, Koehler J, McGwin G Jr, Rue LW III. Frequency of maxillofacial injuries in all-terrain vehicle collisions. J Oral Maxillofac Surg 2004;62:697-701.
39. Nelson TA, Hafner JW Jr. Emergency department pediatric all-terrain vehicle injuries in West Central Illinois. Pediatric Emerg Care 2005;21:719-24.
40. Fonseca AH, Ochsner MG, Bromberg WJ, Gantt D. All-terrain vehicle injuries: are they dangerous? A 6-year experience at a level I trauma center after legislative regulations expired. Am Surg 2005;71:937-40.
41. Levine D. All-terrain vehicle, trampoline and scooter injuries and their prevention in children. Curr Opin Pediatr 2006;18:260-5.
42. Miller B, Baig M, Hayes J, Elton S. Injury outcomes in children following automobile, motorcycle, and all-terrain vehicle accidents: an institutional review. J Neurosurg 2006;105(3 Suppl):S182-6.
43. Wu HY, Gaines BA. Dirt bikes and all terrain vehicles: the real threat to pediatric kidneys. J Urol 2007;178(4 Pt 2):1672-4.
44. Mullins RJ, Brand D, Lenfesty B, Newgard CD, Hedges JR, Ham B. Statewide assessment of injuries and death rates among riders of off-road vehicles treated in trauma centers. J Am Coll Surg 2007;204:216-24.
45. Brown RL, Koepplinger ME, Mehlman CT, Gittleman M, Garcia VF. All-terrain vehicle and bicycle crashes in children: epidemiology and comparison on injury severity. J Pediatric Surg 2002;37:375-80.
46. National Center for Health Statistics (US). Mortality data, multiple cause-of-death public-use data files [cited 2008 May 14]. Available from: URL: http://www.cdc.gov/nchs/products/elec_prods/subject/mortmcd.htm
47. World Health Organization. International statistical classification of diseases and health related problems, 10th revision, volume 1. Geneva: WHO; 1992.
48. All-terrain vehicle fatalities—West Virginia, 1999–2006. MMWR Morb Mortal Wkly Rep 2008;57(12):312-5.
49. Specialty Vehicle Institute of America. State all-terrain vehicle requirements. Arlington (VA): Government Relations Office, SVIA; November 2006.
50. Helmkamp J. Death and injury resulting from ATV and bicycle crashes: a 5-year comparison of national prevalence and cost estimates among children and adults. Washington: Arabella Legacy Fund and Concerned Families for ATV Safety; October 2007. Also available from: URL: http://www.atvsafetynet.org/helmkamp.pdf [cited 2008 Apr 29].
51. Rice DP, MacKenzie EJ, Jones AS, Kaufman SR, deLissovoy GV, Max W, et al. Cost of injury in the United States: a report to Congress. San Francisco: Institute for Health & Aging, University of California, and Injury Prevention Center, The Johns Hopkins University; 1989.
52. Arias E. United States life tables, 2000. Natl Vital Stat Rep 2002 Dec 19;51:1-39.
53. Haddix AC, Teutsch SM, Corso PS, editors. Prevention effectiveness: a guide to decision analysis and economic evaluation. 2nd ed. New York: Oxford University Press; 2002.
54. Gold MR, Siegel JE, Russell LB, Weinstein MC, editors. Cost-effectiveness in health and medicine. New York: Oxford University Press; 1996.
55. Miller TR. The plausible range for the value of life: red herrings among the mackerel. J Forensic Economics 1990;3:17-39.
56. Rodgers GB. Bicycle and bicycle helmet use patterns in the United States in 1998. J Safety Res 2000;31:149-58.
57. Eaton DK, Kann L, Kinchen S, Ross J, Hawkins J, Harris WA, et al. Youth Risk Behavior Surveillance—United States, 2005. MMWR Surveill Summ 2006;55(5):1-108.
58. Christoffel T, Gallagher SS. Injury prevention and public health. 2nd ed. Sudbury (MA): Jones and Bartlett Publishers; 2006.
59. Coffman S. Bicycle injuries and safety helmets in children. Review of research. Orthop Nurs 2003;22:9-15.
60. Dannenberg AL, Gielen A, Beilenson PL, Wilson MH, Joffe A. Bicycle helmet laws and educational campaigns: an evaluation of strategies to increase children's helmet use. Am J Public Health 1993;83:667-74.
61. Injury-control recommendations: bicycle helmets. MMWR Recomm Rep 1995;44(RR-1):1-17.
62. Thompson DC, Rivara FP, Thompson RS. Effectiveness of bicycle

safety helmets in preventing head injuries: a case-control study. JAMA 1996;276:1968-73.
63. Rivara FP, Astley SJ, Clarren SK, Thompson DC, Thompson RS. Fit of bicycle helmets and risk of head injuries in children. Inj Prev 1999;5:194-7.
64. Kanny D, Schieber RA, Pryor V, Kresnow MJ. Effectiveness of a state law mandating use of bicycle helmets among children: an observational evaluation. Am J Epidemiol 2001;154:1072-6.
65. Everett SA, Shults RA, Barrios LC, Sacks JJ, Lowry R, Oeltmann J. Trends and subgroup differences in transportation-related injury risk and safety behaviors among high school students. J Adolesc Health 2001;28:228-34.
66. Finnoff JT, Laskowski ER, Altman KL, Diehl NN. Barriers to bicycle helmet use. Pediatrics 2001;108:E4.
67. Rodgers GB. Effects of state helmet laws on bicycle helmet use by children and adolescents. Inj Prev 2002;8:42-6.
68. Liller KD, Nearns J, Cabrera M, Joly B, Noland V, McDermott R. Children's bicycle helmet use and injuries in Hillsborough County, Florida, before and after helmet legislation. Inj Prev 2003;9:177-9.
69. Karkhaneh M, Kalenga JC, Hagel BE, Rowe BH. Effectiveness of bicycle helmet legislation to increase helmet use: a systematic review. Inj Prev 2006;12:76-82.
70. Lehto MR, Foley JP. Risk-taking, warning labels, training, and regulation: are they associated with the use of helmets by all-terrain vehicle riders? J Safety Res 1991;22:191-200.
71. Upperman JS, Schultz B, Gaines BA, Hackam D, Cassidy LD, Ford HR, et al. All-terrain vehicle rules and regulations: impact on pediatric mortality. J Pediatr Surg 2003;38:1284-6.
72. Keenan HT, Bratton SL. All-terrain vehicle legislation for children: a comparison of a state with and a state without a helmet law. Pediatrics 2004;113:330-4.
73. Gittelman MA, Pomerantz WJ, Groner JI, Smith GA. Pediatric all-terrain vehicle-related injuries in Ohio from 1995 to 2001: using the injury severity score to determine whether helmets are a solution. Pediatrics 2006;117:2190-5.
74. Bicycle Helmet Safety Institute. Helmet laws for bicycle riders [cited 2008 May 22]. Available from: URL: http://www.helmets.org/mandator.htm
75. Department of Health and Human Services (US). Healthy people 2010—objective to improve health, volume 2, chapter 15. Washington: U.S. Government Printing Office; November 2000.
76. U.S. District Court for the District of Columbia. 1988. United States v American Honda Motor Company, Inc., et al. Washington: U.S. District Court for the District of Columbia; 1992. Civil action no. 97-3525.
77. Consumer Federation of America. ATV safety crisis: America's children at risk. Washington: CFA; August 2002. Also available from: URL: http://www.consumerfed.org/pdfs/Final_ATVReportLinks.pdf [cited 2008 May 22].
78. All-terrain vehicle injury prevention: two-, three-, and four-wheeled unlicensed motor vehicles. Pediatrics 2000;105:1352-4.
79. American Academy of Orthopaedic Surgeons. Position statement on all-terrain vehicles, revised June 2005 [cited 2008 May 23]. Available from: URL: http://www.aaos.org/about/papers/position/1101.asp
80. Consumer Product Safety Commission (US). State ATV information [cited 2008 May 29]. Available from: URL: http://www.atvsafety.gov/state/state.html
81. Ehrlich PF, Helmkamp JC, Williams JM, Haque A, Furbee PM. Matched analysis of parents' and children's attitudes and practices towards motor vehicle and bicycle safety: an important information gap. Inj Control and Saf Promot 2004;11:23-8.