

Age-Based Risk Factors for Pediatric ATV-Related Fatalities



WHAT'S KNOWN ON THIS SUBJECT: Younger age has been identified as an independent risk factor for all-terrain vehicle (ATV)-related injuries. Since the mid-1980s, one-third of ATV-related deaths have involved children younger than 18 years of age.



WHAT THIS STUDY ADDS: Using national data, we found both similarities and differences between pediatric age groups in the contribution of known risk factors to ATV-related deaths. The observed differences suggest the importance of targeting injury prevention approaches to specific age ranges.

abstract

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OBJECTIVES: To compare and contrast characteristics and determinants of fatal all-terrain vehicle (ATV) crashes among pediatric age groups.

METHODS: Retrospective descriptive and multivariable analyses of Consumer Product Safety Commission fatality data (1985–2009) were performed.

RESULTS: Relative to 1985–1989 (baseline), pediatric deaths over the subsequent 4-year periods were lower until 2001–2004, when they markedly increased. Also, the proportion of vehicles involved in fatalities with engine sizes >350 cubic centimeter increased, reaching ~50% of crashes in 2007–2009. Ninety-five percent of all pediatric fatalities were on adult-size vehicles. Victims <6 years old had the highest proportion of girls (24%) and passengers (76%), and the lowest helmet use (17%). More than half of 6- to 11-year-old children were vehicle operators; 1 in 4 were carrying passengers in their own age range. Over the study period, 12- to 15-year-old children accounted for more than half of all pediatric ATV-related fatalities. The proportion of youth riding on the road increased with age, as did the proportion of collisions with other vehicles. Older teens had the highest proportions of roadway fatalities (72%) and collision events (63%), and 19% of their crashes involved alcohol. Head injuries occurred in 63% of victims (the major determinant being roadway riding), and helmets reduced the likelihood of head injury among fatal crash victims by 58%.

CONCLUSIONS: There were significant differences between pediatric age groups in the relative contribution of known risk factors for ATV-related fatalities. Future injury prevention efforts must recognize these differences and develop interventions based on the age range targeted. *Pediatrics* 2014;134:1094–1102

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KEY WORDS

all-terrain vehicle, off-highway vehicle, pediatric, motor vehicle crash, fatality, injury prevention

ABBREVIATIONS

aOR—adjusted odds ratio
ATV—all-terrain vehicle
CI—confidence interval
CPSC—Consumer Product Safety Commission
cc—cubic centimeter

Dr Denning requested data from the Consumer Product Safety Commission, created an ACCESS database, helped conceptualize the study, assisted in analysis of the data, and helped draft and revise the manuscript; Dr Harland assisted in the design of data analysis, performed the multivariable logistic regression analyses, and helped draft the Methods section and revise the final manuscript; Dr Jennissen helped conceptualize and design the study, determine analyses to be performed, and draft and revise the manuscript; and all authors approved the final manuscript as submitted.

www.pediatrics.org/cgi/doi/10.1542/peds.2014-1993

doi:10.1542/peds.2014-1993

Accepted for publication Sep 24, 2014

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

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

FUNDING: Funding provided by the University of Iowa Emergency Medicine Department.

POTENTIAL CONFLICT OF INTEREST: The authors have indicated they have no potential conflicts of interest to disclose.

All-terrain vehicles (ATVs) present a significant injury risk to children and teens, with children <16 years of age at 12 times the risk of older adults.¹ In fact, more US children are killed riding ATVs each year than in bicycle crashes.² The high risk for death and injury among youth is likely attributable to a number of factors, including physical and mental immaturity, lack of training and experience, operating adult-size machines, riding on roadways, not wearing a helmet, and carrying or being a passenger.^{3–12}

According to the Consumer Product Safety Commission (CPSC), youth <16 years of age have represented approximately one-quarter of all deaths and one-third of all US ATV-related injuries.¹³ More than 40% of these pediatric deaths were children <12 years of age. Because adult fatalities have been rising at a faster rate than pediatric deaths, younger victims have become a lower proportion of fatalities in recent years.¹³

In previous studies of ATV-related fatalities comparing crashes that occurred on and off the road,⁷ we found that roadway deaths were less common than off-road deaths for those ≤11 years of age. However, more than half of all fatalities among 12- to 15-year-old children occurred on the road. Helmet use was only 25% for victims <16 years of age, regardless of crash location. The current study was designed to determine the major contributors to ATV-related deaths among pediatric age groups and included older teens as a separate group for analysis.

METHODS

CPSC ATV Fatality Database

A retrospective study of ATV-related deaths from 1985 to 2009 using de-identified CPSC fatality data was performed. Data were obtained by using the CPSC online request form.¹⁴ The University of Iowa Institutional Review Board deemed the study to be exempt.

Study Variables

Person-Related Variables

A pediatric victim was defined as a person <18 years old. Age categories analyzed were <6, 6 to 11, 12 to 15, and 16 to 17 years of age. The CPSC variable “victim” coded for operator/passenger. To distinguish operators alone from operators with passengers, “victim” coding was combined with the variable “riders” (1 for operator alone and >1 for operator with passengers).

Vehicle-Related Variables

Only crashes involving 3-wheeled and 4-wheeled ATVs were included. Engine sizes in cubic centimeter (cc) were grouped as follows: ≤90, 110 to 350, 375 to 600, and 625 to 850 cc.

Crash-Related Variables

Crash location was coded as being “ON” or “OFF” the road as previously described.⁷ A second variable “terrain” was used to identify indeterminate and inconsistent location data. Records that were coded OFF but had terrain codes of “paved” or “unpaved” roads were re-coded as unknown (56 records). Records coded as ON but with potentially

inconsistent terrain codes (eg, forest/woods) were also re-coded as unknown (219 records).

Crash mechanism coding was created from the CPSC variables “hp” (hazard pattern)⁷ and “traffic.” Using hp codes for collisions with another vehicle and traffic codes for ATV or other motor vehicle, records were coded as “ATV–ATV” or “ATV–VEH” collisions. A coding of “ATV–Other” was based on combining all hp codes for collisions with objects other than vehicles. All records with hp codes for overturned, rollovers in specific directions, and falling off or being thrown from the vehicle were coded as a “Non-collision” event.⁷

Injuries

Head injuries were determined as previously described.⁷ Because the cause of death narrative was often nonspecific (eg, multiple blunt trauma), all head injuries recorded for fatality victims were included in analysis.⁷

Data Analysis

Only the years for which recorded deaths were indicated by the CPSC to be complete when data were provided (ie,

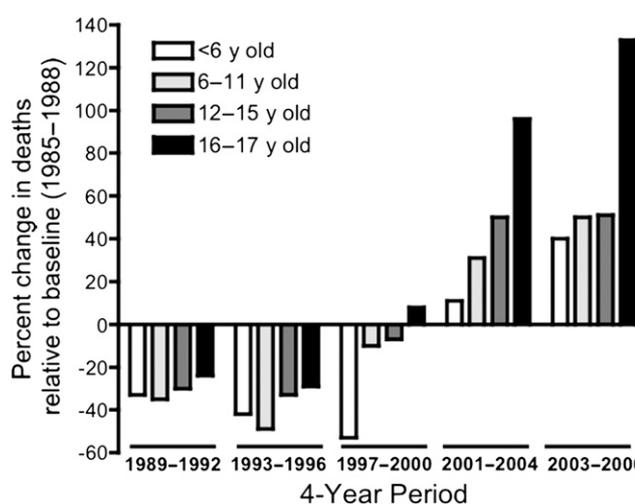


FIGURE 1

The number of deaths for each age group from 1985 to 1988 was determined and defined as baseline. The number of deaths for the indicated 4-year periods were then calculated for each age group and expressed as the percentage increase relative to baseline. Note that the last two time periods overlap. Only years considered complete by the CPSC (1985–2006) were used for analysis.

1985–2006) were used to calculate changes in the number of deaths over time. Data from all years were used for descriptive, comparative, and multivariable analyses. Data designated “unknown” or missing were not included in analysis. Descriptive analyses were performed by using Microsoft ACCESS 2010. Comparisons of proportions for single variable analyses were done by using the χ^2 test (<http://www.vassarstats.net>). All other statistical analyses were performed using SAS software, Version 9.2 of the SAS System for Microsoft (SAS Institute Inc, Cary, NC). Multivariable logistic regression analysis was used to calculate adjusted odds ratios (aOR) and 95% confidence intervals (95% CI) for categorical variables, after controlling for significant covariables. Victims who had missing data for 1 or more of the variables in the model were not included in multivariable analyses.

RESULTS

Pediatric Fatalities 1985–2009

Out of 10 012 ATV-related fatalities, 3240 were victims <18 years old. When the percent change in fatalities was calculated for 4-year time periods relative to the 4 earliest years provided (baseline years 1985–1988), there was a decrease in fatalities among all age groups for 1989 to 1992 and for 1993 to 1996 (Fig 1). The 4-year number was still lower than baseline for all pediatric age groups, except 16- to 17-year-olds, for the time period 1997 to 2000, with half as many deaths as at baseline for victims <6 years of age. These decreases were followed in time by significant increases, with the percent increases from baseline among older teens being similar to those of the next oldest age group, 18 to 25 years of age (data not shown).

Person-Related Variables

The highest proportion of pediatric deaths was among 12- to 15-year-olds

(Table 1). By individual age, the 2 highest proportions were for victims 14 (14%) and 15 (13%) years of age. Girl fatalities were most common among victims <6 years of age, and the proportion significantly decreased as age increased.

An inverse relationship was also observed between pediatric age group and being a passenger victim. For victims <6 years of age, the proportion of fatal crashes with multiple riders was twice as high as for other age groups, and 1 out of every 5 involved 3 or more riders on the ATV.

For passenger victims, the ATV operator was an adult in over 60% of crashes involving children <6 years of age and in one-third of crashes involving 6- to 11-year-old children. In contrast, only 16% of the passenger victims 12 to 15 years of age were in crashes with an adult operator. Almost three-quarters of passenger victims 16 to 17 years of age were on vehicles operated by their peers or by adults, with 83% of these adult operators being 18 to 25 years of age.

For all age groups, operators riding alone had the highest helmet use as compared with riders on vehicles with

TABLE 1 Person-Related Variables For Pediatric ATV Fatalities From 1985 to 2009; *N* = 3240

	Age Range, y				<i>P</i> Value ^a
	<6	6 to 11	12 to 15	16 to 17	
Number of fatalities	234 (7)	849 (26)	1469 (45)	688 (21)	
Person-related variables					
Gender					
Male	149 (76)	571 (80)	1033 (82)	494 (87)	0.001
Female	46 (24)	142 (20)	221 (18)	74 (13)	
Seating position of victim					
Operator alone	38 (20)	353 (51)	677 (58)	325 (61)	<0.001
Operator with passenger	7 (4)	113 (16)	284 (24)	123 (23)	
Passenger	141 (76)	225 (33)	207 (18)	86 (16)	
Number of passengers in crash					
None	51 (28)	373 (56)	693 (61)	334 (64)	<0.001
One	93 (52)	240 (36)	368 (32)	169 (33)	
>1	36 (20)	56 (8)	74 (7)	16 (3)	
Operator age for passenger victims in age range, y					
<6	1 (1)	1 (1)	0 (0)	0 (0)	<0.001
6 to 11	22 (18)	58 (27)	8 (4)	1 (1)	
12 to 15	19 (16)	64 (30)	126 (64)	22 (27)	
16 to 17	5 (4)	20 (9)	30 (15)	24 (29)	
≥18	74 (61)	71 (33)	32 (16)	35 (43)	
Helmet use					
Yes	26 (17)	170 (29)	256 (26)	105 (24)	0.01
No	127 (83)	412 (71)	742 (74)	338 (76)	
Helmet use and seating position					
Operator alone					
Yes	17 (52)	119 (39)	176 (30)	82 (30)	0.003
No	16 (48)	183 (61)	403 (70)	193 (70)	
Operator with passenger					
Yes	0 (0)	17 (16)	53 (21)	10 (9)	0.04
No	6 (100)	89 (84)	205 (79)	97 (91)	
Passenger					
Yes	7 (7)	26 (17)	21 (16)	12 (24)	0.05
No	88 (93)	127 (83)	111 (84)	39 (76)	
<i>P</i> value ^b	<0.0001	<0.0001	0.0002	0.0001	
Alcohol involved					
Yes	9 (8)	13 (3)	26 (3)	66 (19)	<0.0001
No	108 (92)	463 (97)	721 (97)	279 (81)	

All data are presented as *N* (Column %) unless otherwise specified. Column *N* totals may not equal overall totals owing to missing or unknown values.

^a χ^2 comparison of pediatric age groups.

^b χ^2 comparison of helmet use and seating position within each pediatric age group.

one or more passengers. Overall, children <6 years of age had a significantly lower proportion of helmeted riders than other age groups. This was largely because the age group had the highest percentage of passenger victims, and passengers were the least commonly helmeted. Conversely, victims <6 years of age who were operators riding alone had the highest proportion of helmet use (52%).

Alcohol was involved in 8% of crashes with a victim <6 years of age, and in 3% of crashes with victims 6 to 15 years of age. Almost 1 in 5 crashes among victims 16 to 17 years old involved alcohol, with 83% of the teen victims in such crashes having consumed alcohol themselves.

Vehicle-Related Variables

The engine size of vehicles involved in pediatric fatalities increased dramatically over time, particularly after the year 2000 (Fig 2). Over the time-frame studied, adult-sized vehicles (engine displacement >90 cc) were involved in 95% of fatalities among victims younger than the recommended age for these machines (ie, <16 years of age). Higher proportions of victims 12 to 17 years of age were riding on adult-sized ATVs as compared with riders <12 years of age (Table 2).

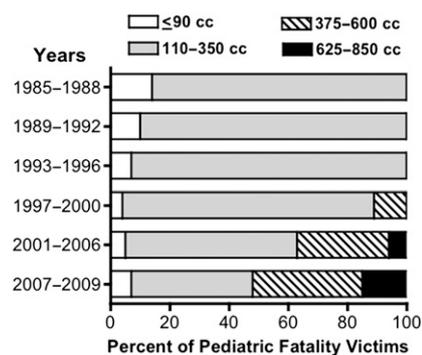


FIGURE 2

The percent of all pediatric (<18 years of age) fatalities that involved the listed ATV engine size ranges in cubic centimeters (cc) was determined for the indicated years.

Crash-Related Variables

As compared with other pediatric age groups, 16- to 17-year-olds had the highest overall proportion of fatal crashes on roadways (Table 2). Although lower than other age groups, almost 40% of the children <6 years of age were killed in roadway crashes. When crash location by seating position was examined for each age group, victims ages 6 to 11 and 12 to 15 years who were on vehicles with >1 rider had higher proportions killed in roadway crashes than in crashes off-road.

For crash mechanism, the same proportion of 12- to 15-year-olds and 16- to 17-year-olds were involved in collisions with other vehicles, but 16- to 17-year-olds had a higher proportion of collisions with other objects. Thus, more than two-thirds of crashes (68%) among these older teens involved collision events. In contrast, victims <6 and 6 to 11 years

of age were involved in a much higher percentage of non-collision events.

Injuries

More than 60% of pediatric victims suffered a head injury (Table 3). For all age groups, the highest proportion of head injuries was among passenger victims. Additionally, higher proportions of victims without helmets suffered head injuries. However, even with a helmet, more than half of all pediatric fatalities included injuries to the head.

Multivariable Analysis

As compared with 16- to 17-year-olds, all other age groups were less likely to be boys and less likely to have been killed in a roadway crash (Table 4). Children ≤11 years of age were significantly more likely to be passenger victims than youth ≥12 years of age. Only

TABLE 2 Vehicle- and Crash-Related Variables for Pediatric ATV Fatalities From 1985 to 2009; *N* = 3240

	Age Range, y				<i>P</i> value ^a
	<6	6 to 11	12 to 15	16 to 17	
Engine size, cc					
≤90	32 (23)	81 (15)	39 (4)	7 (2)	<0.001
110 to 350	90 (63)	381 (70)	771 (80)	293 (73)	
375 to 600	15 (11)	69 (13)	134 (14)	79 (20)	
625 to 850	5 (4)	13 (2)	25 (3)	22 (5)	
Crash location					
Roadway	82 (38)	363 (46)	908 (65)	463 (72)	<0.001
Off-road	131 (62)	425 (54)	482 (35)	177 (28)	
Crash location and seating position					
Operator alone					
Roadway	9 (24)	134 (40)	382 (59)	221 (72)	<0.001
Off-road	28 (76)	200 (60)	269 (41)	84 (28)	
Operator with passenger					
Roadway	2 (33)	58 (52)	197 (72)	89 (77)	<0.001
Off-road	4 (67)	53 (48)	77 (28)	26 (23)	
Passenger					
Roadway	55 (41)	123 (58)	154 (77)	65 (80)	<0.001
Off-road	79 (59)	90 (42)	45 (23)	16 (20)	
<i>P</i> value ^b	0.14	<0.001	<0.001	0.29	
Crash mechanism					
ATV-ATV collision	3 (1)	13 (2)	27 (2)	20 (3)	<0.001
ATV-vehicle collision	18 (9)	110 (15)	260 (20)	111 (19)	
ATV-other collision	68 (33)	169 (23)	427 (33)	245 (41)	
Non-collision	119 (57)	459 (61)	579 (45)	223 (37)	

All data are presented as *N* (column %) unless otherwise specified.

Column *N* totals may not equal overall totals owing to missing or unknown values.

^a χ^2 comparison of pediatric age groups.

^b χ^2 comparison of crash location and seating position within each pediatric age group.

TABLE 3 Injuries Among Pediatric ATV Fatalities From 1985 to 2009; *N* = 3240

	Age Range, y				<i>P</i> value ^a
	<6	6 to 11	12 to 15	16 to 17	
Head injury					
Yes	147 (67)	484 (60)	894 (64)	423 (65)	0.07
No	71 (33)	324 (40)	505 (36)	225 (35)	
Head injury and seating position					
Operator alone					
Yes	19 (51)	178 (53)	408 (63)	185 (60)	0.012
No	18 (49)	160 (47)	240 (37)	122 (40)	
Operator with passenger					
Yes	5 (71)	71 (65)	168 (61)	80 (69)	0.50
No	2 (29)	38 (35)	106 (39)	36 (31)	
Passenger					
Yes	98 (72)	148 (66)	145 (73)	56 (69)	0.46
No	39 (28)	75 (34)	53 (27)	25 (31)	
<i>P</i> value ^b	0.07	0.002	0.01	0.14	
Head injury and location					
Roadway					
Yes	53 (71)	232 (65)	600 (67)	304 (67)	0.78
No	22 (29)	125 (35)	294 (33)	153 (33)	
Off-road					
Yes	86 (66)	229 (55)	279 (59)	109 (63)	0.07
No	45 (34)	190 (45)	192 (41)	63 (37)	
<i>P</i> value ^b	0.56	0.004	0.005	0.52	
Head injury and helmet use					
Helmeted					
Yes	13 (52)	86 (52)	138 (56)	53 (51)	0.74
No	12 (48)	80 (48)	107 (44)	51 (49)	
Not helmeted					
Yes	90 (72)	264 (65)	505 (70)	231 (71)	0.22
No	35 (28)	140 (35)	213 (30)	93 (29)	
<i>P</i> value ^b	0.08	0.004	<0.001	<0.001	

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Column *N* totals may not equal overall totals owing to missing or unknown values.

^a χ^2 comparison of pediatric age groups.

^b χ^2 comparison of head injury and the specified variable within each pediatric age group.

victims who were 6 to 11 years old were more likely than older teens to be helmeted. There were no age-dependent differences in crash mechanism.

After controlling for other variables, boys were more likely to be helmeted than girls (Table 5). Conversely, crash victims with passengers on the vehicle and riders of adult-sized vehicles were less likely to be wearing helmets. There was no association between helmet use and age or crash mechanism.

Roadway crashes were more likely to result in a head injury than crashes off-road (Table 5). On the other hand, the likelihood of a head injury when controlling for all variables did not depend on gender, age, engine size, or crash

mechanism. Among pediatric fatality victims, helmets reduced the likelihood of a head injury by 58%.

DISCUSSION

Pediatric Fatalities

Pediatric ATV-related deaths fell from 1988 to 1998 and rose rapidly thereafter. This increase is likely attributable to many factors, including increasing numbers, size, and speed of ATVs. There were also changes in governmental regulation of the industry during this timeframe,⁴ the impact of which remains unknown. Recent studies illustrate the ongoing and serious nature of ATV crashes.^{10,11,15} One report showed that pediatric ATV-related traumas were associated with more

interhospital transfers and higher injury severity scores than other trauma admissions.¹⁵

Targeted Injury Prevention Approaches

Under 6 Years of Age

Not surprisingly, more than three-fourths of victims in this age range were passengers. More than 60% were riding with adult operators, potentially a parent or grandparent. Additionally, 1 in 5 of these crashes involved >1 passenger. Our recent studies showed that ATV seat length varied significantly.¹⁶ Longer seats could encourage the carrying of passengers.

There are no motorized ATVs designed for operation by children <6 years of age. Yet 1 in 4 victims in this age range were operators, and 42% of these operators were driving adult-sized machines. Our seat studies showed that the fronts of some adult vehicle seats are as little as 3.25 inches from the handlebars.¹⁶ Seats starting closer to the handlebars could allow operation of the steering mechanism by very young children.

The extreme vulnerability of this age range justifies laws prohibiting their riding on any ATV. In this respect, some success has been seen with age restriction legislation.^{17,18} Although age restriction laws were not popular among focus groups of teens and their parents,⁵ it is not clear whether this sentiment would extend to children this young. In addition, reducing deaths and injuries in this age range will require targeted adult education regarding the hazards of carrying children on ATVs, engineering changes in seat design, and the passage and/or stronger enforcement of “no passenger” laws.

6 to 11 Years of Age

Almost half of victims in this age range were on ATVs with >1 rider, and nearly half were on the road. Among the two-thirds of victims who were operators,

TABLE 4 Multivariable Analysis of the Likelihood That the Pediatric Age Group Has the Indicated Characteristic (Referent, 16- to 17-Year-Old Children)^{a,b}

	Age, y		
	<6	6 to 11	12 to 15
Gender			
Female	1.0 (referent)	1.0 (referent)	1.0 (referent)
Male	0.37 (0.21–0.65)	0.54 (0.35–0.83)	0.55 (0.37–0.81)
Seating position			
Operator alone	1.0 (referent)	1.0 (referent)	1.0 (referent)
Operator with passenger	0.44 (0.16–1.18)	0.94 (0.66–1.36)	1.06 (0.79–1.43)
Passenger	21.1 (11.9–37.6)	3.56 (2.36–5.39)	1.13 (0.75–1.68)
Helmet use			
Yes	1.0 (referent)	1.0 (referent)	1.0 (referent)
No	1.09 (0.61–1.97)	1.45 (1.04–2.02)	1.15 (0.86–1.54)
Location			
Roadway	1.0 (referent)	1.0 (referent)	1.0 (referent)
On-road	0.18 (0.11–0.30)	0.34 (0.24–0.46)	0.66 (0.49–0.89)
Mechanism			
ATV–ATV collision	1.0 (referent)	1.0 (referent)	1.0 (referent)
ATV–vehicle collision	0.65 (0.14–2.98)	1.55 (0.63–3.84)	1.61 (0.75–3.43)
ATV–other collision	0.76 (0.18–3.14)	0.85 (0.35–2.06)	1.51 (0.73–3.15)
Non-collision	1.36 (0.33–5.52)	2.18 (0.91–5.21)	1.89 (0.90–3.95)

All data are presented as aOR (95% CI) unless otherwise specified.

^a Victims who had missing data for 1 or more of the variables in the model were not included in multivariable analysis.

^b ORs were adjusted for all variables listed in the table for the indicated model.

TABLE 5 Multivariable Analysis of the Likelihood of Wearing a Helmet Versus Not Wearing a Helmet and of Having a Head Injury Versus No Head Injury^{a,b}

	Likelihood of Wearing a Helmet versus Not	Likelihood of Having a Head Injury versus Not
Gender		
Female	1.0 (referent)	1.0 (referent)
Male	1.50 (1.01–2.24)	0.85 (0.60–1.20)
Age, y ^b		
<6	0.80 (0.39–1.66)	0.99 (0.53–1.84)
6 to 11	1.22 (0.79–1.89)	0.90 (0.60–1.36)
12 to 15	1.21 (0.83–1.77)	0.96 (0.67–1.38)
16 to 17	1.0 (referent)	1.0 (referent)
Seating position		
Operator alone	1.0 (referent)	1.0 (referent)
Operator with passenger	0.44 (0.30–0.63)	1.01 (0.73–1.39)
Passenger	0.32 (0.21–0.49)	1.24 (0.86–1.78)
Engine size, cc		
≤90	1.0 (referent)	1.0 (referent)
110 to 350	0.36 (0.23–0.58)	1.55 (0.97–2.49)
375 to 600	0.57 (0.33–0.99)	1.35 (0.79–2.31)
625 to 850	0.25 (0.11–0.59)	1.68 (0.79–3.57)
Location		
Off-road	1.0 (referent)	1.0 (referent)
Roadway	0.88 (0.65–1.19)	1.42 (1.08–1.88)
Mechanism		
ATV–ATV collision	1.0 (referent)	1.0 (referent)
ATV–vehicle collision	0.60 (0.26–1.38)	0.43 (0.16–1.15)
ATV–other collision	0.70 (0.31–1.58)	0.40 (0.15–1.04)
Non-collision	0.64 (0.28–1.43)	0.49 (0.19–1.25)
Helmet use		
No	NA	1.0 (referent)
Yes		0.42 (0.32–0.56)

All data are presented as aOR (95% CI) unless otherwise specified.

^a Victims who had missing data for 1 or more of the variables in the model were not included in analysis.

^b ORs were adjusted for all variables listed in the table for the indicated model.

>80% were on adult-sized vehicles (>90 cc), and 13% were operating ATVs with engine sizes >350 cc.

Research on physical and cognitive development suggests that children in this age range, like their younger counterparts, should not be operating ATVs,¹⁹ and higher proportions of roll-overs relative to older riders may reflect these underdeveloped skills. With respect to youth-sized vehicles, previous recommendations were based on engine size (6- to 11-year-olds, <70 cc). New youth-sized ATVs are based on maximum speeds (Table 6). There is currently no safety research supporting the recommended speeds for these youth-sized vehicles.

States should also consider prohibiting this age group from riding on ATVs. The American Academy of Pediatrics states that children <16 years of age should be prohibited from riding on ATVs.²⁰ Minimally, more effective approaches must be found that keep these children off adult-sized vehicles and off roadways. Finally, direct supervision of children in this age range, defined as being within visual and auditory range, should occur and is required by law in some states. However, parents should be aware that deaths and injuries have occurred despite documented supervision.

12 to 15 Years of Age

From 1985 to 2009, this age group accounted for ~50% of all pediatric ATV-related fatalities. This is consistent with survey studies of adolescents showing high levels of unsafe riding behaviors.^{5,21–26} Additionally, on vehicles with multiple riders, two-thirds involved both operators and passengers within this age range, so negative peer influences are of particular concern.

Ninety-six percent of youth in this age range were killed on adult-sized ATVs, with 17% having engine sizes over 350 cc. Almost two-thirds of fatalities involved roadway crashes, which is

TABLE 6 Current Specifications for Youth Size ATVs

Recommended Age, y	Vehicle Model	Maximum Limited Speed, mph ^a	Maximum Unrestricted Speed, mph ^b
≥6	Y-6+	10	15
≥10	Y-10+	15	30
≥12	Y-12+	15	30
≥14	T	20	30 or 38

mph, miles per hour.

^a Maximum limited speed: ATV models in a youth category must have a device capable of limiting the vehicle to this speed or less.

^b Maximum unrestricted speed: highest speed an ATV within a youth category can travel with an adjusted speed limiter or the speed limiter removed.

consistent with a higher proportion of crashes being vehicle-vehicle collisions relative to younger victims.

The risk for crashes among young adolescents probably reflects a number of factors. This includes particularly high levels of risk-taking behavior among boys,^{3,21,27} which has been directly associated with unsafe ATV riding behaviors.²¹ This age group is also less likely to be supervised. Parents, especially those whose children have been riding since they were young, might assume their offspring are ready to ride without direct monitoring, even though they often lack formal training and continue to have limitations in cognitive function, judgment, and physical skills. Parents might not appreciate these limitations and their child's likelihood of engaging in risky behaviors, including carrying passengers and riding on the roads.^{4,5,22,23,26,28,29}

Safety training is important for these youth who may often lack even basic ATV safety knowledge.^{23,30–32} Injury prevention also requires getting these adolescents off adult-sized vehicles and off roadways, and the Y12+ and Y14+ models must be evaluated with respect to the safety of speed standards. If children in this age group are allowed to ride ATVs, parents need to set strict safety guidelines, carefully monitor riding behaviors, and appropriately respond when safety behavior expectations are violated.

16 to 17 Years of Age

Older teens have never been the focus of pediatric studies of ATV-related deaths

and injuries. Yet we recognize teens as a higher risk population for many other activities, including driving.³³ We found that these adolescents had a higher proportion of roadway versus off-road fatalities and of collision-related events than any other pediatric age group. During comparable time periods, alcohol was involved in 15% to 20% of fatal motor vehicle crashes for this age group³³ and in ATV-related deaths.

It seems unlikely that there will ever be restrictions in vehicle size and speed for youths of this age. Thus, understanding how size and speed, as well as cognitive immaturity, impact ATV handling by older teens is particularly important. ATVs should be treated like other high-speed motorized vehicles with operator training and licensing requirements.

Laws and enforcement keeping teens as single riders, free of alcohol, and off roadways would be among the most effective injury prevention approaches. Unfortunately, 69% of states allow ATVs on public roads to some extent, and recent legislative efforts are primarily increasing roadway use rather than limiting it.^{34,35} Although evidence for the effectiveness of ATV safety laws is mixed,^{18,36–39} we speculate that this reflects varying degrees of enforcement. Environments where laws may be better enforced demonstrate safer riding behaviors.⁴⁰

Helmets and Head Injuries

Head injuries were observed in 63% of pediatric ATV fatalities. When controlling for all other variables, the likelihood of

head injury and of helmet use was similar among pediatric age groups. On the other hand, boys were somewhat more likely to be helmeted than girls, and operators with passengers and passengers themselves were less likely to be wearing a helmet than operators riding alone. In regression analysis, riding on the road was an independent risk factor for head injury, increasing the likelihood by 45%. We speculate that this reflects higher speeds and crash forces on the road. Helmets reduced the likelihood of head injury in fatal crashes by almost 60%, a value similar to comparable studies.^{6,41,42} Although there is strong evidence supporting the effectiveness of ATV helmet use in fatal and non-fatal crashes,^{2,36,43–47} many states lack ATV helmet laws and existing laws are often limited in scope.⁴⁸

Study Limitations

Retrospective studies are often limited by incomplete documentation of some variables and the inability to collect missing data. Data were collected by using a standardized form for all states and every variable used in analysis was available for all years in the study period. Documentation of the variables ranged from 100% (age) to 50% (alcohol). Although we cannot rule out the possibility that documentation and/or inaccuracies in the primary data collected by the CPSC impacted our results, the large number of pediatric fatalities reduces this likelihood. Study data are for US fatalities and may not be generalizable to other countries.

CONCLUSIONS

Age-dependent variations in the extent to which major risk factors contribute to pediatric ATV-related deaths suggest that injury prevention strategies must be targeted to specific age groups. In each case, combinations of educational, engineering, and enforcement strategies will be needed. The high morbidity

and mortality associated with pediatric ATV crashes justifies significant investment in these strategies.

ACKNOWLEDGMENTS

We thank the US Consumer Product Safety Commission for providing us

with these data and the University of Iowa Department of Emergency Medicine for providing funding support.

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Pediatrics 2014;134;1094

DOI: 10.1542/peds.2014-1993 originally published online November 24, 2014;

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