PASSENGER AGE AND GENDER EFFECTS ON ADULT DRIVER FATAL CRASH RATE

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Summary: Driver behavior and crash rates vary with the presence of passengers but the details of this relationship are not well understood. The literature generally does not take into account the characteristics of passengers, yet effects on crashes may vary dramatically with passenger age and gender. This study estimated the amount of exposure (driving miles) done by various driver age/gender categories with various combinations of passengers. Statistical imputation techniques were used to derive travel estimates for various pairings using data from the 2001 National Household Travel Survey. Crash frequencies for every pairing were obtained from the Fatality Analysis Reporting System and were used to compute fatal crash rates (per 10 million trip miles). The findings reported here focus on adult (21 and older) drivers. The results show that drivers of a given type (age/gender group) show dramatically different crash rates as a function of passenger type. Some passenger types are associated with fatal crash rates higher than that with no passenger, while other passenger types are associated with lower crash rates. The details of this relationship depend to some degree on driver characteristics. Crash rates for different driver age/gender groups overlap substantially based on the passenger, so that the "best" and "worst" driver groups are passenger-specific. For adult male drivers, female passengers are generally associated with lower crash rates. For male drivers, there is a higher crash rate with a male passenger of a given age than with a female passenger of the same age, even for child passengers.

INTRODUCTION

The crash risk for a particular driver is not static, but varies as a function of many factors. Not surprisingly, there has been a great deal of research on the aspects of the driver and the driving environment that directly relate to the driving task. However, it is becoming evident that aspects of the driver's *social* environment can have effects that are as profound as aspects of the physical environment. Under some conditions, the presence and characteristics of passengers in the vehicle may be associated with changes in crash risk that compare with those of roadway design elements, traffic characteristics, weather, and so forth. Yet there has been relatively little research on the effects of passengers on crash risk and the underlying causes. Although there has been attention given to the issue of peer passenger effects on teenage drivers (e.g., Williams, 2001), even this has been studied only to a limited degree, and passenger effects for more mature drivers are little understood.

There is a history of research establishing that the presence of passengers may influence both driving behaviors and crash likelihood. For example, traffic observational studies conducted decades ago demonstrated that passenger presence can influence gap acceptance (Jackson and Gray, 1976), stopping decisions at traffic signals (Konecni, Ebbesen, and Konecni, 1976), car following headway (Evans and Wasielewski, 1983), and speed (Wasielewski, 1984). Other studies have examined the relationship of crash rates to passenger presence. This generally requires the use of a crash database (outcome) with a travel database (exposure). For example, Chen, Baker, Braver, and Li (2000) examined crash rates for 16- and 17-year-old drivers, using fatal crash data from the Fatality Analysis Reporting System (FARS) and travel data from the Nationwide Personal Transportation Survey (NPTS). The analysis examined crash rates as a function of the number of passengers, but since NPTS does not provide the age and sex of all vehicle occupants for all trips, the analysis did not include these factors.

In an observational study of teenage drivers (Simons-Morton, Lerner, and Singer, 2005), we observed the effects of male or female teen passengers on speeding and tailgating by male or female teen drivers. The results indicated that the effects of passengers are complex. Relative to the “no passenger” condition, depending on the combination of driver and passenger genders, the passenger may be associated with small or large effects, in either direction. The point here is therefore that describing passenger effects, without disaggregating the findings on key passenger characteristics, could result in misleading conclusions.

One difficulty in analyzing passenger effects on crashes in greater detail is the lack of good travel exposure data. One would need to know the relative amount of travel by various combinations of driver type and passenger type. While national crash databases, such as FARS, provide age and gender detail on all vehicle occupants, national travel databases do not provide complete comparable occupant data. Some studies have attempted to overcome the absence of exposure data by using the “induced exposure” technique (e.g., Aldridge, Himmler, Aultmann-Hall, and Stamatiadis, 1999), but this method has limitations and relies on sometimes questionable assumptions. The present study represents another approach to this problem, applying statistical imputation techniques to a national travel database.

OBJECTIVE AND SCOPE

The objective of this study was to understand how fatal crash involvement rates are related to the presence, age, and gender of passengers. To simplify the analysis, the study only considered the two-occupant (driver and one passenger) and single occupant (no passenger) cases. Based on national travel and fatal crash databases, crash rates for various combinations of driver age and gender and passenger age and gender were computed and compared. This paper focuses in particular on passenger influences for adult (21 and older) driver fatal crash rates. Analyses focusing on teen drivers and passengers will be presented elsewhere.

METHOD

This study estimated the amount of travel done by adult drivers with various combinations of passengers and used this exposure measure to compute fatal crash rates. The analysis was confined to cases with a single passenger in the vehicle, and to "no passenger" cases. Passengers were grouped into age categories of <13, 13-15, 16-20, 21-34, and 35+. For each combination of driver age/gender and passenger age/gender, it was necessary to determine both the number of fatal crashes and the amount of driving exposure. The 2000-2004 Fatality Analysis Reporting System database provided fatal crash frequencies and age and gender information on all vehicle occupants.

The 2001 National Household Travel Survey (NHTS) provided the basis from which statistical imputation techniques derived appropriate exposure estimates. The NHTS is the successor to the 1995 NPTS. It is a periodic large national survey that records detailed information about all trips made by household members during a 24-hour "travel day." It collects information on the age and gender of those vehicle occupants that are members of the household, but only on the presence of other (non-household member) occupants; we imputed the non-household member's age and gender. Each trip with a non-household passenger was matched to a trip with a non-household driver, and the age and gender of the passenger in the former trip (the recipient trip) was assigned from that of the household passenger in the latter trip (the donor trip).

The rationale for the imputation method is as follows. In a complete census of all two-occupant trips, for every trip with a household driver and non-household passenger there would be a corresponding trip with a non-household driver (reported by another household) and a household passenger. With sufficiently detailed trip characteristics, such matching trip pairs could be uniquely identified. With only relatively coarse trip characteristics being available in the NHTS, and restricted to a sample of trips with one household and one non-household occupant, only groups of corresponding trip pairs could be identified in this study. These groups were used as the imputation cells for implementing the hot deck imputation with the Westat macro WESDECK. This program uses a list of hard boundary (h.b.) variables to define h.b. imputation cells and a list of soft boundary (s.b.) variables to define s.b. imputation cells within the h.b. imputation cells. Once the cells were defined, for each recipient trip a donor trip was randomly selected from available donor trips with the same s.b. imputation cell. If no donor trip was available within this cell then the nearest available donor trip was selected within the h.b. imputation cell.

The h.b. variables were trip purpose (11 values), time of day (4), and weekend indicator (2). The s.b. variables were trip distance (3), urban/suburban/rural (3), census region (4), season of year (4), average speed (3), and household income (2).

FINDINGS

Crash rates for various combinations of drivers and passengers were computed on both a per-trip and per-mile basis. Findings were generally similar, and the mileage-based crash rate (fatal crashes per 10 million miles) is provided here. Key findings are highlighted below.

Importance of Exposure Considerations

Any analysis of gender or age effects on crashes needs to take exposure into account, because there are substantial differences in trip making as a function of driver/passenger age and gender combinations. This is true even when the passenger is a child and the driver is mature. For example, mature (35+) female drivers are involved in about 15% more fatal crashes with female passengers <21 than with male passengers <21, but they make about 22% more trips with the female passengers; the crash rates are actually (slightly) higher with the male passengers. Mature female drivers make more trips with female children than with male children; while mature male drivers make more trips with male children than with female children. This is even true for children aged 12 or younger.

Range of Passenger Effects

Table 1 indicates the range of crash rates for each of four categories of adult drivers: males 21-34, females 21-34, males 35+, and females 35+. The rates shown in the table are fatal crashes per 10 million driving miles. For each driver category, the table shows the crash rate for driving with no passenger, the crash rate for the passenger category that showed the lowest crash rate for the particular driver category, and the crash rate for the passenger category that showed the highest crash rate for the particular driver category.

Table 1. Range of Crash Rates (per 10M miles) for Adult Driver Categories

Driver Group	Crash Rate with No Passenger	Minimum Crash Rate	Passenger Type (Minimum Rate)	Maximum Crash Rate	Passenger Type (Maximum Rate)
Male 21-34	0.26	0.06	Female 13-15	2.01	Male 16-20
Female 21-34	0.15	0.09	Female 13-15	0.69	Female 21-24
Male 35+	0.21	0.06	Female 13-15	0.37	Male 35+
Female 35+	0.14	0.06	Female 13-15	0.23	Female 35+

There are several important points illustrated in this table. For all categories of driver, there is a dramatic range of crash rates depending on the passenger conditions. The rates vary by at least a factor of 3.8 (for females 35+) up to a factor of 33.5 (for males 21-34). For all driver groups, it is also the case that with some passenger types, the observed crash rate is higher than when driving alone, and with other passenger types, the crash rate is lower than when driving alone. For all driver categories, the lowest crash rate was observed when the passenger was a girl in the early teens (13-15 years old). Generally, crash rates were highest with the driver's age/gender peers. This was true for adult female drivers in both age categories and adult male drivers aged 35+. The exception was that male drivers aged 21-34 had the highest crash rate when driving with male passengers 16-20. The second highest rate for this driver group was with their age/gender peers (0.97 crashes per 10M miles).

Female passengers generally have a "protective" effect (i.e., lower crash rate than with no passenger) on adult male drivers. This is true for female passengers of all ages for male drivers 35+ and for female passengers other than the 16-20 year age group for male drivers 21-34. Male children also are associated with lower crash rates (male passengers <21 for males 35+, male passengers <13 for males 21-34). Except for age peers (of either gender), mature (35+) female drivers show lower crash rates with any sort of passenger. Beneficial passenger effects appear least consistent for females age 21-34, whose rates are lower with young children and older women.

Overlap of Crash Rates Among Driver Groups

We tend to characterize some driver categories (e.g., young, male) as having higher crash rates than others (e.g., middle age, female). Young male drivers are considered the riskiest group and mature female drivers the safest group. The findings of this study underscore that while true in the broad sense, these characterizations are generalizations and are not true under all passenger conditions. Table 2 illustrates this point by comparing driver crash rates with no passenger, a mature (35+) male passenger, and a mature female passenger. Considering the case where there is no passenger, the expected findings emerge. Male drivers have higher crash rates than females, younger have higher crash rates than older drivers, and the extremes are the young (<21) males (0.64 crashes/10M miles) and the older (35+) females (0.14 crashes per 10M miles). However, when there is a 35+ male passenger in the car, young male drivers show lower crash rates than more mature males and young females show lower crash rates than more mature females. Males still have higher crash rates than females, however, and the young male crash rate is still somewhat higher than the older female crash rate (0.21 versus 0.14). However, when there is a mature (35+) female passenger, young male drivers show the lowest crash rate of any group and mature female drivers show the highest crash rate—more than three times the younger driver crash rate. Thus depending on the passenger conditions, the driver groups with highest and lowest crash rates can completely reverse. The relatively "bad" driving group is passenger-specific.

Table 2. Crash Rates for Driver Age/Gender Groups with Mature (35+) Passengers

Passenger Type	Driver Category			
	Driver Gender	Driver Age		
		<21	21-34	35+
No Passenger	Male	0.64	0.26	0.21
No Passenger	Female	0.31	0.15	0.14
Male 35+	Male	0.21	0.34	0.37
Male 35+	Female	0.05	0.18	0.14
Female 35+	Male	0.07	0.12	0.11
Female 35+	Female	0.11	0.13	0.23

Passenger Gender

Youthful driver observational studies (e.g., Simons-Morton et al., 2005; McKenna, Waylen, & Burkes, 1998) have observed a strong effect of peer-age passenger gender on risky driving behaviors. In fact, the direction of effects may be opposite: relative to no passenger, young male passengers are associated with increased risk while young female passengers are associated with little change or decreased risk. While findings of peer effects for teen drivers are often discussed in the literature in terms of teen-specific factors (e.g., showing off for peers, need to demonstrate competence), it is not clear that these types of effects are specific to youthful drivers. As Table 1 previously indicated, adult drivers generally show higher crash rates when traveling with their age/gender peers. Adult drivers also appear more broadly sensitive to the gender of their passengers across the age range, as indicated in Table 3.

Table 3. Ratio of Male to Female Fatal Crash Rates

Driver		Passenger Age				
Gender	Age	<13	13-15	16-20	21-34	35+
Male	<21	2.0	1.6	3.0	5.8	3.0
	21-34	1.6	5.3	6.2	6.3	2.9
	35+	1.4	2.5	1.6	2.3	3.2
Female	<21	0.7	0.4	0.9	2.4	0.5
	21-34	1.0	1.4	0.8	0.4	1.4
	35+	1.1	1.7	1.2	1.3	0.6

Table 3 shows the ratio of the male passenger crash rate to the female passenger crash rate for each driver category and for each passenger age group. A ratio of 1.0 would indicate that there was the same crash rate for male and female passengers of a given age. This is not the case, particularly with male drivers. It is a striking finding that for male drivers of all ages, accompanied by passengers in all age groups, the ratio is substantially greater than 1.0 in every case (ranging from 1.4 to 6.2). This is true even for mature (35+) male drivers and even with child (<13) passengers. The pattern of findings was less consistent for female drivers, with high rates for males in some passenger age groups and higher rates for females in others.

CONCLUSIONS

Adult drivers are substantially influenced by the age and gender of passengers. This is not simply a youthful driver phenomenon, although some of the effects may be more extreme for young drivers. Passenger influences on crash rates are a critical, but little understood, consideration in highway safety. Focusing only on overall crash rates of particular driver groups obscures substantial differences in crash risk (in either direction) associated with passenger characteristics.

Although the present findings demonstrate an association between driver and passenger characteristics and fatal crash risk, the study does not address the causal basis of this relationship. Passengers might influence the driver's performance through effects on attention, perception of risk, desire to please or to demonstrate certain behaviors/attitudes, or other mechanisms that affect what the driver does. It is also possible that passenger effects may relate to risk exposure factors, rather than to direct influences on driver behavior. Although the various driver/passenger groups were compared on a per-mile driven basis, not all travel miles are equally risky. Passenger characteristics may be correlated with trip factors such as time of day, roadway type, trip purpose, etc. Further research on this topic should address the causal basis of passenger influences. It would also be desirable to examine the relationship of passenger effects with crashes for other than fatal crashes, since fatal crashes represent only a small portion of the total vehicle crash problem, and the relationships may not be representative of non-fatal crashes.

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