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A Comparison of Fatal Crashes Involving Male and Female Car Drivers

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Abstract

This report examines differences between male and female drivers in terms of travel characteristics, fatal crash risk, fatal crash characteristics and factors affecting injury outcome. This is in contrast with road safety analyses of driver behaviour which have traditionally concentrated on the role of the male driver. While virtually all drivers killed 45 years ago were male, the percentage of female driver fatalities had risen to 13% in 1970 and in recent years females have accounted for between 22% and 27% of all driver deaths.

Keywords

Fatal crashes, road fatalities, injury outcomes, travel characteristics, statistical analysis

Notes

(1) FORS research reports are disseminated in the interests of information exchange.
(2) The views expressed are those of the authors and do not necessarily represent those of the Commonwealth Government.

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Executive summary

Importance of crashes involving female drivers

Road safety analyses of driver behaviour have traditionally concentrated on the role of the male driver. While this is in keeping with the fact that the majority of drivers involved in fatal crashes are male, the relative proportion of fatal crashes involving female drivers has been steadily increasing over many decades. Thus, while virtually all drivers killed 45 years ago were male, the percentage of female driver fatalities had risen to 13% in 1970 and in recent years females have accounted for between 22% and 27% of all driver deaths.

In view of this situation, this report examines differences between male and female drivers in terms of travel characteristics, fatal crash risk, fatal crash characteristics and factors affecting injury outcome.

Travel characteristics

Male drivers account for about 65% of total passenger vehicle kilometres travelled. This reflects both the fact that males are more likely to have a driver's licence and that, on average, male drivers travel more each year. While males of all ages travel more than females, the difference is particularly high for those over the age of 45.

The type of travel performed also differs for male and female drivers. For example, female drivers tend to do relatively more travel during weekdays and during daytime hours. They also engage in relatively less driving associated with work and relatively more for personal business, such as shopping, driving others and visiting.

Data from the United States suggests that there has been an increase in female travel relative to males for many decades. While Australian data are not available prior to 1985, there is evidence in recent years in Australia, that the relative increase in female travel is largely accounted for by increases in travel among female drivers over the age of 45.

Relative fatal crash risk

On average, male car drivers are about 46% more likely to be involved in a fatal crash per distance travelled. However, this differential between male and female drivers decreases with age, resulting in the rates being essentially equal for male and female drivers over the age of about 45. It is interesting to note that for *non-fatal* crashes resulting in hospitalisation, where the male and female crash involvement rates are more nearly equal, there is still the same relative increase in crash involvement among older female drivers resulting in this group having a higher hospitalisation crash rate than older male drivers.

It is difficult to interpret fatal crash involvement per distance as a measure of crash propensity, since it is distorted by extraneous factors, such as differences in the conditions under which travel occurs and the probability of crash survival.

Another measure of risk is the proportion of crashes which are caused by the driver in question. For this measure, there was no difference between male and female car drivers, both being deemed responsible for the same proportion of fatal crashes in which they were involved. This was the case in all age groups. It was also true for the small subset of fatal crashes involving collisions between two cars, one driven by a man and the other driven by a woman. In such cases, male and female drivers were equally likely to be judged to be at fault.

The only difference found was for fatal pedestrian crashes, in which male drivers were more likely to be at fault than female drivers.

Whatever the difficulties of the crash involvement rate measure, if it is assumed that the influence of extraneous factors has remained constant, then changes in the involvement rate over time should provide useful information about changes in crash propensity. Results indicate that both male and female rates have declined in recent years with no significant difference in the extent of this decline. This is consistent with data from the USA which indicates that, although there was a relative increase in the female fatality rate from 1969-1977, there has been no substantial change in the past decade.

Differences between fatal car crashes caused by male and female drivers

Fatal car crashes caused by female drivers differ in many important ways from those caused by male drivers.

General description of crash characteristics

Many of the differences reflect contrasting travel patterns. For example, female driver crashes are relatively more likely to occur during daytime and on weekdays. The origin and destination of travel for drivers causing fatal crashes also differ. Male driver crashes are more likely to have involved travel either from one recreational site to another or from the recreational site to the driver's home. Fatal crashes caused by female drivers are more likely to have involved travel from the driver's home to a recreational site or travel from the site of personal business to the driver's home or to further personal business.

There were no differences in terms of the number of passengers carried by cars driven by male or female drivers, but women between the ages of 25 and 39 were most likely to have had young children in the car at the time of the crash.

Female driver crashes are more likely to have involved two vehicles as opposed to a single vehicle losing control and rolling over or hitting a roadside object. Nonetheless, single vehicle crashes involving female drivers were more likely to have occurred in rural regions.

Causes of crashes

One of the most marked differences between fatal crashes caused by male and female drivers is the relatively small number of crashes resulting from risk taking or obviously negligent behaviour by female drivers. For example, fatal crashes caused by female drivers were much less likely to have involved drink driving or speeding. In fact, fatal crashes caused by female drivers were much less likely to have resulted from any identifiable cause relating to driver behaviour, vehicle defects or environmental conditions. Overall, 43% of female driver crashes were unexplained as compared with 26% of crashes caused by male drivers. The nature of fatal crashes means there is much less opportunity to document factors relating subjective processes, such as various forms of driver error, misjudgment or inattention. It is therefore reasonable to assume that these events, rather than deliberate risk taking behaviour, play a relatively more important role in explaining fatal crashes where a female driver was at fault.

While little support was found for the notion that female drivers are likely to be distracted by the behaviour of young children in their vehicle, a higher rate of driver error for females might result from a tendency to travel at times when greater cognitive demands are made on the driver, such as when the volume of traffic is highest during the daylight hours of work days. It might also reflect the fact that females are also likely to have relatively less driving experience.

Drink driving related crashes

Although female driver crashes resulting in fatalities are less likely to have been associated with driver intoxication, those cases which did occur differed from male drink driving crashes only in that intoxicated female drivers tended to be somewhat younger. While those between 25 and 39 accounted for the largest proportion of drunk drivers among males, among females the greatest proportion of drunk drivers were under 25 years and in 1990 there were no intoxicated female drivers at all over the age of 50.

No support was found for the suggestion that drink driving by females often resulted from a woman assuming responsibility for driving when both she and her partner had been drinking.

While it has been suggested that there has been an increase in drink driving (or other forms of risk taking) among female drivers, the evidence for this is limited, but whatever increase has occurred, has not prevented fatal crash involvement rates declining equally for male and female drivers in recent years.

Injury outcome

Overall, females may be less likely to be fatally injured in a crash because they are less likely to be speeding and more likely to be wearing a seat belt than males. However, crashes at a given speed generally result in greater injury to the female driver, since they are disadvantaged both by a greater physical vulnerability and a tendency to drive smaller cars.

Conclusion

Female drivers now account for a significant minority of fatal crashes. These crashes differ in many respects from those involving male drivers and there may be opportunities for further research to develop specific counter-measures for these groups separately.

Chapter 1. Introduction

Road safety research has long concentrated on the male driver with relatively little attention paid to fatal crashes involving female drivers. There are two reasons for this. First, female drivers have generally been reported as having a lower fatality rate[1]. Second, although a relatively high proportion of drivers receiving injuries are female, the vast majority of drivers killed are male*.

There is, however, a need to re-examine both these assumptions. Fatality rates, calculated as deaths per distance travelled, may be an inappropriate comparative measure of crash propensity, if travel undertaken by male and female drivers takes place under different conditions. For example, the risk exposure per distance travelled will vary with factors such as time of day, day of week and road type. In addition, this measure will be distorted by differences between men and women in terms of crash survivability.

With regard to the relative number of male and female road deaths, fatalities among female drivers have been increasing in recent decades, both in absolute terms and relative to males. Male driver fatalities reached a peak around 1970 and have decreased dramatically in the last 20 years (Figure 1), but female driver fatalities continued to increase well into the eighties[4].

This means that the relative number of female drivers killed, expressed as a percentage of total driver fatalities, has steadily increased. Even though the 1993 figure was uncharacteristically low compared with immediately preceding years, over 22% of all drivers killed were female, compared with only 13% in 1970 (Figure 2)[4].

These frequencies include both car and truck drivers. Since the vast majority of truck drivers are male, the 1993 figure of 22% of drivers killed being female increases to 27% for car drivers only. There is some evidence that truck driver fatalities have not decreased as rapidly as car driver fatalities[2,5]. Thus, Figure 2 also underestimates the increase in the proportion of car driver fatalities who are women.

Between 1970 and 1990, fatality rates (per population) for male drivers decreased, on average, annually by 3.8%. The corresponding figure for female drivers is an *increase* of 0.5% annually[6]. Further, the trend in fatality rates for female drivers differs according to age. The largest increase in this period was observed for the youngest female drivers (17-29)[7].

In conclusion, female drivers now thus represent a significant minority of those involved in fatal road crashes. If the causes and characteristics of crashes involving male and female drivers are significantly different, then road safety policy may need to target these groups separately.

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* For example, during 1992, females comprised 42% of passenger vehicle (car, van, 4WD, ute) drivers hospitalised as a result of road crashes and only 30% of those killed. This difference was observed in both urban and rural areas[2]. NSW figures on minor injuries are also available. Females constituted 48% of passenger vehicle (car, van, 4WD) drivers with minor injuries, 41% of those hospitalised and 25% of those killed in 1992[3].

Figure 1. Number of male and female driver fatalities in Australia (selected years 1949-93)*

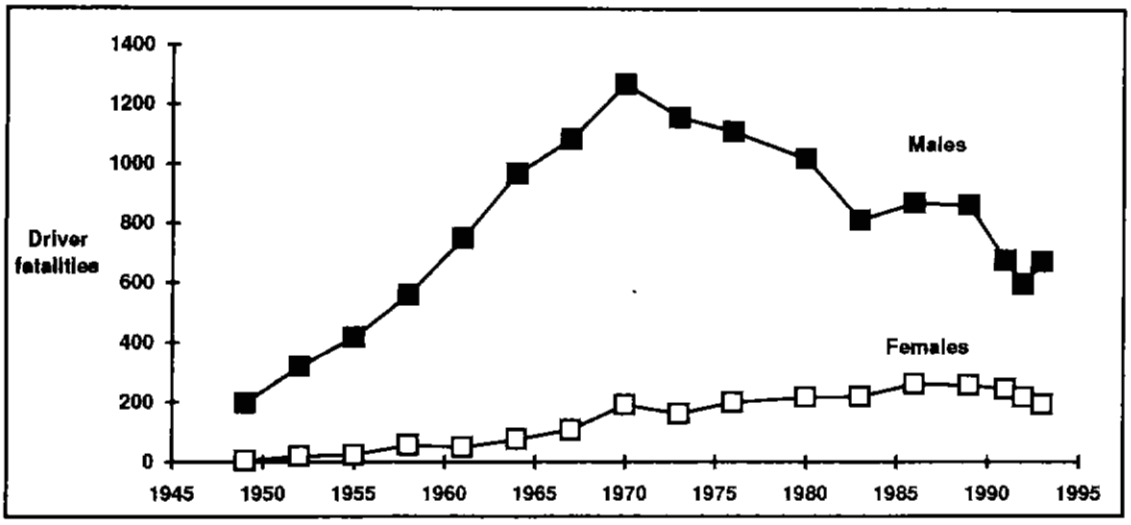
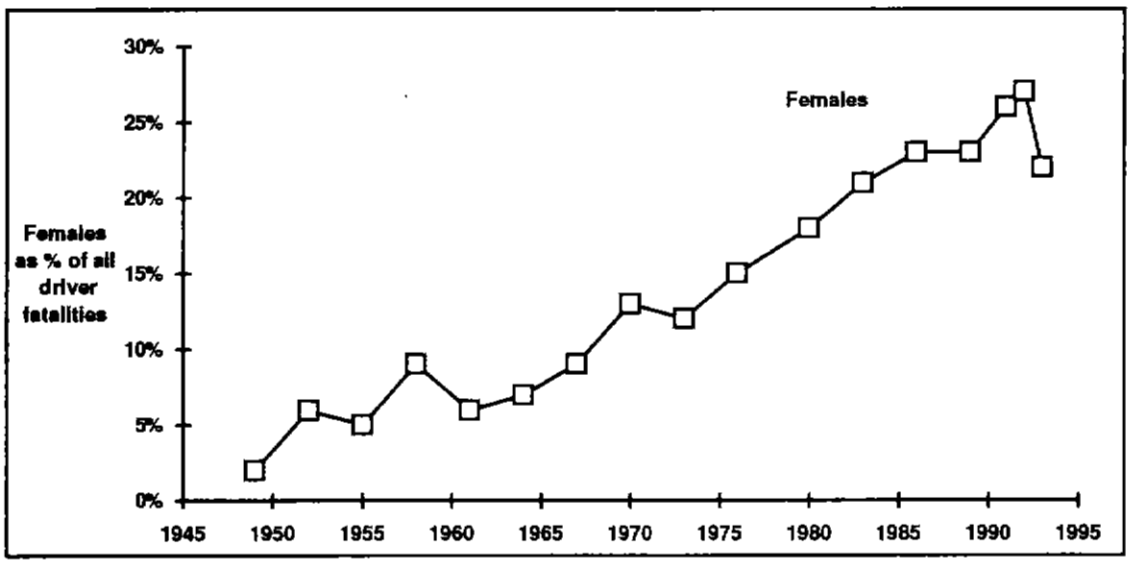


Figure 2. Female driver fatalities as a proportion of total driver fatalities in Australia (selected years 1949-1993)*



* Drivers of motor vehicles (eg cars, vans, buses and trucks); motorcyclists are excluded

Chapter 2. Description of male and female travel patterns and crash involvement

In order to understand differences in crashes involving male and female drivers, it is important to look at differences in the amount and type of travel undertaken. Both Australian and overseas data are presented and evaluated with respect to trends over time. The latter part of this chapter then combines this exposure data with crash frequency data in order to compare male and female crash involvement rates per distance travelled.

2.1 Amount and type of travel

ABS Survey of Motor Vehicle Usage (SMVU)

Information on the distance travelled by male and female car drivers is available from the Survey of Motor Vehicle Usage conducted by the ABS every 3 years[8]. A sample of registered vehicle owners are required to fill in a questionnaire concerning their vehicles and the age and sex of the usual drivers, the total number of kilometres travelled in the preceding year and the percentage of the total kilometres travelled for each of the usual drivers of that vehicle.

The figures from the 1991 survey show that, on average, a male car driver covers 1.41 times more distance than a female car driver (Table 1). Also, there were 1.31 times more males driving cars than females. These figures combined, give a ratio for 1.84† for the total distance travelled by all car drivers. So male drivers account for almost twice as many kilometres travelled as women, since there are both more male drivers and, on average, male drivers travel more each year.

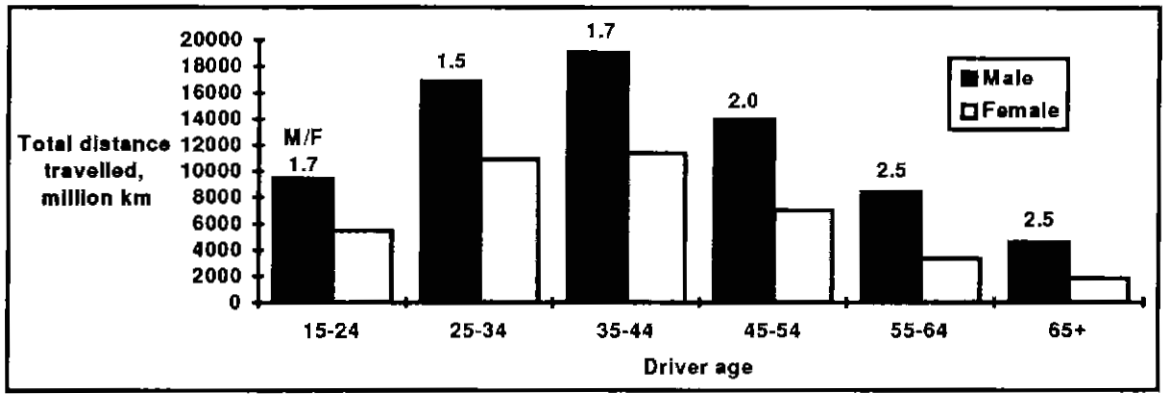
Both the distance travelled and the male to female ratios vary with age (Figure 3). The middle age groups have the highest kilometres travelled. The male to female ratios, on the other hand, increase with age, although they are greater than one for each age group. Further investigation of the data shows that similar patterns are evident for both the average kilometres travelled and the number of drivers.

Table 1. Average distance travelled per driver, number of drivers and total distance travelled in the twelve months ended 30 September 1991 for male and female passenger vehicle drivers estimated from the ABS Survey of Motor Vehicle Usage, 1991. (Passenger vehicles include sedans, stationwagons, passenger vans and four wheel drive passenger vehicles.)

Annual measures	Passenger vehicle drivers		Ratio M/F
	Male	Female	
Average annual distance per driver, km	10,611	7,551	1.41
Number of passenger vehicle drivers, millions	6.979	5.331	1.31
Total distance travelled, million km	74,051	40,257	1.84

† This male to female ratio 1.84 is equivalent to males accounting for 65% of total travel.

Figure 3. Total distance travelled in Australia in the twelve months ended 30 September 1991 by age for male and female passenger vehicle drivers estimated from the ABS Survey of Motor Vehicle Usage, 1991. Passenger vehicles include sedans, stationwagons, passenger vans and four wheel drive passenger vehicles. (Male/female ratios also shown.)



US travel survey

Data from the US for 1990[11,12] show an almost identical male to female driver total distance ratio of 1.85. However, is interesting to note that this is composed of a higher male to female average distance ratio (1.75) and a lower male to female licensed driver ratio (1.06). The US figures on total distance travelled exhibit a similar pattern to the Australian data with respect to age with a maximum amount of travel being done by the middle age groups and an increasing male to female ratio with age.

Day-to-day travel survey (Australia)

Another survey of approximately 18,000 Australian households provides more detail on the type of travel undertaken by men and women, but was conducted several years ago(1985-86)[9]. For a randomly chosen day in the year-long survey period, details of all trips made by all members of the selected households were collected on a self completion, mail questionnaire.

The average number of trips per person per day, the average number of kilometres travelled per person per day and the average time spent travelling per person per day estimated from this survey for male and female car drivers is summarised in Table 2. Per head of population, male car drivers made more trips and travelled further. These results are partly due to the greater proportion of females who do not drive at all and the differences are smaller, but still marked, when only licensed drivers are considered. This general pattern is similar to that seen in other countries[10].

It was also found that trips taken by males were longer, on average, and that males tended to travel in higher speed zones.

Table 2. Average number of trips, kilometres travelled and minutes spent travelling per person per day for male and female passenger vehicle drivers based on the day-to-day travel survey conducted in Australia 1985-86. The same measures are also shown per licensed drivers.

Travel measures	Passenger vehicle† drivers		Ratio
	Male	Female	Male/female
Travel per person			
Average no. of daily trips	2.0	1.3	1.5
Average daily km travelled	25.1	10.5	2.4
Average daily travel time, min	42.7	21.1	2.0
Travel per licensed driver			
Average no. of daily trips	2.7	2.3	1.2
Average daily km travelled	36.1	17.8	2.0
Average daily travel time, min	58.0	35.4	1.6

Further subdivision of the travel survey data revealed that the ratio of the average distance travelled by male car drivers compared to female car drivers varied by age group, time of day, day of the week and country of birth. Compared to an average ratio of 2.4 (Table 2), the largest male to female ratios were observed for travel very late at night (approximately 3:1), for travel on weekends (approximately 3:1) and for persons not born in Australia (approximately 4:1). The male to female ratio also increased slightly with age, as seen for the ABS 1991 data. However, in all categories the ratio was always greater than one.

There was also some evidence to suggest that the amount of male car travel relative to female car travel varied according to where people lived. The male to female ratios of car driver trips, distance and travel time were somewhat lower (although still greater than one) for persons from rural areas than those from larger urban centres.

Trip purpose was another of the aspects of travel covered in the survey. Driving to work comprised a greater percentage of travel for men compared with women, whereas women were relatively more likely than men to be engaged in travel relating to shopping, picking up and dropping off others and visiting.

† The Day-to-day Travel Survey report contained no explicit definitions of vehicle types, but bicycles, taxis, cars, buses, trucks and semi-trailers were listed separately in the tables. *Cars* are thus assumed to include cars and car derivatives (ie all non-truck) and are given the broader name *passenger vehicles* in this report.

2.2 Change in amount of travel

There is evidence from several sources that the amount of travel for females is increasing, relative to males.

USA

Figures from the Nationwide Personal Transportation Surveys conducted in the United States[11] indicate that both male and female drivers increased their average annual mileage in 1990 compared with earlier surveys (1969, 1977 and 1983) and the numbers of male and female licensed drivers also increased over this period. However, both the ratios of average distance travelled for male versus female drivers and the ratios of male to female licensed drivers decreased during this time period, corresponding to a relative increase in female travel (Table 3).

These relative increases in the average travel and the number of female drivers were reasonably consistent in all age groups.

Table 3. Male/female ratios of average annual miles per driver, number of licensed drivers and total travel in the USA in 1969, 1977, 1983 and 1990 (Source: US Nationwide Personal Transportation Surveys)

Male/female drivers	1969	1977	1983	1990
Annual travel per driver	2.1	2.3	2.2	1.7
Licensed drivers	1.4	1.2	1.1	1.1
Total travel (all drivers)	2.8	2.7	2.4	1.8

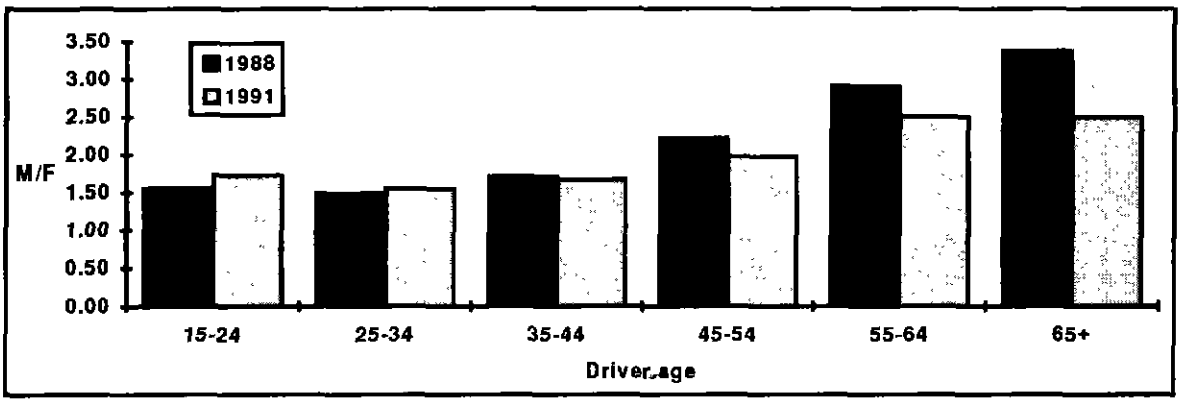
Australia

Figures from the two previous ABS Surveys of Motor Vehicle Usage[8] (1985 and 1988) are available and compatible with the Australian 1991 data (Table 4). There has been a small relative increase in the average distance travelled by females and a small but consistent relative increase in the number of female drivers. However, the increases are not as large as those observed in the corresponding period in the US (Table 3).

Table 4. Male/female ratios of average annual kilometres travelled per passenger vehicle driver, number of drivers and total travel in Australia (Source: ABS Surveys of Motor Vehicle Usage 1985, 1988 and 1991) (Passenger vehicles include sedans, stationwagons, passenger vans and four wheel drive passenger vehicles.)

Male/female passenger vehicle drivers	1985	1988	1991
Annual travel per driver	1.5[†]	1.4	1.4
Licensed drivers	1.4	1.3	1.3
Total travel (all drivers)	2.0	1.8	1.8

Figure 4. Male to female ratio of total annual kilometres travelled by male and female passenger vehicle drivers in Australia estimated from the 1988 and 1991 ABS Survey of Motor Vehicle Usage.



What is interesting to note, however, is that within age groups there is some variation (Figure 4). The male to female ratios for total kilometres for the older age groups decreased substantially in 1991. Although this data was collection in a recession year and all groups except the youngest males drove less in absolute terms in 1991 compared with 1988, the relative increase in the total kilometres travelled for the 'older' women (over 45) compared with the older men was due to relative increases in the number of older female drivers and relative increases (smaller decreases) in the average annual distance travelled by them.

In the absence of detailed measures of travel for men and women for earlier periods of time in Australia, it is useful to consider other related measures for which reliable time series are available. Labour force participation rates are one such measure, since travel to and from work is a major component of car travel and since factors associated with greater work force participation may also increase non-work related travel.

[†] The estimate of the male/female ratio of average km travelled in the ABS SMVU 1985 survey (1.5) is somewhat less than the corresponding estimate from the Day-to-Day Travel Survey 1985-6 (2.0, Table 2). Further investigation shows that the ABS estimates for km travelled are lower for male drivers and higher for females compared with the other survey, thus resulting in the smaller ratio. Two possible reasons for this include the different methodologies employed (the ABS survey relying on an annual estimate by the car owner, and the other survey using a personal day log), and the slightly different definitions of car (the ABS definition was narrower) used in the two surveys.

In the twenty-five years from 1968 and 1992, female work force participation in Australia grew from 37% to 52% of the female population aged 15 and over[13]. The percentage of men in the work force, on the other hand, *decreased* from 83% to 74% in the same period. These results are consistent with a relative increase in female travel and lend support to the generalisability of the US results in Table 3 to Australia, since similar social changes have occurred in both countries in the same time period.

2.3 Crash involvement rates in Australia

The FORS Serious Injury Database[2] provides annual Australian data concerning crashes resulting in either fatalities or hospitalisations according to police records. Despite some possibly minor incongruity with respect to time period and definition of vehicle type, these data can be combined with the ABS denominator data to form rates of fatal (and hospitalisation) crash involvement per distance travelled for male and female passenger vehicle drivers. For example, the male driver hospitalisation crash rate per distance travelled for 1991 is calculated as the total number of male passenger vehicle drivers involved in road crashes resulting in at least one hospitalisation (but no fatalities) in 1991 divided by the estimate of the total number of kilometres travelled in 1991 by all male passenger vehicle drivers.

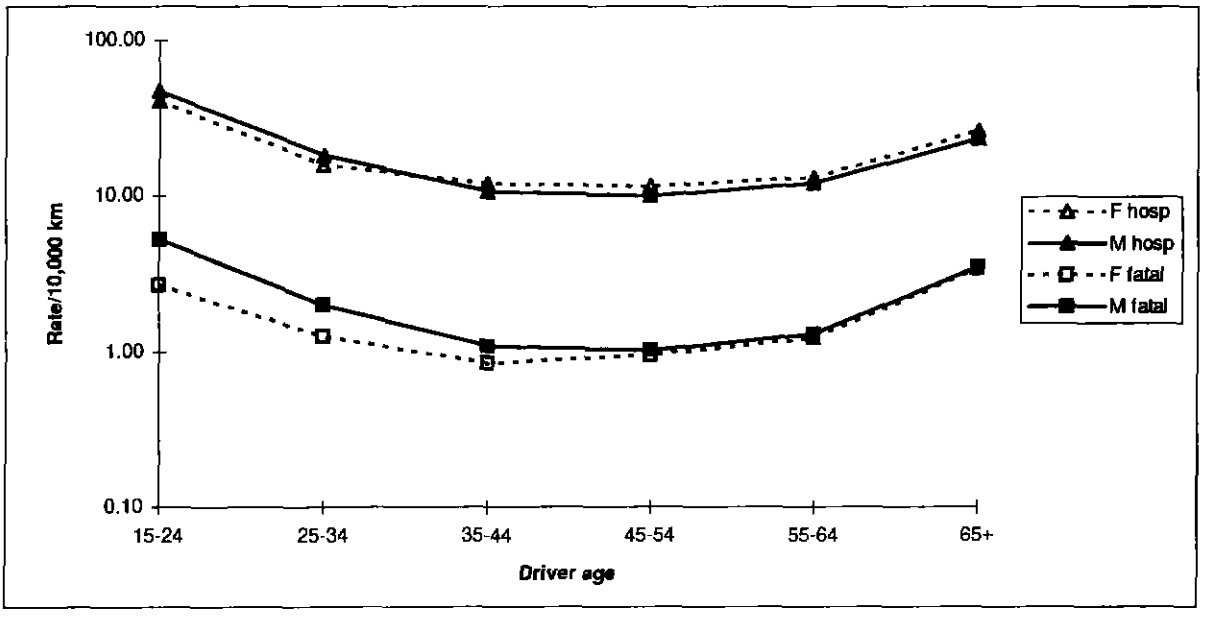
In 1991, the fatal crash involvement rates for male and female passenger vehicle drivers were 1.97 and 1.38 per 10,000 kilometres, respectively, resulting in a crude male to female rate ratio of 1.43. Hospitalisation crash rates were naturally much higher, but were similar for male and female drivers; 17.9 per 10,000 km for males and 17.7 for females (male/female ratio 1.01).

The male and female crashes rates can be compared statistically using Poisson regression modelling. This enables formal testing of whether the rate ratio of male to female rates is statistically significantly different from one, 95% confidence interval estimation for the ratio, and also allows for multivariate modelling with simultaneous adjustment for age*. The age adjusted male to female fatal crash rate ratio is 1.46 with 95% confidence interval (1.32,1.62). The hospitalisation crash rate ratio, though smaller in magnitude, is also statistically significantly greater than one: 1.04 (1.01,1.07). So, male drivers have a much higher involvement rate in fatal crashes than female drivers, but the difference in involvement rates is negligible for less severe crashes.

Both male and female involvement rates in fatal and serious crashes vary in a characteristic U shape with age, ie. the youngest and the oldest drivers have the highest crash rates per distance travelled (Figure 5). However, it should be noted how the rate ratios also vary with age. The male to female fatality rate ratio is clearly largest for the younger drivers and decreases with age. On the other hand, the rate ratios for hospitalisation crashes are similar, although the female rates do increase relative to the males and the female rates become higher than the male rates around the 35 year age group.

* Age is a potential confounder since the proportion of male and female drivers differs with age and the crash rate varies with age.

Figure 5. Fatal and hospitalisation crash involvement rates per kilometres travelled for male and female passenger vehicle drivers by age, 1991 (Sources: FORS Serious Injury Database, ABS Survey of Motor Vehicle Usage). Note the Y axis is a logarithmic scale.



Statistical testing confirms these findings. There are statistically significant variations in the rate ratios with age, both for fatal crash involvement and for crashes of lower severity. Male drivers have statistically significantly higher fatal crash rates than females only for the first three age groups (with rate ratios 1.9 (15-24 age group), 1.6 (25-34)and 1.3(35-44)). They also have statistically significantly higher hospitalisation crash rates for the youngest age groups (rate ratio 1.2 in both 15-24 and 25-34 age groups), but thereafter the female rates are higher.

2.4 Crash involvement rates in the US

Comparable data were available from the US for the year 1990[12]. The US figures quoted below refer to all drivers, however, not just passenger vehicle drivers as in the Australian figures. The male driver crash involvement rate was 1.93 fatal crashes per 10,000 km travelled (almost equal to the 1991 Australian passenger vehicle driver rate of 1.97). The US female driver crash involvement rate was 1.11; somewhat less than the Australian rate of 1.38) leading to a larger male to female rate ratio of 1.74 (age adjusted: 1.80 95% confidence interval 1.77, 1.84).

Similar patterns with respect to age were observed in the US data. The male rate was higher than the female rate at all ages, but the gap decreased consistently from a ratio of 2.2 in the youngest age group (15-24) to 1.1 in the oldest age group (65+).

Though hospitalisation crash data were not available, rates were calculable for a much broader class of crashes (all non-fatal). Again, a similar pattern was observed in the US data with much smaller differences in the male and female rates as compared with fatal crashes. As indicated in Figure 5 for the Australian data, the US female drivers had slightly higher involvement rates in non-fatal crashes than men in all but the youngest age group.

2.5 Crash involvement rates in New Zealand

A recent report from New Zealand for the time period 1989-90 also showed similar patterns[14]. Specifically, male drivers under the age of 50 had higher fatal crash involvement rates per distance travelled than females (all types of vehicles) with the difference being most pronounced in the youngest age groups. Unlike the Australian or US figures, the New Zealand data showed higher female rates than male rates for fatal crashes among the older age groups (over 50). The non-fatal crash involvement patterns were essentially similar to that observed in Australia and the US, with female rates higher than males in all but the youngest age groups (under 30).

2.6 Crash involvement rates trends with calendar year in Australia

It has been shown that the number of female drivers killed in the last 40 years has increased relative to male drivers (Figure 2) and also that both the number of female drivers and the distance they cover has increased relative to males in the same period. It remains to be seen whether the female crash risk relative to males has actually increased, or whether the increase in the crash involvement just reflects increases in travel. Comparable national numerator and denominator data were obtainable only for the years 1985, 1988 and 1991. The numerators come from the FORS 1985 and 1988 Fatality Files[15] and the FORS 1991 Serious Injury File[2] and the denominators from the 1985, 1988 and 1991 ABS SMVU[8].

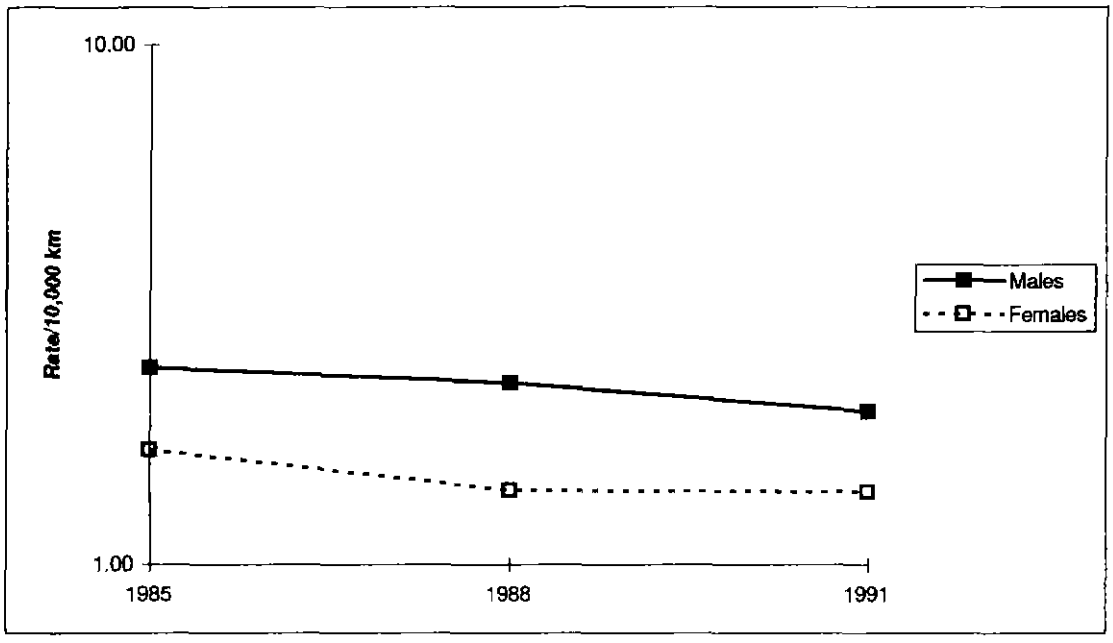
In this seven year period, the fatal crash involvement rate per distance travelled decreased for both for male and female passenger vehicle drivers (Figure 6). The adjusted rate of decrease was estimated to be 2% annually (95% confidence interval 1%, 3%). There was no statistically significant difference between the rate of decrease for males and females (p=0.15). This is the same as testing for differences in the male to female rate ratio with time. Despite a slightly larger male to female rate ratio in 1988, these three ratios were not statistically significantly different (1985 1.44 (1.31,1.58); 1988 1.61 (1.46,1.77); and 1991 1.43 (1.29,1.57))†.

Limiting the analysis to the youngest age group (15-24) also showed a consistent decrease in fatal crash involvement rates for both male and female drivers with a consistently higher male and female rate ratio of approximately 2.0 at each time point.

† The corresponding age adjusted male/female rate ratios for 1985, 1988 and 1991 were 1.46, 1.65, 1.47, respectively and they were not statistically significantly different (p=0.14). The age adjustment, however, was only approximate as the age categories available were not strictly comparable for all three years.

A recent study by the NRMA which was limited to NSW car drivers for the same time period reported decreases in male and female fatal crash involvement rates[16], but also reported a narrowing of the gap between the male and female rates for all but the youngest drivers (under 20). Further statistical analysis of these data, however, showed that the male/female fatal crash involvement ratios for NSW car drivers were not statistically significantly different between the three years (1.50, 1.74, 1.35 for 1985, 1988 and 1991, respectively; p=0.11). It should be noted that the pattern was similar to that observed for the national data.

Figure 6. Fatal crash involvement rates per kilometres travelled for male and female passenger vehicle drivers in Australia in 1985, 1988 and 1991. Passenger vehicles include sedans, stationwagons, passenger vans and four wheel drive passenger vehicles. (Note: Y axis is a logarithmic scale)



2.7 Fatality rates trends with time in the US

A recent study from the US compared male and female driver fatality rates in the period 1969-1990[17]. It was reported that the fatality rate per distance travelled decreased for both male and female drivers in this period. Although the report concluded that the relative decrease in the fatality rate had been greater for male drivers, a closer inspection of the data suggested that there has been little difference in the relative fatality rate since 1977. For example, the crude male to female rate ratio was 1.75 in 1977, 1.67 in 1988 and 1.73 in 1991.

2.8 Summary

Travel differences

Overall, females account for a disproportionately small amount of kilometres travelled relative to males, but there are indications that the gap is narrowing. The increase in the number of kilometres travelled by women relative to men appears to be due to relative increases in both the number of female drivers and the average distance travelled per driver. In recent years it appears that women in the older age groups (where the male to female ratio is highest), have contributed most to the increase.

In addition to differences in the amount of travel, there are differences in the type of travel undertaken by men and women, especially with respect to the time of day and day of the week and with the purpose of the travel. Unfortunately, there are not sufficient data available to conclude whether these differences are decreasing with time.

Rate differences

Since females travel less than males, comparisons of crash risk ought to take into account some measure of exposure. When crash risk is measured as a rate of involvement per distance travelled, males have been shown to be at higher risk for fatal crashes and this is clearly most pronounced for younger drivers. On the other hand the non-fatal crash rates are similar for men and women, although there is some evidence to indicate that among the younger drivers, males are at slightly greater risk, whereas female non-fatal crash rates are higher than males among the older drivers.

Involvement per distance travelled has several weaknesses as a measure of crash propensity, since it is affected by a number of other factors such as type of travel and crash survivability. (This is discussed further in later chapters). Assuming that these extraneous factors have remained constant, however, a change in the involvement rate should reflect a change in the underlying crash propensity rate.

Despite the paucity of comparable numerator and denominator data in Australia for the period before 1985, it is concluded that both male and female fatal crash involvement rates per distance travelled are decreasing. There is no strong evidence to suggest, however, that the rate of decrease in recent years is different for male and female drivers. However, it is possible that, similar to that observed in the US, prior to 1985, the gap between male and female crash rates decreased.

Chapter 3. Comparison of fatal crashes involving male and female car drivers

This chapter describes fatal crashes involving male and female car drivers.

3.1 Crash types overview

The 1990 Fatality File Database[18] contains detailed information on all fatal crashes occurring in Australia in 1990. Of the 2037 fatal crashes in the file, attention is restricted in this report to the 1378 crashes (68%) involving non-stationary passenger cars for which the sex of the drivers is recorded. The definition of passenger cars used for selections from the Fatality File includes sedans, station wagons, hatchbacks and convertibles, and excludes passenger vans, panel vans, utilities and 4-wheel drive vehicles. The term *car* will be used for these vehicles in the remainder of this report. Only 19 crashes were excluded on the basis of missing information on the type of vehicle or the sex of the driver.

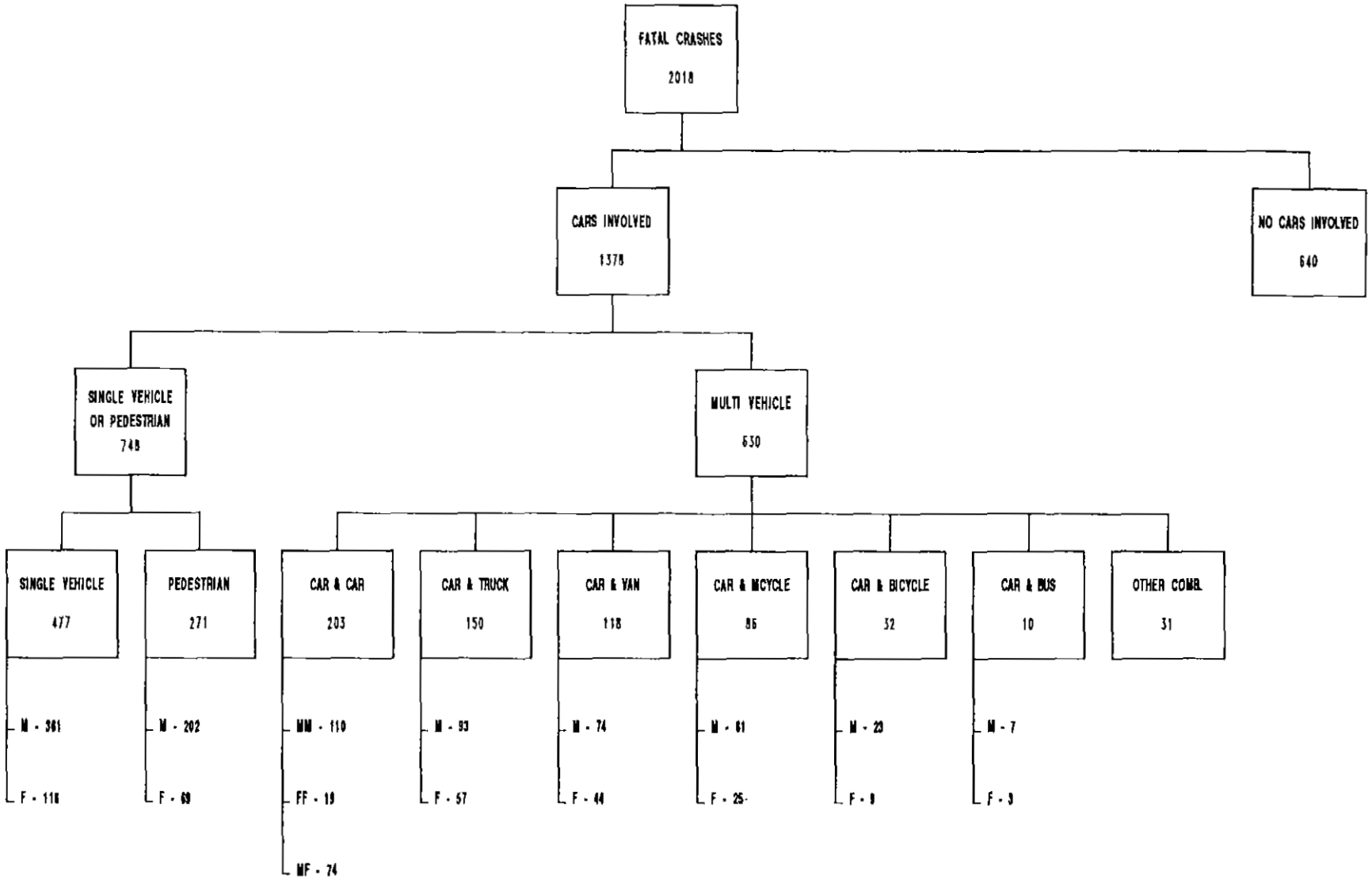
Just under one half of the fatal crashes involving cars were multiple vehicle crashes (630, 46%), an additional 35% were single vehicle crashes (477) and the remainder (271, 20%) involved a car hitting a pedestrian (Figure 7).

Of the 630 multiple vehicle crashes involving cars, 34% involved a collision between two cars, 27% involved a car and a bus or truck and 20% involved a car and a van or utility.

In 74 of the 203 two car collisions, a car driven by a male collided with a car driven by a female (Figure 7).

Relative to males, female car drivers were involved in a higher proportion of multiple vehicle crashes than males. The type of crash and the crash setting are further investigated for male and female drivers in the next section.

Figure 7. Number of fatal crashes according to the number and type of non-stationary cars and other vehicles and pedestrians in the crash and the sex of the car driver(s) involved (M=Male car driver, F=Female car driver, MM=Male car drivers, FF=Female car drivers, MF=Male and Female car drivers) FORS 1990 Fatality File (Australia)*



* For example, there were 61 male car drivers in fatal collisions with motorcyclists and 25 female car drivers in fatal collisions with motorcyclists.

3.2 Differences between male and female fatal crash involvement

The fatal crash setting and the type of crash were compared for male and female car drivers. The crash setting was defined in terms of when and where the crash occurred. Crashes were grouped according to the number of vehicles and whether pedestrians were involved. The percentage breakdown of day/night, weekday/weekend, urban/rural and crash type (pedestrian/ single/multiple vehicle) are shown in Table 5 for male and female car drivers involved in fatal crashes in 1990.

Whereas there was an equal breakdown of day/night fatal car crashes for male drivers, females were relatively more likely to be involved in daytime fatal crashes (65% day vs 35% night, Table 5).

Also, there were higher percentages of weekday crashes and multiple vehicle crashes for female compared with male car drivers.

Table 5. Number and percentage of male and female car drivers involved in fatal crashes by time of day and day of week, crash type and location. Percentages are bolded if differences between males and females are statistically significant ($p<0.05$). (FORS 1990 Fatality File).

Fatal crash setting	**Car drivers**			
	Male		**Female**	
Total car drivers	1178	100%	456	100%
Time of day				
Day (6 am - 6 pm)	593	50%	296	**65%**
Night	585	**50%**	160	35%
Day of the week*				
Weekday	637	54%	310	**68%**
Weekend	541	**46%**	146	32%
Crash type				
Multiple vehicle	612	52%	271	**59%**
Single vehicle	361	**31%**	116	25%
Pedestrian	205	**17%**	69	15%
Region#				
Rural	463	39%	201	44%
Urban	712	61%	255	56%

* Weekend defined from 6 pm Friday night to 6 am Monday morning

Urban/rural status unknown for 3 drivers

There was a slightly higher proportion of female car drivers involved in rural crashes (44% rural) compared with male car drivers (39% rural).

The time of day and day of week associations were confirmed with multivariate log linear analysis. These associations are thus not confounded by the other factors.

Additionally, the log linear analysis was repeated at the crash rather than the driver level. A 'female' crash being defined as a fatal crash involving no male car drivers. At this level, time of day, day of week and crash type were found to be statistically significantly related to the sex of the car drivers involved. The directions of the associations were consistent with those in Table 5.

3.3 Over-representativeness of fatal crash involvement relative to travel exposure

The relative involvement of male and female car drivers in fatal crashes based on the 1990 Fatality File can be compared with the exposure data from the 1985-86 Day-to-day Travel Survey in terms of the time of the day and week. Both the day versus night and the weekday versus weekend female to male quotients from the travel survey were greater than one. Thus, differences between male and female car driver involvement in fatal crashes can be at least partly explained by differences in travel patterns. This will be discussed further in Chapter 4.

Chapter 4. Comparison of fatal crashes for which male and female drivers were responsible

4.1 Introduction

The 1990 Fatality File contains information on who was considered responsible for the initial event leading to each fatal crash.

Male and female drivers of cars were equally likely to be at fault when involved in fatal crashes in 1990. Of the 1177 male car drivers who were involved in fatal crashes, 640 (54%) were considered solely at fault and a further 65 (6%) at least partly at fault. The corresponding percentages for female drivers were essentially the same; 245 out of 456 car drivers (54%) were considered fully responsible and 21 car drivers (5%) partly responsible.

Subdivision by age of the drivers did not alter the results. Similar proportions of male and female at fault car drivers were found within the following age groups; <25, 25-59, 60+ years.

Restricting attention to the 74 fatal crashes involving a car driven by a man colliding with a car driven by a woman with no other vehicles or pedestrians involved, the female driver was considered responsible for 35 (47%) of these crashes, the male driver was considered responsible for 32 (43%) and both were considered partly at fault in 2 crashes (3%). The remaining 7% were attributed to vehicle or road conditions and not associated with driver behaviour. Thus, in situations in which the timing, location and conditions are the same for both drivers, the sex of the driver does not appear to be associated with the probability of being at fault.

Assuming that the probability of being innocently involved in a fatal crash is primarily determined by travel exposure, but that the probability of being at fault in a crash is a function of both crash involvement propensity *and* travel exposure, then the ratio of *at fault* to *not at fault* drivers should provide a rough measure of crash propensity. This method of using the innocent drivers involved in crashes as exposure denominators, called quasi-induced exposure estimation, was introduced in the late sixties[19,20,21] and the resultant estimates have been recently shown to be consistent and reproducible[22].

Therefore, the fact that this ratio is similar for male and female car drivers suggests that there are no substantial differences in the likelihood of fatal crash involvement per unit of travel exposure for men and women.

The conclusion that males and females have equal likelihood of fatal crash involvement based on the 1990 Fatality File fault data needs to be looked at in relation to the comparison of crash rates in Chapter 2 and other similar studies. Previous studies which have examined differences between males and females in terms of *non-fatal* crashes per distance travelled have found either little difference or have found the female rate to be slightly higher depending on the injury severity and age of the driver[23, 12, 24]. Yet studies both in Australia[1,16] and overseas[12] have found that males have significantly more *fatalities* per distance travelled and a higher rate of fatal crash involvement particularly among younger drivers.

Since the fault ratios are similar for male and female drivers of all ages, it is possible that the differences are due to the different units of measurement. For example, the measure, fatalities per distance travelled, may underestimate female crash risk, since this measure takes no account of differences in the type of travel undertaken. Thus, females may have a lower rate of fatal crashes per distance travelled because they tend to travel at the less risky times and this may be most marked for the youngest drivers. In the 1984-5 study, the larger male to female fatality rate ratio was still in evidence after adjustment for time of day, but there was no simultaneous adjustment for day of the week. Although the available data to not permit precise recalculation, it does appear that a simple analysis which stratifies by day of week reduces the estimated difference between males and females in terms of fatalities per distance travelled.

4.2 Comparison of fatal crashes for which male and female drivers were responsible

The characteristics of fatal crashes involving a *male* car driver who was considered fully responsible for the crash (640 crashes) are compared with fatal crashes involving a *female* car driver who was considered fully at fault (245 crashes). Comparisons are made for crash, trip, driver and passenger characteristics and causal factors. These are dealt with in separate sections. Although approximately 90 variables were tested, only major differences between the male and female at fault crashes are reported.

Where appropriate, attempts have been made to investigate whether significant differences in the proportion of 'at fault' male and female driver crashes accounted for by a particular factor were purely a result of differences in travel exposure. For example, if crashes caused by female drivers were more likely to have taken place during the daytime, this finding by itself may say nothing about crash propensity, but instead merely reflect the fact that a greater proportion of female travel occurs during this time.

This was controlled for by checking whether differences between male and female at fault drivers were also reflected in differences between innocently involved drivers.

4.3 Crash characteristics

The major differences between fatal crashes caused by male and female car drivers are summarised in Table 6 in terms of the timing, number of vehicles involved and location of the crash.

Timing

Fatal crashes caused by female car drivers were more likely during the day and on weekdays (Table 6). Male car drivers were more likely to cause fatal crashes at night and on weekends (especially Saturdays).

In considering the not at fault male and female car drivers involved in fatal crashes, these differences appear to be a direct result of differences in travel patterns between males and females, rather than an increase in risk for daytime travel or travel during the week for females.

Crash type

Female car drivers who were at fault were more likely to be involved in fatal multiple vehicle crashes than male car drivers who where at fault. Male car drivers at fault were more likely to be involved in pedestrian and single vehicle crashes.

Within each of these three broad categories of crash, there was no difference in the percentage distribution of different crash types for male and female car drivers. For example, for fatal multiple vehicle crashes, the proportion of head on crashes and adjacent direction crashes were similar for male and female at fault car drivers. Also, for single vehicle crashes, male and female car drivers were equally likely to have overturn crashes.

Furthermore, similar proportions of crashes caused by male and female car drivers involved a complex chain of events (approximately 7%), rather than a single collision.

The car driver was considered fully at fault in only 14% of the 268 fatal pedestrian crashes involving a single passenger car in 1990. However, among these crashes male car drivers are more likely to be at fault compared with women car drivers (16% vs 9%). This was also observed for the corresponding fatal pedestrian crashes in 1988[15] (24% of male car drivers fully at fault vs 12% of females).

Table 6. Percentage of crashes with certain characteristics (timing, crash type, location) for fatal crashes with a male car driver solely at fault (n=640) and for those fatal crashes with a female car driver solely at fault (n=245). Percentages are bolded if differences between males and females are statistically significant (p<.05). Percentages exclude missing values where appropriate. (FORS 1990 Fatality File)

Crash characteristics	**Sex of car driver at fault**	
	Male	**Female**
	(n=640)	(n=245)
Timing		
Weekday (vs weekend[1])	54%[2]	**67%**[3]
Day (vs night)	47%	**65%**
Weekday daytime (vs other)	30%	**46%**
Weekend night time (vs other)	**29%**	14%
Crash type		
Multiple vehicle crashes	43%	**53%**
Single vehicle crashes	**52%**	45%
Pedestrian crashes	5%	2%
Location		
Urban	50%	44%
Rural	50%	56%
Location with respect to intersections		
Mid block	78%	76%
Intersection (within or related to)	22%	24%
Within intersection crashes	(n=129)	(n=57)
Intersection type		
X intersection	47%	**68%**
T intersection	**49%**	28%
Other intersection	4%	4%
Controls at intersection		
No controls	**40%**	14%
Stop signs	14%	**37%**
Lights	16%	**23%**
Other controls	30%	26%

[1]Weekend defined from 6 pm Friday night to 6 am Monday morning

[2] 54% of 640 fatal crashes in which a male car driver was at fault occurred on weekdays.

[3] 68% of 245 fatal crashes in which a female car driver was at fault occurred on weekdays.

Location with respect to urban/rural status

Approximately half of both the fatal crashes caused by male car drivers and crashes caused by female drivers occurred in rural as compared to urban areas. There was no indication that the proportion of male and female not at fault drivers differed in rural and urban areas.

Subdivision by crash type showed that females were more likely than males to have single vehicle crashes in *rural* areas (females 75% vs males 59%). This was also borne out in a comparison of speed limits at crash sites. Seventy-nine percent of female driver single car crashes occurred in areas with speed limits of at least 80 km/h, compared with 65% of male single car crashes in these higher speed zones.

Although there were proportionally more female single car crashes in rural areas, the types of single car crashes in rural areas, in terms of overturn crashes, or loss of control on a straight section or curve, were similar for both men and women.

Location with respect to intersections

The proportion of mid-block crashes (as opposed to crashes occurring at intersections) was similar for males and females (approximately 77%). However, for intersection crashes, the type of intersection at which the crash occurred varied significantly for crashes caused by male and female car drivers.

Female car drivers were more likely than males to be at fault in fatal crashes occurring at X intersections, whereas there were proportionally more male driver crashes at T intersections. This was statistically significantly different in urban regions, but not in rural crashes (although the direction of the association was the same).

Male car drivers were also more likely to cause crashes at intersections with no traffic controls, whereas females were more likely to cause crashes at intersections with stop signs or traffic lights. This difference was observed in both urban and rural areas, but most pronounced in urban regions.

These patterns were not observed to the same extent among the male and female not at fault drivers involved in intersection crashes. However, the responsibility ratios were not statistically significantly different for males and females at the different intersection types. Thus, there is insufficient evidence to rule out the explanation of the differences in terms of different amounts of male and female travel in the vicinity of different types of intersections.

4.4 Trip characteristics

The place of origin was recorded in the 1990 Fatality File for 46% of the at fault car drivers. Both origin and destination were recorded for slightly fewer drivers (39%). The percentage of missing information was similar for male and female at fault car drivers overall, and within single vehicle crashes and multiple vehicle crashes. However, there was a higher percentage of missing trip details for car drivers causing fatal crashes during the day and on weekdays.

Origin

Female car drivers responsible for fatal crashes were more likely to be travelling from home or on personal business, whereas males were more likely to be coming from social/recreational venues (Table 7). These differences were observed, in general, for both single and multiple vehicle crashes. However, there were some further differences when destination as well as origin was taken into account.

Origin and destination

Approximately one third of both male single vehicle crashes and female single vehicle crashes occurred on homeward journeys from recreational activities. However, males were more likely to have single vehicle crashes travelling from one recreational venue to another, and females were more likely than males to have single vehicle crashes travelling from home to recreation (Table 7).

Multiple crashes were more likely to be caused by males coming from recreational activities or females going home from, or on personal business.

Not at fault drivers

The not at fault male car drivers had the same pattern of origin relative to female not at fault drivers. Thus, the observed differences in at fault drivers are assumed to be at least partially a result of different travel patterns.

It should also be noted that both male and female car drivers coming from recreational activities were more likely to be at fault in fatal crashes than those drivers coming from work.

Table 7. Percentage of crashes according to origin and destination of the trip† for fatal crashes with a male car driver solely at fault and for those fatal crashes with a female car driver solely at fault. Percentages are bolded if differences between males and females are statistically significant (p<.05). (FORS 1990 Fatality File)

Trip characteristics (origin and destination)	Sex of car driver at fault	
	Male	**Female**
Origin	(n=247)	(n=102)
From recreation	**61%**	46%
From home/personal business	32%	**48%**
From work	7%	6%
Origin and destination		
Single vehicle crashes	(n=146)	(n=56)
Recreation to recreation	**37%**	20%
Recreation to home	33%	34%
Other (eg home to personal business, to/from work)	12%	20%
Home to recreation	11%	**20%**
Personal business to home	4%	2%
Personal business to personal business	3%	4%
***Multiple* vehicle crashes**	(n=94)	(n=43)
Other (eg home to personal business, to/from work)	33%	22%
Recreation to home	**29%**	12%
Recreation to recreation	**22%**	12%
Home to recreation	9%	**14%**
Personal business to home	7%	**26%**
Personal business to personal business	0%	**14%**

† This table is based on less than half the total number at fault male and female drivers since information on origin and/or destination was not available for a large percentage of the drivers.

4.5 Driver characteristics

Driver age

The age distribution of male and female at fault car drivers was essentially similar (Table 8). Nor was any statistically significant difference in age found for the not at fault drivers involved in fatal crashes.

Car driver occupation

Employment status and occupation were recorded in the 1990 Fatality file for 71% of car drivers at fault. The percentage with occupation details was slightly higher for female compared with male drivers (76% vs 69%).

Male car drivers at fault in fatal crashes were more likely to be tradesmen or labourers or unemployed, and female at fault car drivers were more likely to be in clerical or sales positions or at home (Table 8).

The different occupations of the male and female at fault drivers were also observed for the not at fault drivers.

A comparison of male drivers at fault or involved in fatal road crashes with the Australian male workforce showed that labourers and machine operators were over-represented in fatal road crashes. The occupation distribution for females in fatal crashes was similar to the Australian female workforce.

Table 8. Percentage of crashes according to driver age and occupation for fatal crashes with the male car driver solely at fault and for those fatal crashes with a female car driver solely at fault. Percentages are bolded if differences between males and females are statistically significant (p<.05). (FORS 1990 Fatality File)

Driver characteristics	**Sex of car driver at fault**	
	Male	**Female**
Age of driver	(n=636)	(n=245)
<25	38%	40%
25-29	14%	9%
30-39	17%	18%
40-49	7%	10%
50-59	7%	6%
60+	17%	17%
Driver occupation	(n=444)	(n=185)
Labourer/operator	**26%**	8%
Retired	20%	22%
Trades	**15%**	3%
Adm/professional/para-professional	15%	12%
Unemployed	**9%**	3%
Sales/service	5%	8%
Student	5%	8%
Other	4%	2%
Clerical	1%	**18%**
Household duties	0%	**16%**

4.6 Car passenger characteristics

Male and female car drivers at fault in fatal crashes were equally likely to have passengers in their vehicles and, overall, the number of passengers was also similar (Table 9). However, females were more likely to have children (<17 years of age) in the car. This was most pronounced for drivers in the 25-39 age group (Table 9). For drivers in this age group, female at fault car drivers were more likely than males to have children in the car at all times (day and night, and week days and weekends).

The presence of young passengers in cars driven by young to middle-aged women was also observed in a comparison of female and male not at fault car drivers.

Table 9. Percentage of crashes according to passenger details for fatal crashes with a male car driver solely at fault and for those fatal crashes with a female car driver solely at fault. Percentages are bolded if differences between males and females are statistically significant (p<.05). (FORS 1990 Fatality File)

Passenger characteristics	**Sex of car driver at fault**	
	Male	**Female**
Passengers	(n=640)	(n=245)
No passengers	47%	48%
1 passenger	29%	29%
2 passengers	12%	11%
3 passengers	7%	9%
4 or more passengers	5%	3%
Age of passengers	(n=598)	(n=230)
At least 1 passenger under 5	2%	**6%**
At least 1 passenger aged 5-16	5%	**10%**
At least 1 passenger aged <17 (child)	7%	**13%**
Age of driver, presence of child passengers		
Driver aged <25: >=1 child pass	(n=226) 6%	(n=93) 8%
Driver aged 25-39: >=1 child pass	(n=183) 10%	(n=59) **34%**
Driver aged 40+: >=1 child pass	(n=185) 3%	(n=78) 5%

4.7 Causal factors

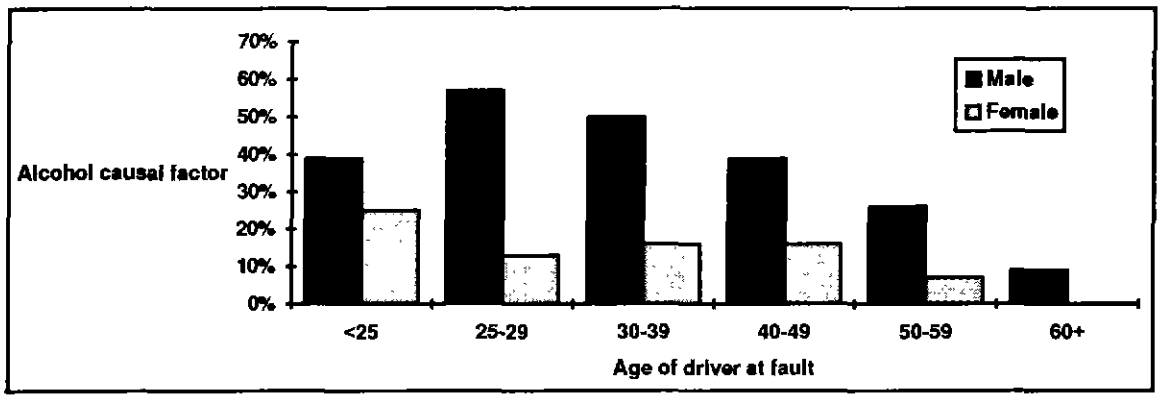
Alcohol

In 37% of fatal crashes caused by male car drivers, alcohol intoxication of the driver responsible for the crash was considered to be a contributing factor[†] . The corresponding percentage for females was only 16%. This difference is statistically significant.

The higher incidence of alcohol intoxication as a causal factor among male car drivers at fault was observed for both single vehicle crashes (52% males vs 28% females) and multiple vehicle crashes (19% males vs 8% females).

Although the percentage of alcohol crashes was higher for men in all age groups, the largest difference between the sexes was observed for those aged 25-39, and the smallest relative difference was seen for the youngest (39% of male car drivers under 25 vs 25% of females) (Figure 8).

Figure 8. Percentage of fatal crashes attributed to alcohol impairment of male car drivers (solely at fault) and female car drivers (solely at fault) within separate driver age groups. (FORS 1990 Fatality File)



The lower rate of intoxication among female drivers compared with male drivers and the different 'peaks' in drink driving with respect to age are consistent with overall patterns of alcohol consumption estimated in the National Health Survey[25]. For example, although females generally are less likely to drink alcohol in a given week, the contrast is most marked in the case of high risk drinking (defined as daily consumption greater than 75 ml for men and 50 ml for women). The overall proportion of male high risk drinkers was more than four times greater than for females (7.1% vs 1.6%). This ratio ranged from 3.1 times for those aged 18-24 to 5.4 times for those aged 25-44.

[†] For each crash in the 1990 Fatality File, up to three major causal factors are coded. These are factors which are considered to have probably contributed to the likelihood of the crash occurring. 37% of the 640 fatal crashes caused by male car drivers had alcohol intoxication of the male car driver coded as one of up to three contributing factors.

The reasons behind the different age patterns in alcohol use for men and women are not clear. The age related reduction may occur earlier in women. On the other hand, it may be a cohort effect, ie. young women in 1990 are more likely to consume alcohol than young women of a previous generation and may continue to do so even as they become older. This is consistent with many studies in a number of countries which have shown an increase in drink driving among females.

For example, from 1978 to 1988 in New York State in the US, the proportion of females convicted of drink driving increased steadily, while the proportion of male drivers convicted decreased during this period[26]. Similar trends were also reported for blood and breath tests for male and female drivers New Zealand for the period 1985-91[14]. However, the drink driving rates for females are still well below those for males.

A study of blood alcohol levels (BAC) among a sample of 146 fatally injured female drivers in the period 1981-87 in Australia reported a (non-statistically significant) increasing trend with calendar year in the percentage with non-zero BAC. However, due to the relatively small numbers in each year, the power of this study was low (approximately 8% to detect increasing odds ratios ranging from 1.3 to 5.0 in the period 1982-87). The percentage of drunk drivers ranged from 12.5% in 1981 (based on only 8 drivers) to 45.5% in 1986 (based on 22 drivers)[27].

However, no significant increase in drink driving was found among Australian female drivers involved in fatal and serious injury crashes from 1990 to 1992[2]. This may suggest that any increase which may have occurred may be less rapid in recent times.

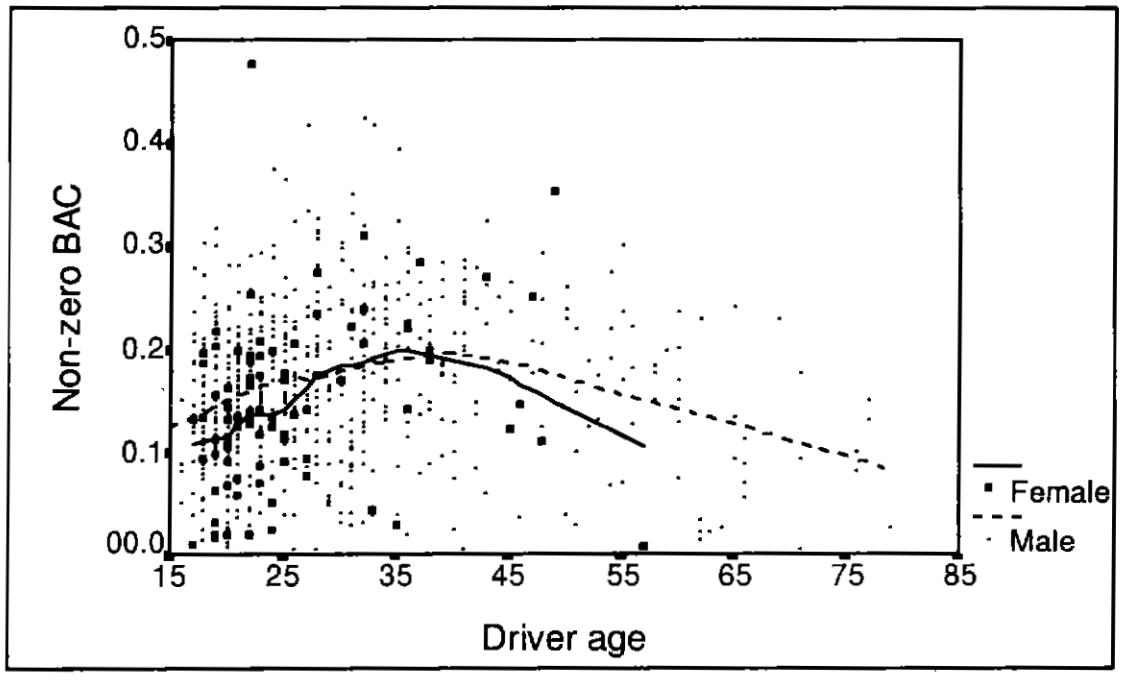
Specific BAC levels were also available in the 1990 Fatality File. Approximately 80% of male and female at fault drivers were tested for alcohol. Thirty-nine percent of all male car drivers causing fatal crashes had blood alcohol levels (BAC) exceeding 0.05 gm/100 ml (assuming those not tested were not drunk). The corresponding figure for females was only 17%[†] .

In order to investigate the BAC levels among the drunk drivers, the 1990 data was augmented with the corresponding data from the 1988 Fatality File. There were a total of 573 male and 86 female car drivers with non-zero BAC levels who caused fatal crashes in these two years. Overall, the median non-zero BAC level for males was 0.17 gm/100 ml and the corresponding figure for females was 0.15. Figure 9 shows how the BAC levels vary with age for both male and female drunk drivers, reaching a peak around 40 and tailing off. The BAC levels are slightly lower for the younger females compared with the younger males, but are similar in the 30 to 40 age group.

It is noteworthy that there are very few female at fault drivers with non-zero BAC levels who over the age of 40, relative to males. In fact, there was only one women over the age of 50 with a non-zero BAC reading in the combined 1988 and 1990 data (Figure 9). This may be a cohort effect reflecting the fact that drink driving was uncommon among women several decades ago. So, even though there is not much evidence for a relative increase in drink driving in recent years, there may have been a change over the longer term which is reflected in fewer female drunk drivers in the older age groups.

[†] These percentages are slightly higher than those quoted for alcohol being a contributing factor in the crash, since the intoxication may not necessarily have been considered a causal factor in a small number of cases and since these figures are based only on those drivers for which BAC level was measured.

Figure 9. Distribution of BAC levels versus age for 573 male and 86 female car drivers with non-zero BAC levels causing fatal crashes. The lines are LOWESS fits (locally weighted regression smoothing) (FORS 1988 + 1990 Fatality Files)



Passengers of drunk drivers

BAC levels were available for passengers as well as drivers in the 1990 Fatality File . Approximately 58% of the drunk drivers (BAC>0) had no other adult passengers in their vehicle, 31% of the drunk drivers had at least one passenger who was not drunk and in 11% of vehicles all adult occupants were intoxicated. These percentages were essentially similar for the 238 male and 40 female drunk drivers (Table 10).

It has often been suggested that drink driving being undertaken by females may be due to women driving instead of their partners when both have been drinking. However, there was no evidence to suggest that this was a large contributing factor, since only 4 of the 40 drunk female at fault drivers had a male front seat passenger who was also drunk.

Table 10. Number and percentage of male and female drunk car drivers fully at fault in fatal crashes according to the presence and intoxication status of their adult passengers (FORS 1990 Fatality File)

Passenger characteristics	**Sex of at fault drunk driver**	
	Male	**Female**
No adult passengers	137 (58%)	24 (60%)
All adult passengers drunk	26 (11%)	5 (13%)
At least one sober adult passenger	75 (32%)	11 (28%)
Total drunk drivers	238 (100%)	40 (100%)

Voluntary risk taking behaviour

Causal risk factors grouped under voluntary risk taking behaviour in the 1990 Fatality File include excessive speed, dangerous manoeuvres, skylarking, illegal overtaking and other deliberate violation of traffic rules. Excessive speed accounts for 85% of these.

Fatal crashes caused by male car drivers were more likely to be due to risk taking than fatal crashes caused by women (31% vs 20%). This appeared consistent in all age groups (Figure 10). The difference was most pronounced for single vehicle crashes (males 38% vs females 24%) and not significant for multiple vehicle crashes (males 14% vs females 10%).

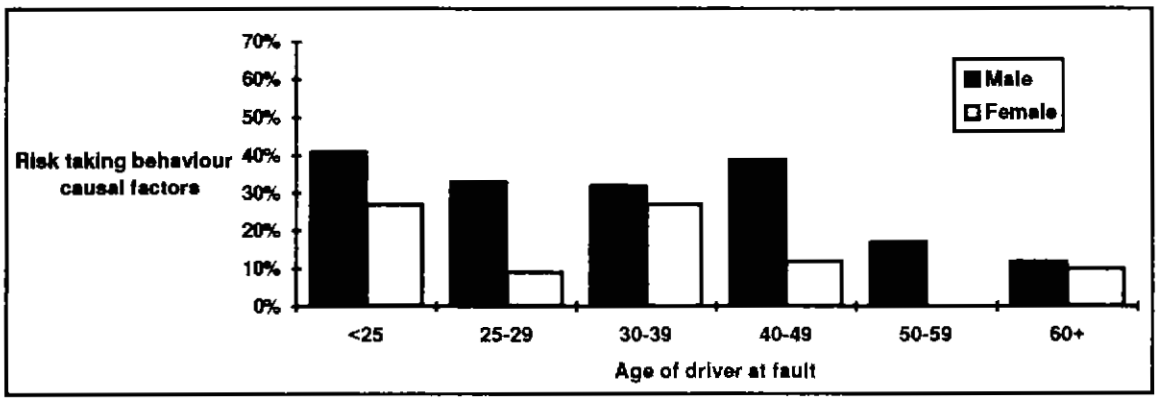
Since up to three major causal factors could be coded for any one fatal crash, it could be seen from the data that drunk driving and risky behaviour were related. Forty-five percent of at fault drivers who were classed as speeding or taking deliberate risks were also drunk. However, even among the sober drivers, there was still a higher proportion of males for whom risk taking was identified as a major causal factor (26%) compared with females (16%).

Vehicles in the 1990 Fatality File were coded as either unlikely, possibly or definitely speeding, or within the legal limit but fast for conditions. Based on these data, there were proportionally more male at fault drivers than female at fault drivers who were considered to be possibly or definitely over the speed limit in both single and multiple vehicle crashes.

On the other hand, females were slightly more likely to be driving within the speed limit but fast for the conditions (8% vs 3% all crashes). This was probably more likely to be due to an error of judgement than deliberate risk taking.

There was no difference in the age distribution of men and women classified as speeding.

Figure 10. Percentage of fatal crashes attributed to deliberate risk taking behaviour of male car drivers (solely at fault) and female car drivers (solely at fault) within separate driver age groups. (FORS 1990 Fatality File)



Passenger distraction

It has been suggested that many crashes involving women may be caused by inattention due to passenger distraction, especially with respect to young children. However, passenger distraction was the cause of only 2% of fatal crashes caused by car drivers with at least one passenger and there was no difference in the incidence of this causal factor for male and female car drivers.

There must be a witness statement for passenger distraction to be recorded as a causal factor in a fatal crash. Thus, the incidence of this may be underreported for those drivers killed or seriously injured. Nevertheless, the total possible number of crashes due to distraction by young children is small, since only 6% of cars driven by women at fault in fatal crashes contained passengers under the age of 5.

Driver error

There was a slightly, but not significantly, higher incidence of fatal crashes attributed to driver error for females (21%) compared to males (16%). Driver errors include crashes for which the driver at fault failed to see another road user or signal or road condition, or made an error of judgement.

Again, there may be an underreporting of these factors due to an inability to obtain statements from seriously or fatally injured drivers.

Summary of causal factors

Deliberate risk taking (including alcohol, speeding and other risky actions) played a role in just over half (53%) the fatal car crashes caused by male drivers. The corresponding figure for females at fault is 30%. These results are consistent with earlier overseas reports on differences between males and females in terms of driving behaviour. Storie reported in 1977 in the UK a higher incidence of alcohol and speed related crashes for males and more crashes related to inexperience and perceptual error for females[28]. Popkin also found than young female drivers in the US were less likely stop, give way or check for other vehicles appropriately than young male drivers[29].

At the beginning of this chapter, it was shown that the percentage of male car drivers who were at fault in fatal crashes was similar to that for females (54%). However, the percentages differ when the deliberate risk taking drivers are excluded from the comparison. Of the sober, non-speeding car drivers involved in fatal crashes, 37% of the males were at fault compared with 47% of the females. So, women are slightly more likely to be at fault if neither drinking or speeding are involved.

4.8 Unexplained crashes

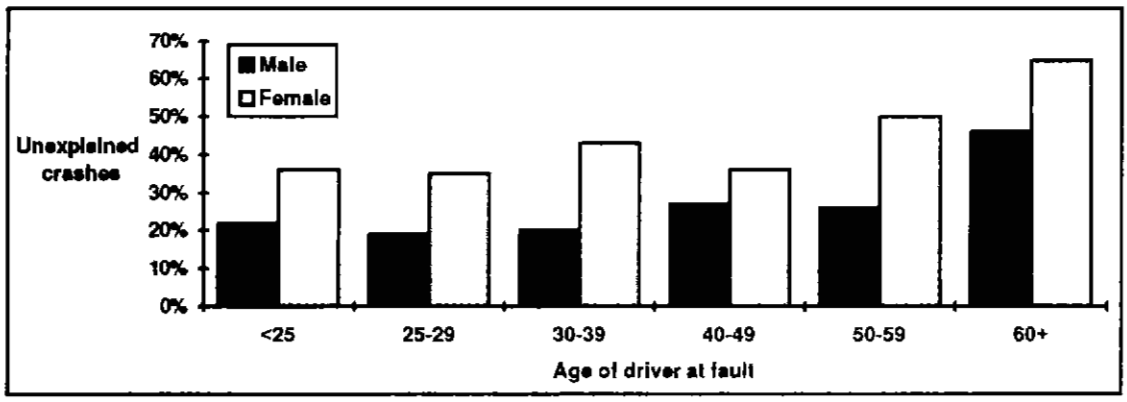
Overall, in 31% of fatal crashes where a car driver was solely responsible for the crash, no explanation in terms of impairment or deliberate risk taking could be found for the action which led to the crash. In these crashes, even though it was clear who was at fault, the crash event could not be explained.

The percentage of 'unexplained' crashes was statistically significantly higher for females (43%) than males (26%). The higher incidence of unexplained fatal crashes for female car drivers was consistent over all age groups (Figure 11, Table 11).

Table 11. Percentage of unexplained fatal crashes with a male car driver solely at fault (n=640) and a female car driver solely at fault (n=245). The percentages are also given within separate driver age groups. Percentages are bolded if differences between males and females are statistically significant (p<0.05). (FORS 1990 Fatality File)

Major causal factor unexplained	Sex of car driver at fault	
	Male	Female
Unexplained road user action*	26%	**43%**
Age <25	22%	**36%**
Age 25-29	19%	35%
Age 30-39	20%	**43%**
Age 40-49	27%	36%
Age 50-59	26%	50%
Age 60+	46%	65%

Figure 11. Percentage of fatal crashes with unexplained causes for male car drivers solely at fault and for female car drivers solely at fault within separate driver age groups. (FORS 1990 Fatality File)



* Crashes for which the sequence of events which lead to the crash cannot be explained.

This may occur through two possible mechanisms. There may be underreporting of factors such as alcohol and speeding for female drivers. Alternatively, factors which are harder to detect may be more common for female drivers. For example, female drivers may be more likely to cause crashes through errors in perception or attention, and there would be no means of detecting these events in the case where the driver was killed or suffered memory loss as a result of head injury.

With regard to the first mechanism, it is unlikely that the higher proportion of unexplained crashes caused by female drivers is a result of bias in the information collected on alcohol or speeding. In the case of drink driving, male and female car drivers involved in fatal crashes are equally likely to be tested (79% and 78%, respectively). Moreover, for those drivers not tested, there is no reason to think that they included a relatively higher proportion of drunk females.

Also, it is unlikely that female car drivers who were speeding and caused fatal crashes are less likely to be detected, since crashes involving females are more likely to occur during high volume times of the day and week.

Characteristics of unexplained crashes

The different types of unexplained crashes are listed in Table 12. Approximately one third of these crashes involved loss of control of the vehicle and one third were head on collisions.

Table 12. Number and percentage of different types of unexplained fatal crashes caused by male and female car drivers (FORS 1990 Fatality File)

Type of unexplained crash event	Total		Sex of car driver at fault: Male		Female	
	n	%	*n*	%	*n*	%
Ignore traffic control signals/signs	60	22%	34	20%	26	25%
Inexplicable loss of control on a curve	60	22%	37	22%	23	22%
Inexplicable loss of control on a straight road	52	19%	27	16%	25	24%
Wrong side of road or unsuccessful o/taking	48	18%	34	20%	14	13%
Driving into another vehicle (mid block)	32	12%	22	13%	10	10%
Other unexplained action	21	8%	14	8%	7	7%
Total unexplained fatal crashes	273	100%	168	100%	105	100%
(Percentage of all fatal crashes)	(31%)		(26%)		**(43%)**	

A multiple logistic regression of unexplained crashes versus crashes explained by specific causes showed that, as well as the sex difference, unexplained crashes involving passenger cars were independently more likely to occur in the daytime than at night, and more likely to involve more than one vehicle or a pedestrian than a single vehicle. Furthermore, unexplained crashes were also more likely to be caused by older drivers (aged at least 60).

The addition of these other factors into the model did not significantly affect the size of the odds ratio for unexplained crashes for females versus males (unadjusted OR 2.1, adjusted OR 2.0)

Neither day of the week, the presence of passengers, the deaths of all occupants in the car nor the location of the crash were associated with the explanation of the crash. There were no statistically significant interaction terms with sex of the driver. In other words, the timing, number of vehicles and age associations were consistent for males and females.

Comparison of male and female unexplained crashes

There was no statistically significant difference in the type of road user action that was unexplained for the 168 at fault male drivers compared with the 105 at fault female drivers (Table 12). Nor were there any statistically significant differences in terms of other factors, such as time of the day, day of the week, location, number of vehicles and number of passengers. Nor were there any statistically significant interactions between these factors.

Thus, although female car drivers cause a larger proportion of fatal crashes for which the cause is unknown compared to male car drivers, there is no specific type of unexplained crash which is more common for females.

By definition, these unexplained fatal crashes are not associated with deliberate risk taking. Also, due to the severity of injury in fatal crashes, it is often difficult to obtain information on the subjective processes of the drivers involved. Thus, the unexplained crashes are more likely to be related to driver error or misjudgment. This is consistent with the slightly higher incidence of deliberate driver error among the females in the explained crashes.

4.9 Summary

There are many differences in the nature and circumstances associated with crashes caused by male and female drivers. Some differences, such as the higher proportion of female driver crashes caused during the day, are merely a reflection of travel patterns, while other differences seem to represent differing patterns of crash propensity.

A higher proportion of female driver crashes involve more than one vehicle. There is also some evidence to indicate they also are likely to cause fatal crashes at X intersections, whereas men appear more likely to cause fatal crashes at T intersections. Female car drivers are less likely than men to cause fatal crashes due to alcohol intoxication or speeding, whereas crashes caused by female car drivers are more likely lack evidence regarding causation, which is consistent with a slightly higher percentage of crashes attributed to driver error.

Chapter 5. Factors affecting injury outcome

5.1 Impact type and location

In approximately one half of the fatal crashes involving passenger cars in 1990, a car driver was killed. Figure 12 shows the breakdown of these 663 fatal crashes resulting in the death of at least one car driver in terms of the number and type of vehicles involved in the crash and the sex of the car driver(s) killed. Approximately half of these crashes are multiple vehicle crashes. At least one female car driver was killed in 212 (32%) of these 663 fatal crashes.

Previous chapters indicated that fatal crashes involving female car drivers were more likely to involve collisions with another vehicle rather than single vehicle crashes. This is also the case for fatal crashes which result in car driver deaths (Figure 12). In 34% of multiple vehicle crashes resulting in at least one car driver death, a female driver was killed, compared with only 27% of single car crashes in which female drivers were killed.

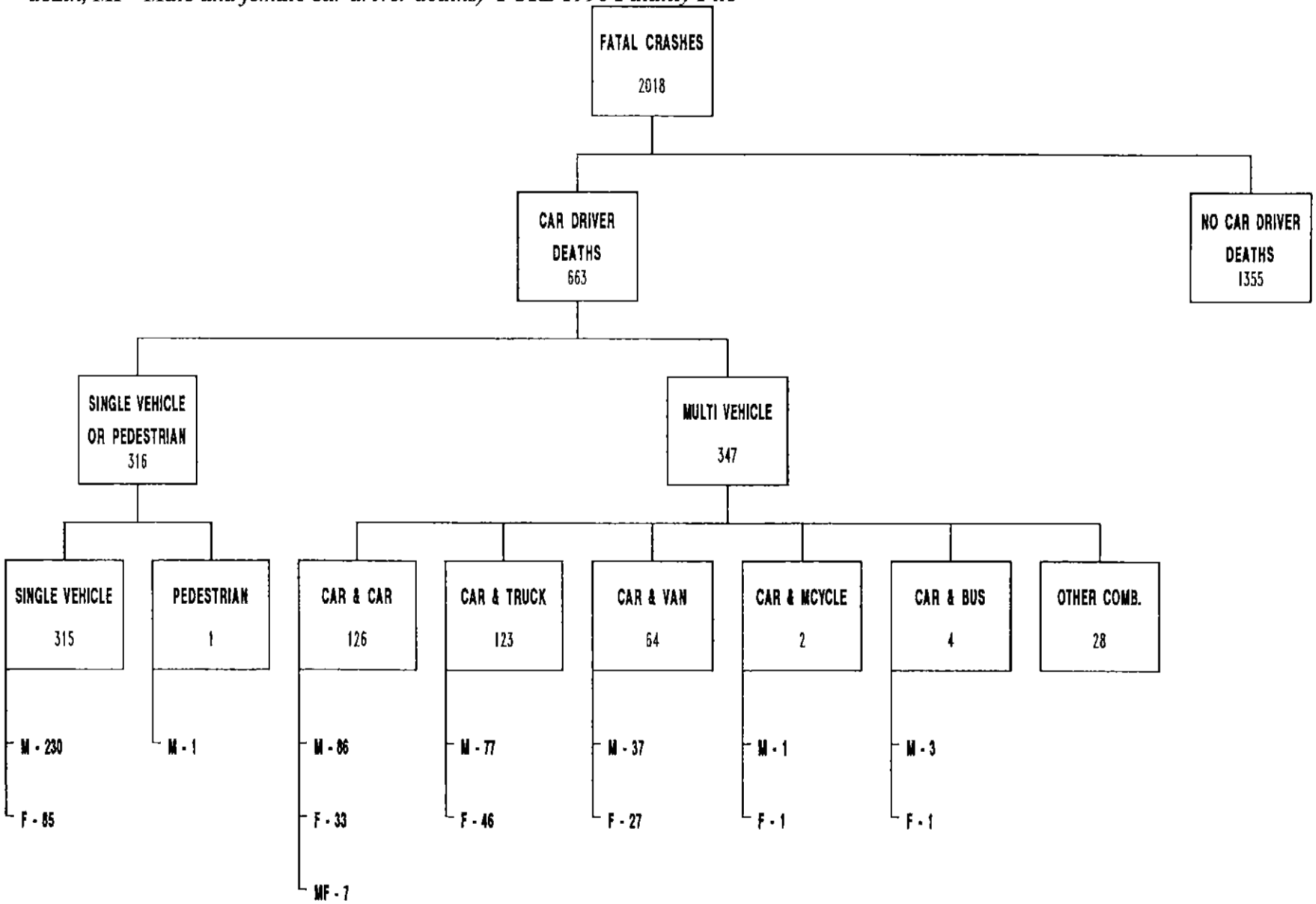
No statistically significant differences were noted in the pattern of vehicle point of impact between cars driven by male and female drivers who were killed (Table 13).

Also, no differences in point of impact were noted within multiple vehicle crashes or single vehicle crashes involving passenger cars driven by male and female drivers.

Table 13. Percentage distribution of fatal point of impact on passenger cars in which the driver died, by sex of the driver (FORS 1990 Fatality File)

Fatal point of impact on car	**Sex of car driver at fault**	
	Male	**Female**
	(n=377)	(n=182)
Front	46%	51%
Right side (driver's side)	21%	20%
Left side	9%	9%
Rear/roof/undercarriage	3%	5%
Overturn	21%	15%
Total	100%	100%

Figure 12. Number of fatal crashes resulting in the death of at least one car driver according to the number of non-stationary passenger cars, pedestrians and other vehicles involved, and the sex of the car driver(s) who died (M=Male car driver death, F=Female car driver death, MF=Male and female car driver deaths) FORS 1990 Fatality File



5.2 Crash survivability

Although a recent Australian study[30] found that female drivers killed in crashes were more likely to sustain spinal injuries than their male counterparts, the major difference lies not in injury pattern, but in overall crash survivability.

The fact that female drivers account for a much higher proportion of those injured than those killed, probably reflects that they are less likely to be involved in high speed crashes. However, in a crash of a given intensity, female drivers have a greater probability of being killed.

For example, the estimated odds ratio for death of a female car driver compared with a male driver in a fatal, two vehicle, frontal crash from the combined 1990 and 1988 Fatality File data bases is 1.6 (95% confidence interval 1.2, 2.2). This is adjusted for the number of persons involved in the crash, a crude estimate of the impact speed* and whether the car hit another car or a larger vehicle.

In order to make a purer comparison, attention was restricted to two car, frontal impact crashes between a car driven by a man and a car driven by a woman, in which only one of the drivers dies. Even with the inclusion of the crashes from 1988 and 1990, this results in only 41 crashes. However, in 24 (59%) of these crashes it is the female who dies.

The likelihood of the woman being injured was also assessed using the Serious Injury Database for the years 1990 and 1991[31]. (This database contains hospitalisations based on police records). Head-on crashes between cars driven by males and females were considered, in which either the man or the woman, but not both, were taken to hospital (214 crashes in 1990; 195 crashes in 1991). In 1990, 74% of these crashes resulted in serious injury to the woman, and in 1991 the corresponding figure was 72%. Both these percentages are statistically significantly higher than 50%.

This overall effect seems to be a result of a number of conflicting factors. On the one hand, female drivers might be expected to have a greater chance of surviving a crash because they are less likely to be drunk and it is known that alcohol intoxication increases the probability of dying in a crash of given intensity[32]. A blood alcohol level of 0.1 gm/100 ml has been estimated to be associated with twice the risk of death in a traffic accident compared with sober drivers and a level of 0.3 has been associated with a threefold increase in risk.

In addition, females are somewhat more likely to be wearing a seat belt. Ninety-one percent of female car drivers involved in fatal crashes in 1990 were wearing seat belts as opposed to 86% of males. Surveys of the general public[33,34,35] also show higher wearing rates for females, although the male rate is still reasonably high.

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* Impact speed was estimated and categorised according to the speed limit and whether the vehicles were speeding.
1=Limit <80 kph and neither vehicle speeding
2=Limit <80 kph and one vehicle speeding or limit 80+ kph and neither vehicle speeding
3=Limit <80 kph and both vehicles speeding or limit 80+ kph and one vehicle speeding
4=Limit 80+ kph and both vehicles speeding

On the other hand, a female driver's probability of survival is reduced by physiological vulnerability and the tendency to drive smaller cars. Evans (p. 25)[37] has shown that in a collision of a given intensity, females between the ages of 15 and 60 are more likely to be killed than males and that this increase in risk may be as high as 31% for 30 year olds.

A household survey in New Zealand showed that women are more likely than men to drive smaller cars[36]. Of the cars involved in fatal crashes in Australia in 1990, the proportion of smaller cars driven by women was higher than for men (Table 14). This was observed for all age groups.

Evans (p. 95)[37] reported that in single vehicle crashes, the fatality risk in a 900 kg car is about 2.4 times that in an 1800 kg car. In the case of multiple vehicle collisions, the effect of mass is even more significant. For example, when a 900 kg and a 1800 kg car collide, the risk of death in the small car is about 13 times that in the large car.

Table 14. Percentage distribution of passenger car weight for cars involved in fatal crashes by sex of the car driver (FORS 1990 Fatality File)

Car mass*	**Sex of car driver involved in a fatal crash**	
	Male	**Female**
	(n=1172)	(n=453)
Small (<1100 kg)	25%	**41%**
Medium (1100-1300 kg)	**35%**	30%
Heavy (1300-2600 kg)	**40%**	29%
Total	100%	100%

* Car mass estimated and categorised on the basis of model and make.

Chapter 6. Summary

Increases in female travel have lead to increasing involvement in fatal crashes to the extent that females now comprise a significant minority of driver fatalities. There appear to be important differences between male and female drivers in terms of travel behaviour, crash characteristics and injury outcome.

Women account for only 35% of total passenger vehicle kilometres travelled, reflecting the fact that there are proportionally fewer women drivers and that, on average, women drivers travel less. In addition, travel by women is less likely to occur during the night time or on weekends.

Fatal crashes caused by female drivers also differ from those caused by male drivers in a range of factors, some of these reflecting different travel. One of the dominant characteristics, however, is the relatively small percentage of fatal crashes caused by women which are attributable to risk taking behaviour. Both drink driving and speeding are less common among females compared to males found to be at fault in fatal crashes.

Although overall women drivers involved in serious crashes are more likely than men to be hospitalised rather than killed, in crashes of a given severity, women are likely to suffer more severe injuries than men.

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