



## Teenage drivers: patterns of risk

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### Abstract

*Problem:* To determine patterns of risk among teenage drivers. *Method:* Review and synthesis of the literature. *Results:* On most measures, crash rates during the teenage years are higher than at any other age, for both males and females. Risk among teenagers varies greatly by driving situation; it is particularly low in some situations (e.g., the learner period) and particularly high in others (e.g., right after licensure, late at night, with passengers present). In some of these high-risk driving situations, risk is elevated for drivers of all ages (e.g., late night driving), in others risk is elevated more for teens than adults (e.g., driving after consuming alcohol), and in others the risk is unique to teen drivers (e.g., having passengers). *Impact on Research, Practice, and Policy:* These varying patterns of risk form the basis for graduated licensing systems, which are designed to promote low-risk and discourage high-risk driving.

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*Keywords:* Teenage drivers; Crash rates; Risk

### 1. Introduction

The elevated crash risk of teenage drivers is well known. In this article, the overall crash risk of teenage drivers in comparison with older drivers will be described, taking gender differences into account. The patterns of driving risk for teenagers will also be indicated, emphasizing the times and driving situations associated with especially high risk. These will be sorted into situations in which risk is elevated for drivers of all ages, situations in which risk is elevated more for teenagers than for older drivers, and risk situations unique to teenagers. Teen drivers ages 16–19 are the target group, but 16 and 17-year-olds will be featured because these are the ages that graduated licensing generally encompasses in the United States.

### 2. Overall risk

The shape of the distribution of crash rates by age varies, depending on how ages are categorized and what numerators (fatal crashes, all crashes) and denominators (total population of that age, licensed drivers, mileage) are used. For example, because crash rates are highest at the extremes of the age spectrum, crash rate comparisons of

younger versus older drivers and younger and older versus other drivers are considerably affected by how drivers are grouped. It makes a big difference whether young drivers are grouped as 16- to 19-year-olds or separately as 16-, 17-, 18-, and 19-year-olds, and whether the oldest group is classified as 65+, 75+, or 85+. As another example, crash rates for elderly drivers are relatively higher when based on fatal crashes rather than all crashes, due to their fragility. In addition, different denominators yield different crash rate distributions by age because of age differences in licensure rates and miles driven per license holder. Mileage data allow comparisons of crash risk while controlling for amount of exposure, licensure data yield information on per person rates, and population data provide a means of assessing overall effects on an age group.

Tables 1–6 and Figs. 1–6 indicate crash rates by age and gender using different combinations of numerators and denominators. In the tabulations, age categorizations begin at 16 and end at 85+. Data on crashes, presented in this article, are based on the Fatality Analysis Reporting System (FARS), a census of all fatal crashes occurring on public roads in the United States, and from the National Automotive Sampling System/General Estimates System (NASS/GES), a national probability sample of police-reported crashes. Mileage data are taken from the Nationwide Personal Transportation Survey (NPTS), licensing data come from annual tabulations published by the Federal Highway Administration, and population data are from the U.S.

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Table 1  
Driver crash involvements per million miles traveled, 1995

Age	Males	Females	All
16	42	29	35
17	18	23	20
18	14	13	14
19	12	14	13
16–19	17	18	17
20–24	10	9	9
25–29	6	7	6
30–34	4	5	4
35–39	4	5	5
40–44	4	4	4
45–49	3	4	4
50–54	3	4	4
55–59	3	4	4
60–64	3	4	4
65–69	3	4	4
70–74	4	6	5
75–79	7	7	7
80–84	11	12	12
85+	16	11	14

Bureau of the Census. All but the mileage data are from year 2000. The most recent national mileage data are from 1995, so mileage-based rates can only be updated to that year.

There are many age and gender differences in these data, and attention will be given only to those most pertinent to teenagers. Figs. 1–6 indicate that most of the curves are U-shaped, with young and old drivers having the highest rates. Generally, young drivers have higher crash rates than older drivers, and men have higher rates than women, but there are exceptions. For example, fatal crashes per mile driven are highest for the oldest drivers, and—based on all crashes—women have slightly higher rates of crash involvement per mile driven than men, overall and at most ages, including 16- to 19-year-olds combined.

Table 2  
Driver fatal crash involvements per million miles traveled, 1995

Age	Males	Females	All
16	19	8	13
17	9	6	8
18	8	4	6
19	6	4	6
16–19	8	5	7
20–24	5	3	4
25–29	3	2	3
30–34	2	1	2
35–39	2	1	2
40–44	2	1	1
45–49	2	1	1
50–54	2	1	2
55–59	2	2	2
60–64	2	2	2
65–69	2	2	2
70–74	3	3	3
75–79	6	5	5
80–84	12	9	11
85+	20	10	16

Table 3  
Driver crash involvements per 1,000 licensed drivers, 2000

Age	Males	Females	All
16	210	175	193
17	176	144	160
18	172	114	144
19	136	103	120
16–19	167	127	148
20–24	100	78	89
25–29	75	58	67
30–34	60	49	55
35–39	58	46	52
40–44	50	40	45
45–49	47	37	42
50–54	43	32	37
55–59	41	29	35
60–64	37	24	31
65–69	34	23	29
70–74	35	23	29
75–79	37	24	30
80–84	35	25	30
85+	35	22	28

Crashes per mile driven measures crash risk given comparable amounts of exposure. By that measure the very youngest drivers, particularly 16-year-olds, stand out. When rates per mile are based only on fatal crash involvements, 16-year-olds again stand out among teenagers, but drivers ages 80 and older have higher rates than 16- to 19-year-olds. Note, however, that the number of fatal crash involvements for those 80 and older is 1,587 compared with 6,008 for 16- to 19-year-olds, so from a public health standpoint the youngest group is of most concern. Janke (1991) has noted that interpreting mileage-based rates as a measure of risk exaggerates the risk of low-mileage groups such as teenagers and the elderly when crashes of all types are considered, because more of their mileage is accumulated on congested

Table 4  
Driver fatal crash involvements per 100,000 licensed drivers, 2000

Age	Males	Females	All
16	86	55	71
17	77	40	59
18	87	38	63
19	80	33	57
16–19	82	40	62
20–24	62	23	43
25–29	39	17	28
30–34	32	14	23
35–39	29	14	22
40–44	26	12	19
45–49	24	11	18
50–54	23	10	16
55–59	22	10	16
60–64	24	10	17
65–69	22	11	16
70–74	26	13	20
75–79	33	15	23
80–84	38	19	28
85+	51	20	34

Table 5  
Driver crash involvements per 1,000 population, 2000

Age	Males	Females	All
16	78	65	71
17	101	83	92
18	122	79	101
19	103	76	90
16–19	101	76	89
20–24	84	66	75
25–29	69	52	61
30–34	57	45	51
35–39	54	42	48
40–44	48	37	42
45–49	46	35	40
50–54	42	30	36
55–59	40	26	33
60–64	36	21	28
65–69	33	19	25
70–74	32	18	24
75–79	35	17	24
80–84	32	15	21
85+	27	8	13

two-way city streets than on freeways. Young people also tend to accumulate a higher proportion of their mileage at night, when fatal crash risk is higher (Williams, 1996). Thus, some of the extra risk for teenage drivers is due to the quality of their exposure in terms of where and when they drive.

In regard to crashes per license holder, 16-year-olds have the highest rate of any age group, and 16- to 19-year-old drivers exceed drivers of any older ages for both fatal crashes and all crashes. Young males have higher crash rates than young females, but these differences are not large; for 16-year-olds about one in five crash, both males (21%) and females (18%).

Based on per capita rates, the ordering among the youngest drivers changes. Less than 50% of 16-year-olds are licensed (37% in 2000), and license holders average fewer miles than older teens. Thus, per capita rates for 16-year-olds are the lowest in the 16–19 age group. Note, however, that for total crashes per capita, both male and female 16-year-olds—despite their limited exposure—are higher than any nonteenage group, except those 20–24. In terms of fatal crashes per capita, 16-year-old females have a higher rate than any nonteenage females, and 16-year-old males are exceeded only by males 20–29 and 80 and older.

### 3. Teenage passenger crash rates

The focus of this article is drivers, but many teens also die as passengers in motor vehicles (Williams & Wells, 1995). In 2000, 40% of the deaths of 16- to 19-year-olds traveling in passenger vehicles were sustained by passengers, and for 16-year-olds, there was close to a 50–50 split (54% drivers, 46% passengers). A major contributor to this high death rate is their frequent travel with teenage drivers, a high-risk scenario that will be discussed later. Fig. 7 dis-

plays crash rates per 100,000 population by age for 2000, indicating clearly that crash risk for passengers peaks at ages 16–19.

#### 3.1. Times of highest risk

When we talk about high-risk driving situations for teenagers, most of the attention is given to types of driving that elevate crash risk. However, crash risk varies greatly by what stage of the licensing process teens are in, and this variation provides useful information for establishing licensing policies.

The learner stage is a period of low crash risk. This is quite understandable because driving during this stage is generally under the supervision of a parent, driving instructor, or other adult, exposure is relatively low, and higher risk conditions are generally avoided. Data from Nova Scotia indicate that crash rates are very low during this period, and they do not increase during the course of the learning period (Mayhew, Simpson, & Pak, in press). That is, those who have held learner's permits for several months do not have a higher crash rate than those in the first month of holding permits.

Another study analyzed fatal crashes of 15-year-olds in states that license at age 16 but allow permits to be obtained earlier. It found very few crashes involving learner permit holders driving under supervision (Williams, Preusser, Ferguson, & Ulmer, 1997). Most 15-year-olds involved in fatal crashes either did not hold learner's permits (57%) or were not operating vehicles under the required supervision (16%).

Although supervised driving in the learner stage is low risk, driving once licensed is not. Fig. 8 shows Nova Scotia data, collected before its graduated licensing program went into effect, illustrating both the very low crash rate in the learner period and the much higher crash rate when licensed

Table 6  
Driver fatal crash involvements per 100,000 population, 2000

Age	Males	Females	All
16	32	20	26
17	44	23	34
18	61	27	44
19	60	24	43
16–19	50	24	37
20–24	52	19	36
25–29	36	15	26
30–34	30	13	22
35–39	27	13	20
40–44	25	11	18
45–49	23	11	17
50–54	22	9	16
55–59	21	10	15
60–64	23	9	16
65–69	20	9	14
70–74	25	10	17
75–79	30	10	19
80–84	35	11	20
85+	39	7	17

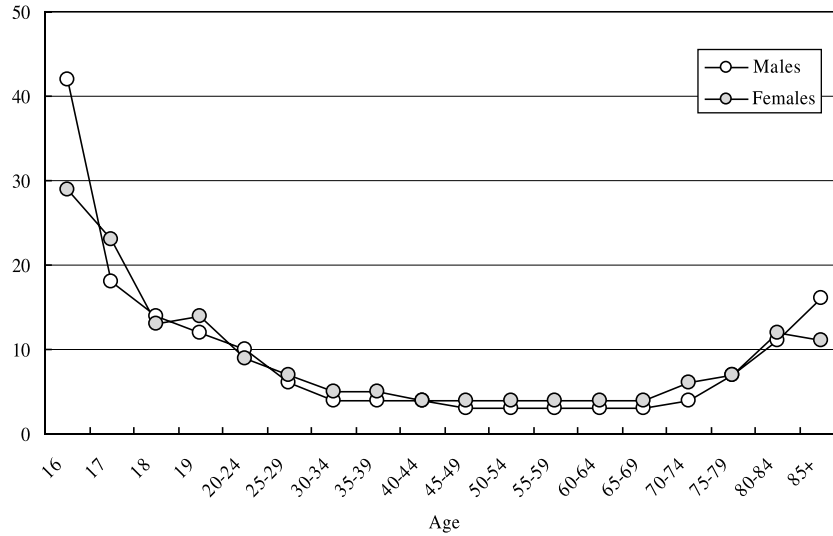


Fig. 1. Driver crash involvements per million miles traveled, 1995.

(Mayhew et al., in press). The crash rate was highest in the first month of licensure, dropped sharply during the next few months, and showed a slower decline during the next year and a half. A study based on self-reported data from four U.S. states, [McCartt, Shabanova, and Leaf \(in press\)](#) found that the likelihood of a first crash or first citation was higher during the first month than during any of the next 11 months.

Virtually the same pattern of crash rates when first licensed has been reported in Quebec ([Laberge-Nadeau, 1998](#)), which, like Nova Scotia, allowed full licensure at age 16, and in Victoria, Australia, Norway, and Sweden, where the licensing age is 18 ([Drummond, 2000](#); [Gregerson et al., 2000](#); [Sagberg, 1998](#)). It has not been established how the imposition of curbs on high-risk unsupervised driving—a central feature of graduated systems—may change this pattern.

#### 4. High risk situations for all drivers

##### 4.1. Nighttime driving

The risk factor that has drawn the most attention in the young driver population is driving late at night. Late-night driving increases crash risk among young drivers for a variety of reasons: the driving task is more difficult in darkness; many newly licensed drivers will have had less driving practice at night than during the day; fatigue—thought to be a problem for teenagers at all times of the day—may be more of a factor at night ([National Sleep Foundation, 2000](#)); and recreational driving that is considered to be high risk, sometimes involving alcohol use, is more likely to take place at night. In a survey asking teenagers to describe their dangerous driving incidents

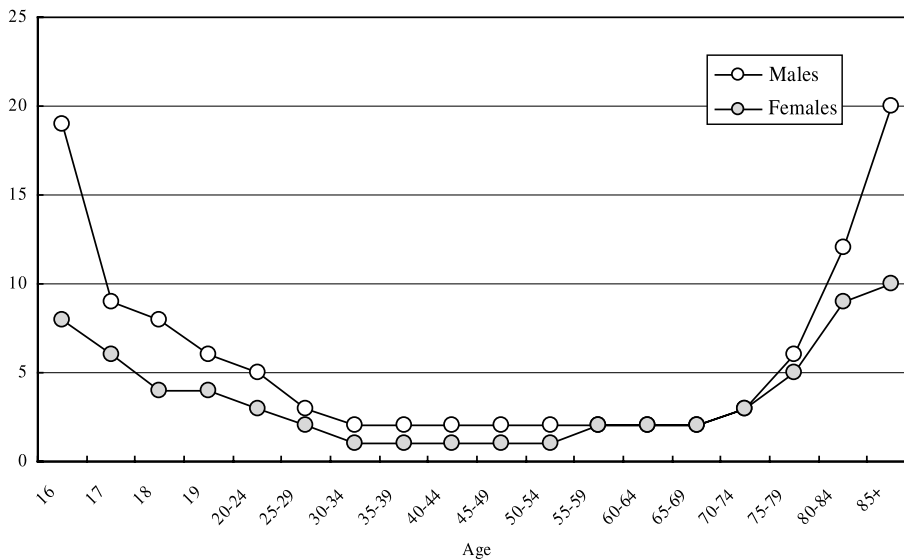


Fig. 2. Driver fatal crash involvements per million miles traveled, 1995.

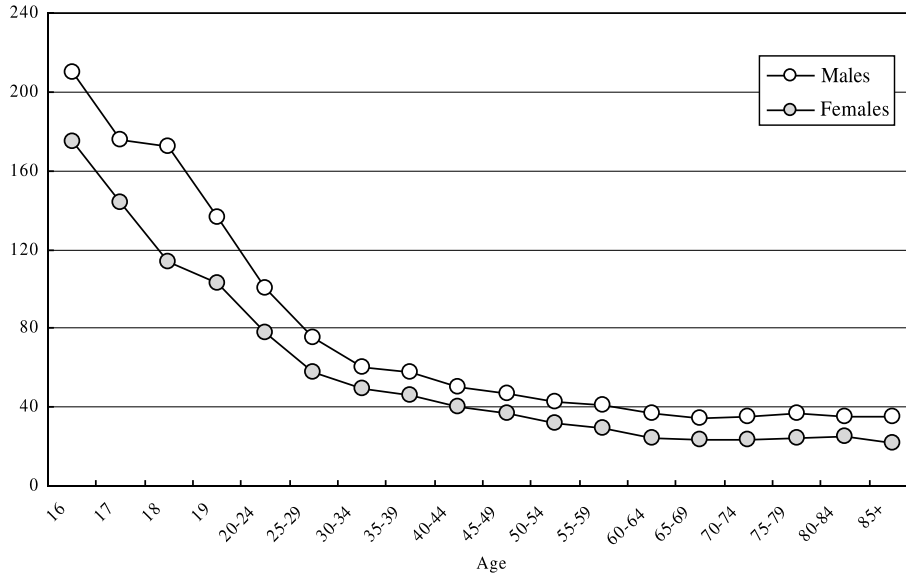


Fig. 3. Driver crash involvements per 1,000 licensed drivers, 2000.

during the past 6 months (“If a cop had been there, you probably would have been stopped”), teens reported that the majority of such incidents took place after 10 p.m. (Farrow, 1987).

Late-night driving increases crash risk, but only for serious crashes. Figs. 9 and 10 show crash rates per mile driven, by age, for fatal crashes and for all crashes. Fig. 9 shows that the nighttime (9 p.m. to 5:59 a.m.) fatal crash risk for 16-year-old drivers is particularly high, about three times the daytime risk. Fatal crash risk is elevated for teen drivers in general during nighttime hours. In fact, fatal crash risk at night is higher than daytime risk for drivers of all ages. Although nighttime risk for the youngest drivers is substantially higher than for older drivers, the differences

between nighttime and daytime fatal crash risks are proportionately greater for drivers ages 20–44. For this older age group, fatal crash risk at night is more than four times the daytime risk. In part, this reflects the major contribution of alcohol impairment to nighttime fatal crashes among 20- to 44-year-olds.

For crashes of all types (Fig. 10), nighttime crash risk is only slightly higher overall than daytime risk (6.6 vs. 5.5 crashes per million miles) and there is no particular pattern by age.

Fatal crash risk is higher at night than during the day, but presumably not all nighttime driving is high risk, and some nighttime driving may have very low risk. Most states with nighttime restrictions exempt certain types of unsupervised

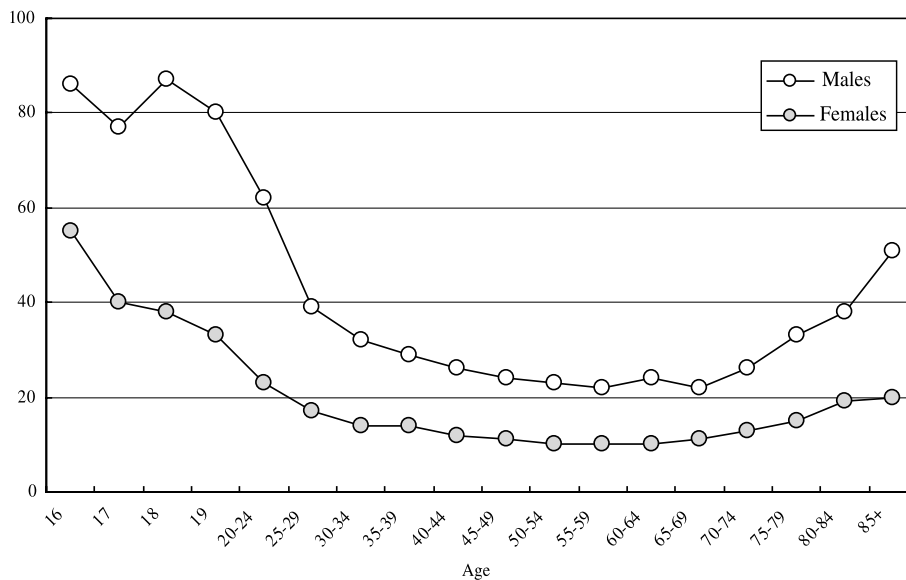


Fig. 4. Driver fatal crash involvements per 100,000 licensed drivers, 2000.

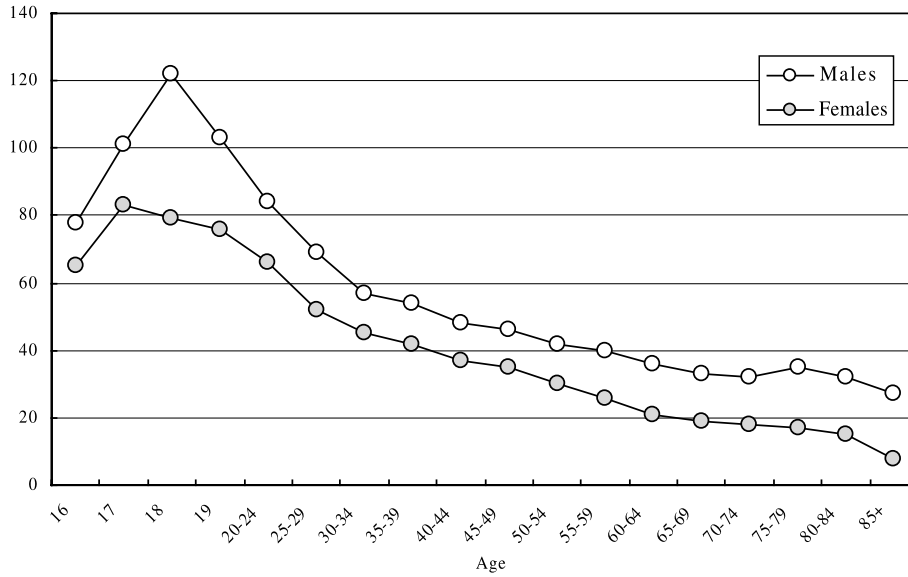


Fig. 5. Driver crash involvements per 1,000 population, 2000.

driving, for example, to and from work and school-related activities in some cases. The premise is that these are essential activities that should be allowed, but also that crash risk is not elevated during these events. Unfortunately, there are no data that can provide guidance on what types of nighttime driving carry lower risk.

Although fatal crash risk is higher at night, nighttime exposure is lower than during the day. In 1995, before the modern graduated licensing movement began, 14% of the mileage and 32% of the fatal crash involvements of 16- to 17-year-olds were between 9 p.m. and 5:59 a.m. Thus, the vast majority of fatal crash involvements occur during the lower risk high-exposure daytime hours. Figs. 11 and 12 show fatal crash involvements and all crash involvements

by single hours throughout the day. In both data sets there are peaks just before and after school, suggesting that school transportation is a topic that needs addressing. These are also high mileage hours for 16- to 17-year-olds (3–4 p.m. is their highest mileage hour during the day, and 7–8 a.m. is the fifth highest, after 4–7 p.m.), and the high exposure results in many crashes. School transportation issues are currently under discussion in the United States and Australia (Queensland School Transport Safety Task Force, 2001; Transportation Research Board, 2002). The Transportation Research Board report indicated that death rates per trip during school hours were highest in passenger vehicles when a student was driving or being driven by a teenager. On a per-trip basis, students were about 44 times more likely

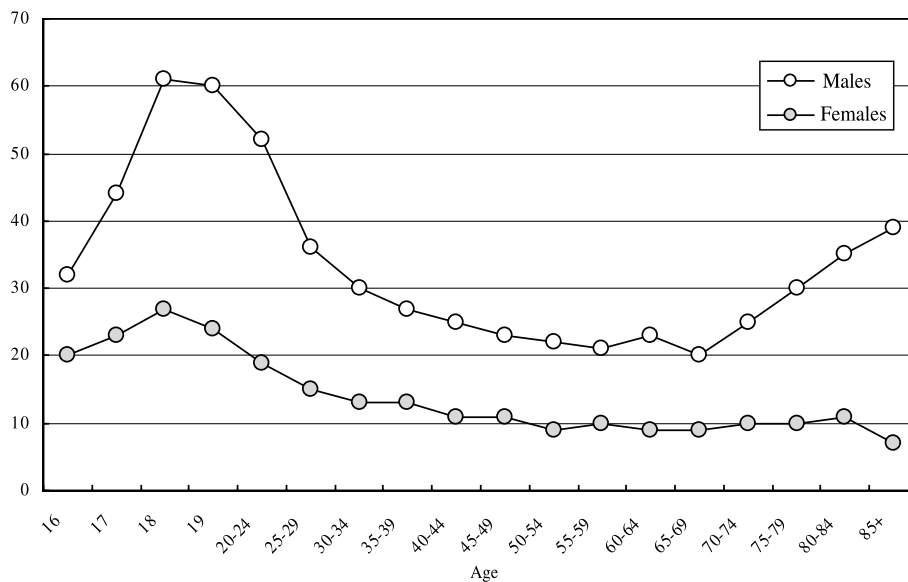


Fig. 6. Driver fatal crash involvements per 100,000 population, 2000.

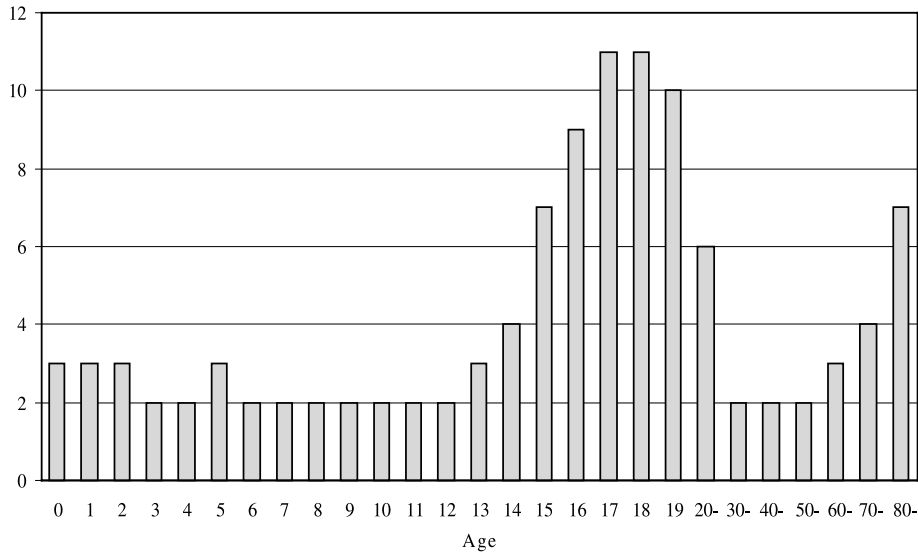


Fig. 7. Deaths of passengers in passenger vehicles per 100,000 population, United States, 2000.

to be killed in a vehicle with a teen driver than while riding on a school bus.

Fig. 11 indicates that attention also needs to be given to the hours 9 p.m. to midnight, which have both high crash risk and high frequencies of fatal crashes. Most states do not begin late-night restrictions until midnight or 1 a.m.

4.2. Alcohol-impaired driving

Alcohol impairs driving behavior for people of all ages. Teenagers drink and drive less often than adults, but their crash risks are higher when they do drink (Mayhew, Donelson, Beirness, & Simpson, 1986; Voas, Wells, Lestina, Williams, & Green, 1998; Zador, Krawchuck, & Voas, 2000). In a summary of the literature, it was noted that data from roadside surveys confirm that young people drive after drinking. They also show that the percentage of drinking drivers is less among people under the age of 20 than older

age groups under the age of 50. Moreover, on average, young drinking drivers consume less alcohol than older drinking drivers. Nevertheless, those young people who drive after drinking have a higher relative risk of crash involvement than older drinking drivers in all BAC ranges (Mayhew et al., 1986). This is probably due to young people’s relative inexperience with drinking, with driving, and with combining these two activities.

Thus, the alcohol-impaired driving problem among teens is limited in that they drink and drive less and with lower consumption levels than adults, but exacerbated by the fact that alcohol renders them more crash-prone than adults. For 16- to 17-year-olds during 1995–2001, 18% of those fatally injured had consumed alcohol and 12% had BACs of 0.10% or greater (78% of the deaths of teen drivers with BACs of 0.10 or greater occurred during 9 p.m. to 5:59 a.m.). This compares to much higher levels in earlier years. For example, in 1982, 43% of fatally injured 16- to 17-year-

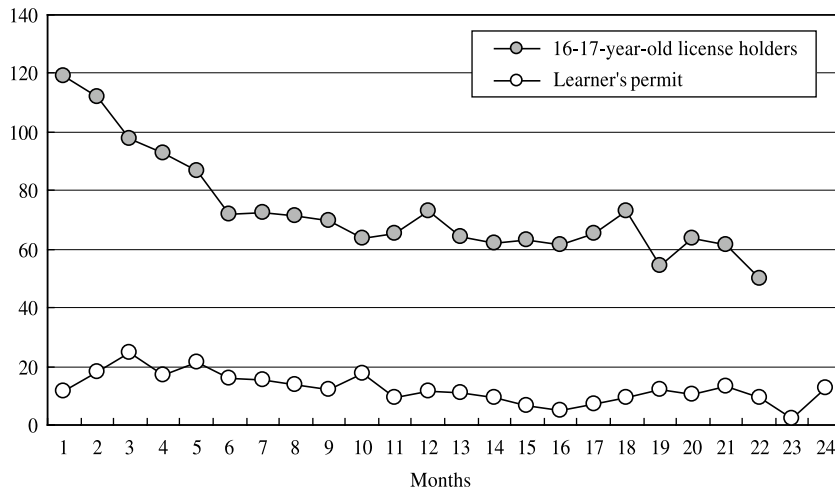


Fig. 8. Crashes per 10,000 drivers, by months of permit or licensure, Nova Scotia.

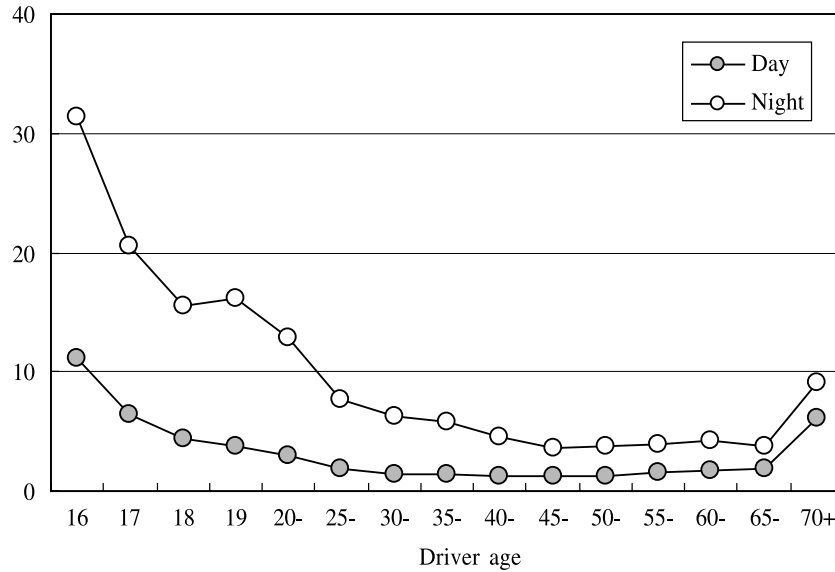


Fig. 9. Fatal crashes per 100 million miles, day versus night, by driver age, 1995.

olds had been drinking and 31% had BACs of 0.10% or greater. Thus, the contribution of this risk factor has greatly decreased, although there has been little change in recent years in the extent to which alcohol is present in the fatal crashes of teens.

There may be other driving situations that entail greater risk for teens than for adults, but empirical evidence is either absent or insufficient. For example, it has been speculated that driving in bad weather conditions would carry more risk for teens, because of their inexperience. Existing data do not support this, either for fatal crashes or all crashes. For example, 16–17% of the crashes of drivers ages 16–60 occurred in adverse weather conditions in 1987–2001. This does not answer the risk question, although, because exposure information is not available. It is conceivable that

young beginners are less likely than adults to drive in adverse weather conditions but have greater risk when they do so.

#### 4.3. Crash risks unique to teens

The potential effects of passengers on crash involvement has long been recognized. Having passengers in the vehicle creates a social system that can affect driving behavior. Recent research has brought increasing recognition that the presence of passengers can powerfully affect the likelihood of a crash, and that the effects can be positive or negative. Earlier research suggested that young drivers were more likely to crash if passengers were present (Foldvary & Lane, 1969), and more recent research has confirmed and elabo-

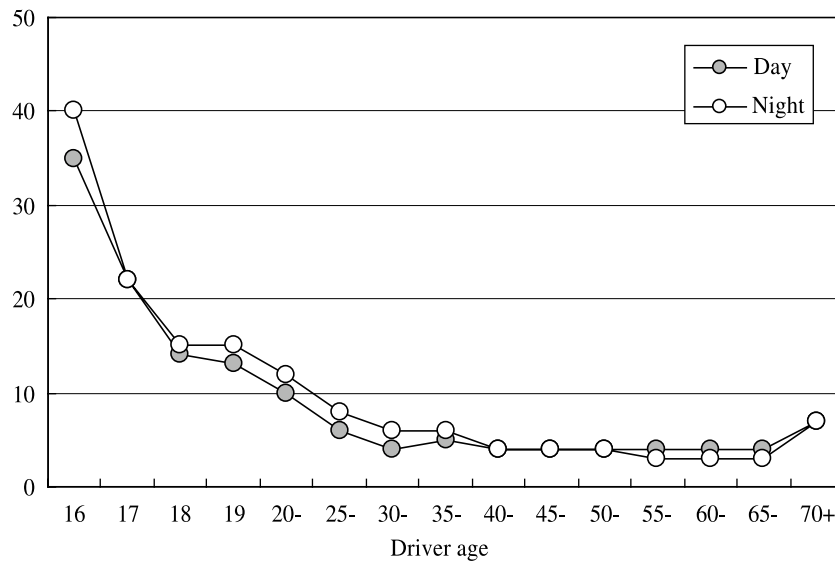


Fig. 10. All crashes per million miles, day versus night, by driver age, 1995.

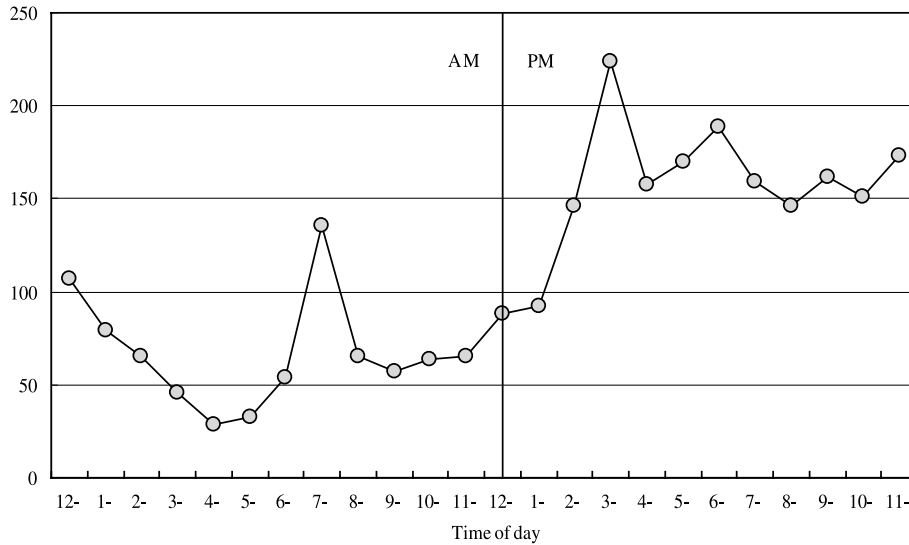


Fig. 11. Sixteen- to 17-year-old drivers in fatal crashes, hour by hour, 1995.

rated that finding (Aldridge, Himmler, Aultman-Hall, & Stamatiadis, 1999; Chen, Braker, Braver, & Li, 2000; Doherty, Andrey, & MacGregor, 1998; Preusser, Ferguson, & Williams, 1998). In short, it is a very high-risk situation for teenage drivers to have passengers present, particularly teenage and multiple passengers. Passengers increase the risk for property damage, nonfatal injury, and fatal crashes, and teenage drivers transporting teen passengers is a high-exposure activity and a major contributor to the overall problem. More than half of all deaths in the crashes of 16- to 17-year-old drivers occur when passengers younger than 20 are being transported and there is no adult in the vehicle (Williams & Ferguson, 2002).

Fig. 13 shows typical findings, based on data from NPTS and NASS/GES. This figure illustrates a central feature of the heightened crash risk associated with passenger pres-

ence: it increases risk only for teenagers, especially the youngest teenagers. For adult drivers, having passengers is associated with slightly decreased risk. Fig. 13 also shows that crash risk for teenage drivers increases exponentially with one, two, or three or more passengers. With three or more passengers, crash risk is about four times greater than when driving alone.

Part of the increased injury risk with passengers could be because higher vehicle occupancy by itself increases the opportunity for injury in a crash. However, there is increased risk for young drivers with passengers in studies based on involvement in crashes, including property damage crashes, or deaths to drivers per million trips by number of passengers (Chen et al., 2000; Doherty et al., 1998). In neither of these cases is the increased exposure due to high vehicle occupancy a factor.

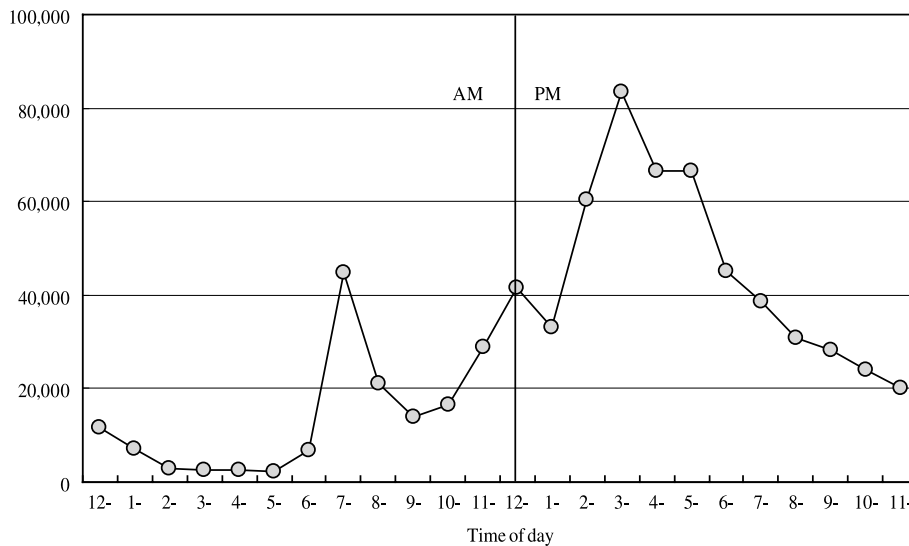


Fig. 12. Sixteen- to 17-year-old drivers in all crashes, hour by hour, 1995.

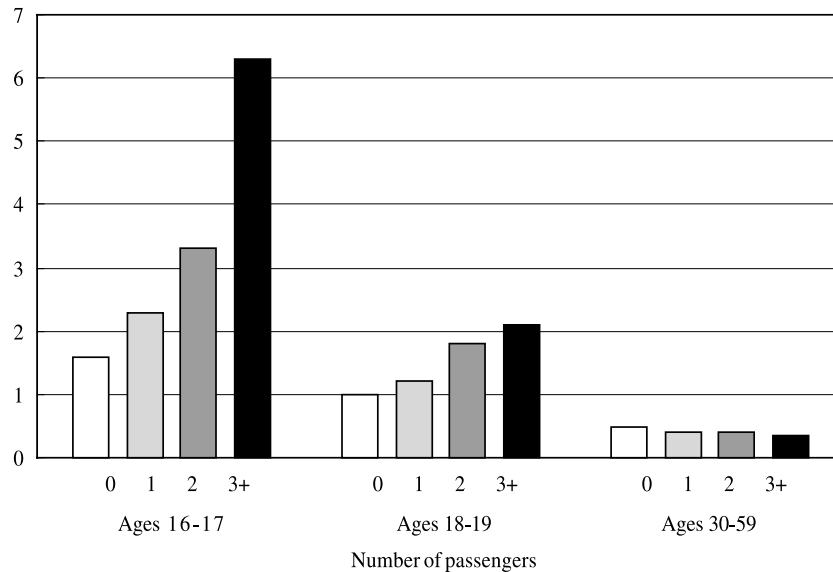


Fig. 13. Crash rates by driver age and passenger presence per 10,000 trips.

Studies have shown that both male and female drivers have increased risks with passengers present, and the increased crash risk exists for both daytime and nighttime hours in about the same proportions, although overall crash risks are much higher at night. In one study, driver death rates from 10 p.m. to 6 a.m. were 1.74 times higher with passengers present than without passengers; during the day the rates were 1.77 times higher (Chen et al., 2000).

Crash risk with passengers can be expected to differ by the nature of the relationship among vehicle occupants, trip purpose, and other factors. Although having passengers increases the overall crash risk for teenage drivers, it does not do so in all cases. In fact, some combinations are associated with reduced risk, whereas others produce extra high risk. Young males readily acknowledge that their driving is adversely affected by having friends in the car, whereas having women or parents present positively affects their driving (Rolls & Ingham, 1992). Other studies confirm these survey findings. The highest risk situation appears to be male or female drivers with male passengers. A situation that reduces risk is when young male teens transport female passengers. These results are based on statistical studies and a study of on-road driving. For example, in a study based on driver death rates, the presence of one male passenger almost doubled the death rate for both male and female drivers; two or more male passengers more than doubled it (Chen et al., 2000). In a study of on-road driving, young drivers with young male passengers drove more dangerously than drivers without passengers; that is, they drove faster and accepted smaller gaps at intersections (McKenna, Waylen, & Burkes, 1998). However, males with a female passenger drove slower and did not follow vehicles as closely as did males driving alone. Baxter et al. (1990)

have also shown that the presence of young male passengers is associated with unsafe driving practices.

The mechanisms by which passenger presence increases or decreases crash risk are not well understood, nor is there sufficient knowledge about precipitating incidents in these vehicles that lead to crashes or crashes being averted. Arnett (2002) discusses the social function of the vehicle as a place where adolescent friends can be together independently of their parents. He notes that “We have, so far, virtually no information about the phenomenology of this situation, of high school friends riding around in a car together, and this is a crucial gap in our knowledge.” Presumably, passengers can help drivers avoid crashes by such actions as providing navigational information, warning drivers of hazards, and keeping drivers alert (Reagan & Mitsopoulos, 2001). Passengers can also distract drivers, which may be a particular problem for young beginners. The presence or actions of passengers (plus other factors such as loud music) cannot only distract but can influence more risky (or less risky) driving as indicated in the on-road study referred to earlier. Case studies of young driver crashes with multiple occupants have also found evidence of risk inducements (Williams, Preusser, & Ferguson, 1998).

## 5. Conclusions and impact on research, practice, and policy

Overall, teenagers have crash rates that exceed those of drivers of any age, 16- to 17-year-olds being particularly risky. Yet risk among teenagers varies greatly by driving situations, being particularly low in some situations and particularly high in others. These varying patterns of risk form the basis for graduated licensing systems which are

designed to promote low-risk driving and discourage high-risk driving.

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