Carrying Passengers as a Risk Factor for Crashes Fatal to 16- and 17-Year-Old Drivers

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Context Injuries from motor vehicle crashes are the leading cause of death among teenagers. Carrying passengers has been identified as a possible risk factor for these crashes.

Objective To determine whether the presence of passengers is associated with an increased risk of crashes fatal to 16- and 17-year-old drivers and whether the risk varies by time of day and age and sex of drivers and passengers.

Design and Setting Incidence study of data from the Fatality Analysis Reporting System and General Estimates System (1992-1997), as well as the Nationwide Personal Transportation Survey (1995).

Subjects Drivers aged 16 and 17 years who drove passenger cars, vans, or pickup trucks.

Main Outcome Measure Driver deaths per 10 million trips by number of passengers, driver age and sex, and time of day; and driver deaths per 1000 crashes by passenger age and sex.

Results Compared with drivers of the same age without passengers, the relative risk of death per 10 million trips was 1.39 (95% confidence interval [CI], 1.24-1.55) for 16-year-old drivers with 1 passenger, 1.86 (95% CI, 1.56-2.20) for those with 2 passengers, and 2.82 (95% CI, 2.27-3.50) for those with 3 or more passengers. The relative risk of death was 1.48 (95% CI, 1.35-1.62) for 17-year-old drivers with 1 passenger, 2.58 (95% CI, 2.24-2.95) for those with 2 passengers, and 3.07 (95% CI, 2.50-3.77) for those with 3 or more passengers. The risk of death increased significantly for drivers transporting passengers irrespective of the time of day or sex of the driver, although male drivers were at greater risk. Driver deaths per 1000 crashes increased for 16- and 17-year-olds transporting male passengers or passengers younger than 30 years.

Conclusion Our data indicate that the risk of fatal injury for a 16- or 17-year-old driver increases with the number of passengers. This result supports inclusion of restrictions on carrying passengers in graduated licensing systems for young drivers.

JAMA. 2000;283:1578-1582 www.jama.com

MOTOR VEHICLE CRASHES are the leading cause of death among teenagers in the United States, accounting for 36% of all deaths of persons aged 15 to 19 years.[1] The fatal crash rate per million miles for 16-year-old drivers is more than 7 times the rate for drivers aged 30 to 59 years.[2] Nearly the same number of deaths occur among teenaged passengers as teenaged drivers: in 1993, two thirds of the deaths of passengers aged 13 to 19 years occurred when teenagers were driving.[3] In recent years, increased attention has been given to graduated licensing systems. The basic premise of these systems is that beginning drivers need to earn a full license step-by-step. Three stages—a supervised learner's period, an intermediate license, and a full-privilege driver's license—are the central framework for graduated licensing systems. During the learner's period, beginning drivers can drive only under supervision. For the intermediate period, restrictions vary widely by state in the United States and may include restrictions on nighttime driving and carrying passengers.[4]

Graduated licensing systems are recommended by the National Highway Traffic Safety Administration and encouraged through an incentive grant program.[5] As of January 2000, 24 states had adopted full graduated licensing systems with all 3 stages. Only 9 of these 24 states included any restrictions related to teenaged drivers carrying passengers.[4]

Although past studies[6-8] provided evidence suggesting a relationship between carrying passengers and crash risk for teenaged drivers, they had insufficient information on travel exposure patterns, driver characteristics, and passenger attributes. Knowing the circumstances associated with increased risk to teenaged drivers is useful for

For editorial comment see 1617.

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formulating graduated driver licensing programs and for advising health professionals who take care of teenagers. Our study examined the associations between crashes fatal to 16- and 17-year-old drivers and the characteristics of passengers. The following potential risk factors were examined: driver age, driver sex, number of passengers, passenger age, passenger sex, and time of day.

METHODS

Data

Data for this study were from 3 federal sources: the Fatality Analysis Reporting System (FARS),[9] Nationwide Personal Transportation Survey (NPTS),[10] and General Estimates System (GES).[11] Drivers aged 16 and 17 years who drove passenger cars, vans, or pickup trucks were the focus of the study. Some analyses included drivers aged 30 to 59 years for purposes of comparison.

FARS collects data on all fatal traffic crashes within the United States that involve a motor vehicle traveling on a public road and result in a death within 30 days of the crash.[9] Data on crashes fatal to 16- and 17-year-old drivers were obtained from FARS for the years 1992-1997.

The NPTS provides comprehensive data on transportation patterns in the United States based on a national telephone survey of 42 033 households conducted from May 1995 to July 1996. Once a household was selected, travel diaries were mailed to the household and every person within the household who was aged 14 years or older was interviewed regarding trips made on a recent preassigned day. A proxy summarized trips for children aged 5 to 13 years.[10] The 1995 NPTS was the source for estimates of the number of trips for 16- and 17-year-old drivers. We chose number of trips as the measurement of travel exposure because individual trips vary in the number and characteristics of passengers.

The GES is a probability sample of US police-reported crashes on public roads that result in property damage, injury, or death.[11] There are 60 primary sampling units in the GES, chosen to be representative of the US population, and about 54 000 crashes per year are sampled.[11] Information on crashes involving 16- and 17-year-old drivers was obtained from GES data for the years 1992-1997.

Because uninjured passengers were not fully reported in some of the primary sampling units in the GES, we excluded those units from GES data to avoid misclassification of drivers with uninjured passengers as having carried fewer passengers. This resulted in exclusion of about 5% of weighted crashes from the GES data and a corresponding 5% overestimation of deaths per 1000 crashes. These primary sampling units could not be identified within FARS because the specific locations of GES primary sampling units are confidential and thus unavailable to researchers.

Analysis

Driver deaths were studied rather than deaths among all vehicle occupants because higher occupancy increases the probability that a crash will be fatal by increasing the population at risk. Statistical software (SPSS for Windows[12] and SAS[13]) was used to calculate rates.

Risk of Death per 10 Million Trips. FARS and NPTS data were used to calculate driver deaths per 10 million trips by number of passengers, driver age and sex, and time of day. These trip-based death rates measured the likelihood of involvement in a crash fatal to a 16- or 17-year-old driver.

Crash Outcome. FARS and GES data were used to compute deaths per 1000 crashes for 16- and 17-year-old drivers, combined, by passenger age and sex (deaths per 10 million trips could not be calculated by passenger age and sex because the NPTS lacked data on characteristics of passengers who were not household members). This different type of measure, deaths per 1000 crashes, represents crash outcome rather than fatal crash incidence and reflects crash forces and other variables (eg, seatbelt use) that might be affected by driver behaviors associated with the presence of passengers.

Passengers of both 16- and 17-year-old drivers, combined, were classified in 3 age groups: aged 13 to 19 years, 20 to 29 years, and 30 years or older. Analyses showed no differences among results based on passengers aged 20, 21, 22 to 24, or 25 to 29 years; therefore, passengers aged 20 to 29 years were grouped.

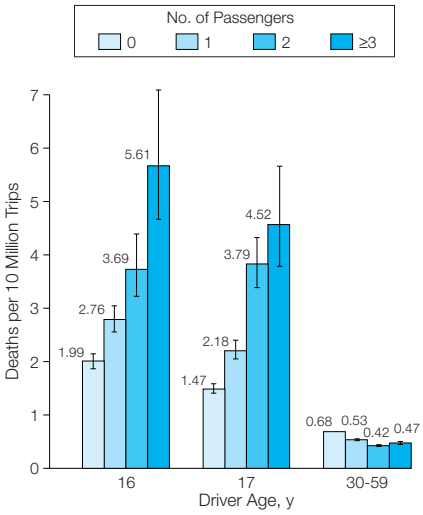
Relative Risk and Confidence Intervals. Relative risk was defined as the death rate ratio, calculated by dividing the death rate for the target group by that of the reference group. Because the GES and NPTS are data sets with multistage sampling designs, the statistical software SUDAAN[14] was used to calculate the SEs of weighted trips and weighted crashes. Ninety-five percent confidence intervals for the rates were calculated by the substitution method described by Daly.[15] Ninety-five percent confidence intervals for the relative risks were calculated based on a method described by Rothman and Greenland.[16]

RESULTS

Trip-Based Death Rates

Driver Age. Drivers aged 16 and 17 years had markedly higher risks for fatal crashes than older drivers (FIGURE, TABLE 1). Compared with driving alone, driver death rates per 10 million trips in-

Figure. Trip-Based Driver Death Rates by Driver Age and Number of Passengers



Error bars are 95% confidence intervals.

creased with the number of passengers for drivers aged 16 or 17 years. The highest death rate (5.61 per 10 million trips) was observed among drivers aged 16 years carrying 3 or more passengers. In contrast, death rates per 10 million trips for drivers aged 30 to 59 years were lower for drivers with passengers than for those without passengers.

Driver Sex. Whether or not passengers were transported, male drivers had higher death rates than female drivers (Table 1). Carrying passengers dramatically increased the risks of 16- and 17-year-old male drivers per 10 million trips: for 16-year-old males, the relative risk was 3.48 with 3 or more passengers vs no passengers. Carrying passengers also significantly increased the fatal crash risks of 16- and 17-year-old female drivers but to a lesser extent.

Time of Day. Nighttime death rates greatly exceeded daytime death rates among 16- and 17-year-old drivers, combined (TABLE 2). For drivers aged 16 to 17 years, carrying passengers significantly increased the risk of driver deaths per 10 million trips during each of the 3 time periods analyzed. The highest driver death rate for 16- and 17-year-old drivers, 21.88 per 10 million trips, was for drivers traveling with passengers between midnight and 5:59 AM.

Crash Outcome Analyses

Passenger Age. When crashes occurred, carrying passengers aged 13 to 19 years or aged 20 to 29 years was associated with significantly increased driver fatalities per 1000 crashes for 16- to 17-year-old drivers, combined (TABLE 3). The risk of death increased with the number of passengers. Carrying passengers aged 30 years or older did not increase the driver fatality rates.

Passenger Sex. Crash-involved 16- and 17-year-old drivers, combined, with male passengers were significantly more likely to die than those with only female passengers (TABLE 4). Risk of death increased with the number of male passengers. Similar effects of male passengers were observed for male and female drivers. Driver deaths per 1000 crashes more than doubled for both male and female drivers when there were 2 or more male passengers and nearly doubled with 1 male passenger.

COMMENT

The incidence of motor vehicle crashes fatal to 16- and 17-year-old drivers increased with the number of passengers

Table 1. Trip-Based Relative Risks for Driver Deaths by Number of Passengers, Driver Age, and Sex*

	No. of Passengers											
	Male Driver				Female Driver				Overall			
	0	1	2	≥3	0	1	2	≥3	0	1	2	≥3
Age 16 y												
Deaths, No.†	831	544	231	193	443	332	106	106	1274	876	337	299
No. of trips‡												
Weighted (in billions)§	0.53	0.21	0.06	0.04	0.54	0.32	0.09	0.05	1.07	0.53	0.15	0.09
Unweighted	556	207	63	26	498	260	76	41	1054	467	139	67
Death rate‖	2.61	4.39	6.29	9.08	1.38	1.72	1.94	3.31	1.99	2.76	3.69	5.61
Relative risk (95% CI)	1.00¶	1.68 (1.44-1.97)	2.41 (1.82-3.20)	3.48 (2.53-4.79)	1.00¶	1.25 (1.06-1.46)	1.41 (1.14-1.74)	2.40 (1.78-3.22)	1.00¶	1.39 (1.24-1.55)	1.86 (1.56-2.20)	2.82 (2.27-3.50)
Age 17 y												
Deaths, No.†	1048	615	238	224	577	281	122	79	1625	896	360	303
No. of trips‡												
Weighted (in billions)§	1.07	0.37	0.09	0.05	0.77	0.32	0.07	0.05	1.84	0.69	0.16	0.11
Unweighted	1091	406	89	52	863	335	94	65	1954	741	183	117
Death rate‖	1.63	2.77	4.61	6.92	1.26	1.48	2.82	2.28	1.47	2.18	3.79	4.52
Relative risk (95% CI)	1.00¶	1.70 (1.49-1.93)	2.83 (2.33-3.42)	4.25 (3.08-5.84)	1.00¶	1.18 (1.04-1.35)	2.24 (1.85-2.72)	1.81 (1.39-2.36)	1.00¶	1.48 (1.35-1.62)	2.58 (2.24-2.95)	3.07 (2.50-3.77)
Age 30-59 y												
Death, No.†	27 362	5785	1703	1318	10 594	2897	1025	836	37 957	8683	2728	2154
No. of trips‡												
Weighted (in billions)§	49.37	12.89	4.55	4.05	43.24	14.46	6.35	3.52	92.61	27.34	10.90	7.57
Unweighted	55 040	14 829	4735	3974	52 435	17 197	7061	4097	107 475	32 026	11 796	8071
Death rate‖	0.92	0.75	0.62	0.54	0.41	0.33	0.27	0.40	0.68	0.53	0.42	0.47
Relative risk (95% CI)	1.00¶	0.81 (0.79-0.83)	0.68 (0.65-0.70)	0.59 (0.57-0.61)	1.00¶	0.81 (0.80-0.83)	0.66 (0.64-0.68)	0.96 (0.93-1.01)	1.00¶	0.78 (0.76-0.79)	0.61 (0.60-0.62)	0.70 (0.67-0.71)

*CI indicates confidence interval.
†Data from National Highway Traffic Safety Administration, *Fatality Analysis Reporting System: 1992-1997*.[9]
‡Data from Federal Highway Administration, *1995 Nationwide Personal Transportation Survey*.[10]
§Weighted to provide national estimates of trips based on probabilities of selection of households, persons, and travel days in the sample.
‖Deaths per 10 million trips, based on weighted trips.
¶Reference group.

for both male and female drivers, during daytime and at night. In contrast, 30- to 59-year-old drivers who carried passengers had decreased death rates. Crashes are more likely to be fatal to drivers aged 16 and 17 years in the presence of male passengers, teenaged passengers, and passengers aged 20 to 29 years, findings not previously documented.

Why were there more deaths when 16- and 17-year-old drivers carried passengers? A survey of 192 high school drivers reported that dangerous driving behaviors (driving after drinking alcohol or using drugs, speeding, swerving, crossing the center line, purposely skidding, and running a red light) were strongly associated with the presence of peers.[17] When carrying passengers, drivers aged 16 to 19 years involved in fatal crashes were significantly more likely to be in single-vehicle crashes or to be coded as having made errors than when driving alone.[8]

The marked increase in fatal outcomes of crashes associated with carrying male passengers may be attributable to riskier driving behavior. A study that observed vehicles on the road found that, on average, young drivers with male passengers drove at higher speeds and followed preceding vehicles more closely than those without passengers or with female passengers.[18]

Alcohol consumption is a major risk factor for involvement in fatal crashes. Another possible explanation for passenger-related increases in fatalities is that drivers are more likely to be impaired by alcohol when carrying passengers, particularly those who can legally purchase alcohol. Unfortunately, we were unable to estimate the increased driver fatality risk associated with carrying passengers because alcohol use information was not consistently available from our data sources. Teenaged drivers are more susceptible than adult drivers to the impairing effect of alcohol: at each blood alcohol concentration, male drivers aged 16 to 19 years have higher risks of fatal crashes than older age groups.[19] The finding that carrying passengers aged 20 to 29 years increased the likelihood of fatal outcomes when 16- and 17-year-old drivers crashed suggests that a restriction on carrying any teenagers unless supervised by an adult at least 21 years old could have a negative effect if it increased the transport of passengers aged 20 to 29 years. Further study will be needed to clarify the relationship between the risk of teenaged driver crashes, carrying passengers of various ages, and alcohol use.

Driving at night is much more dangerous than driving during the daytime. The present study and previous research by Preusser et al[8] indicate that the effect of passengers is similar for

Table 2. Trip-Based Risks for Teenaged Driver Deaths by Time of Day and Passenger Presence*

	Time of Day					
	6 AM-9:59 PM Passenger Present		10 PM-11:59 PM Passenger Present		Midnight-5:59 AM Passenger Present	
	No	Yes	No	Yes	No	Yes
Deaths, No.†	1976	2069	348	424	550	573
Trips, No.‡						
Weighted (in billions)§	2.66	1.57	0.18	0.11	0.06	0.04
Unweighted	2757	1573	181	105	70	34
Death rate‖	1.24	2.20	3.26	6.37	14.20	21.88
Relative risk (95% CI)	1.00¶	1.77 (1.65-1.91)	1.00¶	1.95 (1.67-2.29)	1.00¶	1.54 (1.21-1.95)

*CI indicates confidence interval. Drivers were aged 16 and 17 years.
†Data from National Highway Traffic Safety Administration, *Fatality Analysis Reporting System: 1992-1997*.[9]
‡Data from Federal Highway Administration, *1995 Nationwide Personal Transportation Survey*.[10]
§Weighted to provide national estimates of trips based on probabilities of selection of households, persons, and travel days in the sample.
‖Deaths per 10 million trips, based on weighted trips.
¶Reference group.

Table 3. Teenaged Driver Deaths per 1000 Crashes by Passenger Age and Number of Passengers*

		Age of Passengers, y					
		13-19		20-29		≥30	
	No Passengers	1 Passenger	≥2 Passengers	1 Passenger	≥2 Passengers	1 Passenger	≥2 Passengers
Deaths, No.†	2899	1460	910	150	16	77	6
Crashes, No‡							
Weighted§	2 007 221	700 859	369 193	42 203	4103	49 688	4297
Unweighted	14 755	5612	3078	352	36	382	28
Death rate‖	1.44	2.08	2.46	3.55	3.90	1.55	1.40
Relative risk (95% CI)	1.00¶	1.45 (1.30-1.60)	1.71 (1.50-1.94)	2.47 (2.12-2.86)	2.71 (1.78-4.10)	1.08 (0.91-1.26)	0.97 (0.59-1.60)

*CI indicates confidence interval. Drivers were aged 16 to 17 years.
†Data from National Highway Traffic Safety Administration, *Fatality Analysis Reporting System: 1992-1997*.[9]
‡Data from National Highway Traffic Safety Administration, *General Estimates System: 1992-1997*.[11]
§Weighted to provide national estimates of crashes based on probabilities of selection of geographic areas, police agencies, and crashes in the sample.
‖Deaths per 1000 crashes, based on weighted crashes.
¶Reference group.

Table 4. Teenaged Driver Deaths per 1000 Crashes by Sex of Driver and Passengers*

	No. and Sex of Passengers					
		Female		Male		
	None	1	≥2	1	≥2	Both Sexes
Male Driver						
Deaths†	1879	242	78	931	473	331
Crashes‡						
Weighted§	1 145 262	149 932	33 272	331 871	145 077	105 129
Unweighted	8460	1214	295	2660	1237	890
Death rate‖	1.64	1.61	2.34	2.81	3.26	3.15
Relative risk (95% CI)	1.00¶	0.98 (0.87-1.11)	1.43 (1.20-1.69)	1.71 (1.53-1.92)	1.99 (1.74-2.26)	1.92 (1.66-2.22)
Female Driver						
Deaths†	1020	405	140	211	80	194
Crashes‡						
Weighted§	861 436	265 230	103 248	118 570	28 218	94 583
Unweighted	6293	2062	820	983	246	767
Death rate‖	1.18	1.53	1.36	1.78	2.84	2.05
Relative risk (95% CI)	1.00¶	1.29 (1.15-1.45)	1.15 (0.99-1.33)	1.51 (1.33-1.70)	2.40 (1.98-2.89)	1.74 (1.51-1.99)
Overall#						
Deaths†	2899	647	218	1142	553	525
Crashes‡						
Weighted§	2 007 221	415 162	136 900	450 441	173 295	199 724
Unweighted	14 755	3276	1117	3643	1483	1658
Death rate‖	1.44	1.56	1.59	2.54	3.19	2.63
Relative risk (95% CI)	1.00¶	1.08 (0.97-1.20)	1.11 (0.96-1.26)	1.76 (1.58-1.95)	2.22 (1.95-2.51)	1.83 (1.60-2.06)

*CI indicates confidence interval. Drivers were aged 16 to 17 years.
†Data from National Highway Traffic Safety Administration. *Fatality Analysis Reporting System: 1992-1997*.[9]
‡Data from National Highway Traffic Safety Administration, *General Estimates System: 1992-1997*.[11]
§Weighted to provide national estimates of crashes based on probabilities of selection of geographic areas, police agencies, and crashes in the sample.
‖Deaths per 1000 crashes, based on weighted crashes.
¶Reference group.
#The overall numbers for both sexes are slightly greater than the totals for males and females because the sex of the driver was unknown in some instances.

both daytime and nighttime driving. Nighttime driving restrictions are especially appropriate but cannot substitute for passenger restrictions, since more than half of the fatal crashes of teenaged drivers with passengers occur during daylight hours.

Graduated driver licensing has reduced teenaged driver crashes in Canada,[4] New Zealand,[20] and Florida.[21] Current graduated licensing systems in the United States either do not have passenger restrictions or have restrictions that are of short duration, permit up to 3 passengers, or do not specify passenger age.[4] The results of our study indicate that restrictions on carrying passengers should be considered for inclusion in graduated licensing systems for young drivers. Health professionals should advise parents of teenagers of the risks associated with the transport of passengers by young drivers.

Funding/Support: This work was supported by the Insurance Institute for Highway Safety and by grant R49 CCR 302486 from the Centers for Disease Control and Prevention to the Johns Hopkins Center for Injury Research and Policy.
Disclaimer: The opinions, findings, and conclusions expressed in this publication are those of the authors and do not necessarily reflect the views of the sponsors.
Acknowledgment: We thank Charles M. Farmer, PhD, of the Insurance Institute for Highway Safety for providing statistical advice.

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