

# Evaluation of the Accident Rates of Male and Female Drivers

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The goal of this study was to conduct a comparative evaluation of accident rates and patterns for male and female passenger automobile drivers. Two sections of road in Israel, one urban and one rural, were selected for the study. Counts of passenger automobiles by sex of driver were carried out on each section of road. The relative accident rates for male and female drivers on the two roads were assessed by estimating the relative exposure of the two groups and matching it with relative accident frequencies. Accident patterns in terms of severity and type were also compared for the two sexes. The same comparison was made for accidents that occurred on all urban and rural roads in Israel during 1986. It was found that, on the average, accident rates are similar for men and women, for both urban and rural driving conditions. No significant differences in the severity of accidents were found. On rural roads, women were found to be involved in more single-vehicle accidents, whereas men were involved in more collision accidents. Evidence for the lack of driving experience for women was found both in the literature and in the study data. In contrast, women were found to drive considerably more slowly on rural roads. It is suggested that the lesser experience and greater caution of women may counterbalance each other and this was the reason for the similarity found in the accident rates of men and women.

Comparative evaluation of the accident rates of male and female automobile drivers has important practical applications in driver training, education, and safety-enhancement programs. Normally, a comparison of driving characteristics and safety records between the sexes cannot be conducted easily because of the lack of a common basis for evaluation. Differences in the type of vehicles used, the type of trips performed, and the time of day in which travel takes place hamper meaningful comparison.

The majority of accidents usually reflects a problem in two and sometimes in all three of the major attributes of the transportation environment: traffic, road system, and human attributes. In other words, at the time of an accident, the driver is not performing satisfactorily for the conditions on the road, for the characteristics of his or her vehicle, or both. Often, a fundamental problem in the analysis of accident characteristics is the determination of the functional distribution of system demands and driver capabilities, and the implication frequently made is that the two functions are independent (1). Another major difficulty occurs in attempts to determine the exposure of

a given category, such as class of vehicle, type of driver, or specified time frame. Therefore a comparison of accident rates may be impossible unless these obstacles are overcome.

The purpose of this study was to conduct a comparative evaluation of accident rates for male and female automobile drivers, that is, to analyze the involvement of each sex relative to the appropriate amount of travel for its group. The number of accidents for both men and women can be determined relatively easily from existing police or statistical bureau files. The amount of travel conducted by each group, however, is unknown, and therefore the accident rates for each cannot be easily computed. Thus the aim of the investigation was to provide a valid macroscopic comparison of accident rates between male and female drivers.

The analysis focused on two sites in Israel, one an urban street in Jerusalem and the second a major rural freeway. This division was selected for two reasons: First, it is believed that urban and rural driving tasks are different. Driving in rural areas consists mainly of routine maneuvers performed at high speed, whereas driving on urban streets requires more complex decisions because the amount of information to be processed is huge, even though the speed is low. Second, it was initially assumed (and later confirmed) that the relative percentage of female drivers is considerably higher in urban areas.

The determinations of the number of accidents and the calculation of exposure were undertaken on exactly the same highways to eliminate any ambiguity in the results. In addition, a macroscopic comparison was conducted on national accident data. This comparison supported the general findings of the study.

## BACKGROUND OF THE STUDY

Several studies have dealt exclusively with a comparison of accident rates for male and female automobile drivers. One such study, conducted in England (2), evaluated observed differences in accidents. It was concluded that, basically, little difference existed in the proportion of male and female drivers who were regarded as being at fault in accidents. The causes given for the accidents, however, differed considerably. Male drivers tended to drive too fast for the conditions, were more likely to be impaired by alcohol, and took risks more readily. Female drivers, on the other hand, made errors by being distracted and by not seeing hazards. It was also found that a female driver involved in an accident was likely to be less experienced in comparison with a male driver.

In an Australian study, Foldvary hypothesized that because of differences between the sexes, female drivers on the average

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will be more cautious, more hesitant, and less affected by alcohol (3). He found that the overall involvement rate for women was 80 percent of that for men. Women were also found to be slightly more involved in casualty than in non-casualty accidents. Their casualty rate was particularly high on Thursday, which is the main shopping day for a large sector of the population in metropolitan Brisbane, Australia. One of Foldvary's important conclusions was that middle-aged women appear to have, on the average, less driving experience than men of the same age group.

Additional evidence for the lower experience of female drivers was provided by Toomath and White, who surveyed driver exposure to risk (4). They found that for each age group, the total amount of distance driven by women is considerably lower than that driven by men.

The notion of experience was also investigated in Canada by Chipman (5), who suggested that experience is an important benefit of high exposure for many drivers because it may protect them from accidents in some circumstances. She emphasized that the positive effects of experience are related not so much to years of experience as to current exposure. Chipman suggested that women therefore enjoy a lower observed-to-expected ratio for city accidents than do men (because of their higher exposure to city driving), whereas men have the lower ratio for accidents on limited access highways. It was further suggested that the relationship between accident occurrence and driving experience could be used in driver education programs and in driver training.

A study of risky driving related to driver and vehicle characteristics was recently conducted in the United States by Evans and Wasielewski (6), who analyzed headways (time intervals between successive vehicles) in freely moving freeway traffic in Michigan and in Toronto, Canada. Women were found to be underrepresented in the shortest, most risky headways and overrepresented in the more cautious headways, which were about 1.5 seconds. Although the study did not deal directly with accidents, the researchers concluded from their data set that there is "clear evidence for sex-dependent driving behavior." Further evidence for this sex-dependent difference was found in an analysis of seat belt use. In both Michigan, United States, and Ontario, Canada, a higher proportion of women used seat belts, although only the Michigan values were statistically significant (16.6 percent for women and 12.2 percent for men). This finding was also consistent with a Canadian study that found seat belt use to be more prevalent among women (7). Kirkham and Landauer found that Australian women were underrepresented in all types of traffic offenses, even after allowing for exposure (8).

Additional care on the part of female drivers was reported previously by Parry in his 1968 study on aggression on the road (9). In a clear differentiation between male and female drivers, Parry found that whereas at least 50 percent of the male drivers he surveyed admitted to (for example) "cutting across if in the wrong lane of traffic," not a single woman did so. He suggested, tentatively (because of the relatively small sample size), that this could be due to higher anxiety while driving and, consequently, greater caution on the part of women. Generally, male drivers tended to be more aggressive and female drivers more anxious. Weber, on the other hand, found that men and women drive under very different circumstances and that the

difference between their accident rates does not necessarily reflect difference in quality of male and female driving performance (10).

From this background review, it may appear that there is a distinct difference in driving behavior and experience between the sexes. The exposure to accident risk may therefore be variant. It can further be hypothesized that two conflicting elements control the behavior of women on the road: first, they are on the average more cautious, less willing to take risks, and less aggressive, and second, they have less experience and less exposure to driving. A comparison of road accident rates for men and women should be of considerable interest and may lead to some practical conclusions.

## METHODOLOGY AND DATA COLLECTION

Any valid comparison of accident involvement among different groups of road users must take into account differences in exposure, that is, differences in mileage driven, in patterns of driving, and so on. This is also true when a comparison of the accident involvement rates of men and women is wanted. On the average, women drive less than do men, they make shorter trips, and a higher percentage of their trips take place during the day and on urban roads. On the rural network, the distribution of trips made by women is not similar to that of men; for example, the percentage of female drivers is higher near cities than on remote roads. The design of the current study attempted to control these differences in exposure.

The study was executed separately for urban and rural settings because traffic composition and driving conditions and, consequently, accident patterns are different on the two types of roads. If women do indeed drive in a different manner than do men, their relative risk may be different on each road type. Because women drive less frequently on rural roads, they have less experience in this type of driving. Their accident involvement rate on such roads is thus possibly affected.

Two sections of road were selected for the study, one urban and one rural. The sections were chosen so that their geometry and traffic composition, as well as their rate of female drivers, remained similar along the entire section (the last assumption was later verified). Another criterion was that the number of accidents occurring on each road section was sufficient for statistical analysis. The rural road chosen was Route 1, 60 km of four-lane divided highway connecting the metropolitan area of Tel Aviv to the capital, Jerusalem. The urban route was 8 km of arterial road going through Jerusalem.

The relative accident rates for male and female drivers on the two roads were assessed by estimating the relative exposure of the two groups and matching it with relative accident frequencies. Relative exposure of female and male drivers was observed in the following manner. On each of the two sections of road, an observation site was picked, and the number of male and female passenger automobile drivers passing this site in each direction was counted separately. (The observers encountered no difficulty in determining the gender of the driver.) The counts covered the hours between 6:00 a.m. and 6:00 p.m. on each day of the week, a total of 84 hours for each site. Control counts were performed at other sites along the two routes to check the assumption that the rate of female drivers is constant along these routes. All counts were performed over several weeks during the period April 1985–February 1986.

Accident data were collected from the files of the Israel Central Bureau of Statistics for the years 1982–1986 (11). These files contain only data on accidents involving casualties. Israeli law requires notifying the police of any accident involving casualties, but there is no obligation to report damage-only accidents. The authors do not believe that this has limited the generality of these findings because injury accidents cover a wide range of accident severity. As with exposure, only accidents involving passenger automobiles and occurring between 6:00 a.m. and 6:00 p.m. were considered. The analysis was restricted to passenger automobiles to eliminate any bias resulting from differences in the types of vehicles driven by men and women.

To test whether the involvement of female drivers in road accidents is different from that of male drivers, the percentage of women among drivers involved in accidents was compared with the percentage of women among all drivers. This comparison does not require knowledge of the absolute number of drivers of each sex; only the rate of female drivers is necessary. Thus the counts did not have to represent all traffic. The layout of the counts allowed for a changing proportion of female drivers during the day and among the days of the week; however, due to lack of contradictory data and the belief that no significant change in proportion of female drivers occurred, it was assumed that a constant proportion of women prevails throughout the year for the same day and hour.

In addition, the relative risk of female to male drivers was also computed. Relative risk is used for assessing risk in retrospective studies. The definition of relative risk (RR) in the current context is as follows: the accident rate per kilometer for female drivers divided by the accident rate per kilometer for male drivers. Along a fixed route, this translates into the following:  $RR = \text{accident rate per female drivers} / \text{accident rate per male drivers}$ , or

$$\frac{A_f/A_m}{D_f/D_m}$$

where  $A_f$ ,  $A_m$  are the numbers of accidents in a given period for female and male drivers, respectively, and  $D_f$ ,  $D_m$  are the numbers of female and male drivers, respectively, for the same period. Again, only the proportion of female drivers is needed. Accident patterns in terms of severity and type were also compared for the two sexes. The same comparison was made for accidents that occurred on urban and rural roads in Israel during 1986.

## RESULTS

More than 90,000 automobiles were counted on each of the two road sections. The rate of women among all drivers on the rural road was 14.9 percent; on the urban road, 22.8 percent of the drivers were women. Table 1 presents the overall exposure rate, accident involvement, and relative risk for female versus male drivers at the two sites.

During the 5-year period 1982–1986, 384 drivers were involved in casualty accidents on the rural road. Of these, 51 were women, a rate of 13.3 percent. The 95 percent confidence limits for the proportion of female drivers involved in accidents is (9.9; 16.4). This interval contains the rate of exposure 14.9,

TABLE 1 INVOLVEMENT IN ACCIDENTS AND EXPOSURE OF MALE AND FEMALE DRIVERS, 1982–1986

	Urban Road	Rural Road
Percentage of women in traffic	22.8	14.9
Number of drivers involved in accidents	260	384
Percentage of women in accidents	22.7	13.3
Confidence limits for percentage of women in accidents	(17.6; 27.8)	(9.9; 16.7)
Relative risk	0.99	0.88
Confidence limits for relative risk	(0.74; 1.32)	(0.65; 1.17)

so that the involvement rate of female drivers in accidents is not significantly different from their proportion on the road. The relative risk of accident involvement for female drivers is 0.88, with 95 percent confidence interval of (0.65; 1.17).

On the urban road during the same 5-year period, 260 drivers were involved in accidents, 59 (22.7 percent) of them women. The 95 percent confidence limits for the proportion of women drivers involved in accidents is (17.6; 27.8). Again, the accident-involvement rate of women drivers is clearly not significantly different from their proportion on the road. The relative risk of accident involvement for female drivers is 0.99, with 95 percent confidence interval of (0.74; 1.32).

Table 2 displays the distribution of accidents by severity for male and female drivers on the rural section of road. As can be seen, there was no significant difference between the sexes. On the urban road, 93 percent of the accidents were slight, so such a comparison could not be made.

Table 3 presents the male-female distribution by accident type for each road type. On the rural road, female drivers suffered relatively more single-vehicle accidents, whereas male drivers were involved more in collision accidents ( $\chi^2_2 = 9.14$ ;  $p = 0.01$ ). The same trend was found on the urban road, although the difference was not significant.

Similar results were obtained for the whole country for both rural and urban roads, as presented in Table 4. On the national

TABLE 2 DISTRIBUTION OF DRIVERS INVOLVED IN ACCIDENTS BY SEVERITY OF ACCIDENTS AND BY SEX OF DRIVER, 1982–1986

Severity	Number of Drivers			Females (%)
	Female	Male	Total	
<b>Rural Road</b>				
Slight	38	242	280	13.6
Severe	10	80	90	11.1
Fatal	3	11	11	21.4
Total <sup>a</sup>	51	333	384	13.3
<b>Urban Road</b>				
Slight	57	183	240	23.8
Severe	2	17	19	10.5
Fatal	—	—	—	—
Total <sup>b</sup>	59	200	259	22.8

<sup>a</sup> $\chi^2_2 = 1.19$  (N.S.).

<sup>b</sup> $\chi^2_1 = 1.08$  (N.S.).

TABLE 3 DISTRIBUTION OF DRIVERS INVOLVED IN ACCIDENTS BY TYPE OF ACCIDENT AND SEX OF DRIVER, 1982-1986

Type of Accident	Number of Drivers			Females (%)
	Female	Male	Total	
<b>Rural Road</b>				
Pedestrian	3	12	15	23
Single vehicle	21	76	97	20.2
Collision	27	245	272	9.9
Total <sup>a</sup>	51	333	384	13.3
<b>Urban Road</b>				
Pedestrian	8	35	43	18.6
Single vehicle	5	13	18	27.8
Collision	46	153	199	23.1
Total <sup>b</sup>	59	201	260	22.7

<sup>a</sup> $\chi^2_2 = 9.14; p = 0.01.$

<sup>b</sup> $\chi^2_1 = .69$  (N.S.).

TABLE 4 DISTRIBUTION OF DRIVERS INVOLVED IN ACCIDENTS IN THE WHOLE COUNTRY BY TYPE OF ACCIDENT AND SEX OF DRIVER, 1986

Type of Accident	Number of Drivers			Females (%)
	Female	Male	Total	
<b>Rural Road</b>				
Pedestrian	17	82	99	17.1
Single vehicle	61	234	295	20.7
Collision	226	1,204	1,430	15.8
Total <sup>a</sup>	304	1,520	1,824	16.7
<b>Urban Road</b>				
Pedestrian	407	1,307	1,714	23.7
Single vehicle	87	191	278	31.3
Collision	1,199	3,880	5,079	23.6
Total <sup>b</sup>	1,693	4,378	6,071	27.9

<sup>a</sup> $\chi^2_2 = 4.2; p = 0.12.$

<sup>b</sup> $\chi^2_2 = 8.6; p = 0.01.$

system, women were found to be more involved in single-vehicle accidents, while men were involved more in collision accidents.

The distribution of drivers involved in accidents by severity and sex for all urban and rural roads in Israel during 1985 is presented in Table 5. Women were found to be less involved in severe and fatal accidents than men. This trend was not confirmed on the single road studied, and this may be explained by the small sample.

Analysis of accidents by day of the week for the rural and urban sites was also conducted (Table 6). It can be observed that at both sites, the involvement rate for women on Saturdays was considerably lower than their relative exposure. On Saturday, which is the Sabbath in Israel, driving patterns are different than they are on weekdays. On urban roads, the involvement rate on Thursday was particularly high; this in accordance with Foldvary's 1979 finding, which was explained by the increased shopping activity that takes place on Thursdays (3). Weber also reported that women have a greater portion of their accidents on weekdays than do men and a lower portion on the weekend (10).

TABLE 5 DISTRIBUTION OF DRIVERS INVOLVED IN ACCIDENTS IN THE WHOLE COUNTRY BY SEVERITY OF ACCIDENTS AND SEX OF DRIVER, 1986

Severity	Number of Drivers			Females (%)
	Female	Male	Total	
<b>Rural Road</b>				
Slight	248	1,117	1,425	17.4
Severe	53	313	366	14.5
Fatal	3	53	56	5.4
Total <sup>a</sup>	304	1,543	1,847	16.5
<b>Urban Road</b>				
Slight	1,580	4,803	6,383	24.8
Severe	153	600	753	20.3
Fatal	12	50	62	19.4
Total <sup>b</sup>	1,745	5,453	7,198	24.2

<sup>a</sup> $\chi^2_2 = 8.342; p = 0.02.$

<sup>b</sup> $\chi^2_2 = 8.0; p = 0.02.$

TABLE 6 DISTRIBUTION OF DRIVERS INVOLVED IN ACCIDENTS BY DAY OF WEEK AND SEX OF DRIVERS, 1982-1986

	Day of the Week						
	Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
<b>Rural Road</b>							
Total no. of drivers	79	70	54	48	67	42	35
No. of female drivers	11	10	11	2	9	7	1
Percentage of female drivers	13.9	14.2	20.3	4.2	13.4	16.6	2.9
Percentage of female drivers in traffic	16.4	15.4	15.4	15.2	14.8	13.7	13.3
<b>Urban Road</b>							
Total no. of drivers	47	46	37	29	46	35	20
No. of female drivers	10	12	9	6	17	4	1
Percentage of female drivers	21.3	26.0	24.3	20.7	37.0	11.4	5.0
Percentage of female drivers in traffic	24.5	24.6	25.7	25.5	23.9	17.6	15.1

## DISCUSSION

The main finding of this study was that, overall, no significant difference exists in accident involvement rate between male and female drivers in Israel. This finding is in accordance with most previous studies dealing with this subject. Several differences between male and female drivers are suggested in the literature, and they can be adopted to explain variances in accident rates. Yet the rates for each sex are found to be similar and therefore the hypothesis of "balance of impacts" is proposed.

According to this hypothesis, involvement of female drivers in accidents is the result of two major, contradictory parameters. First, the behavior of female drivers is more cautious: they drive slower than do men, they take fewer risks, and they use seat belts more often (2, 6, 7, 9, 10). On the other hand, women have less experience in driving, they are more prone to distraction, and they make more errors of perception (2, 4, 5).

The result of these contradictory impacts is the creation of a general balance or equilibrium in the occurrence of accidents. On the average, therefore, the accident-involvement rate of women is not different from that of men. Weber also found that "men and women seem to be involved in accidents in about the same ratio as the amount they drive" (10).

The behavioral differences just described may account for the differences experienced by the two sexes in the distribution of accident types on the rural road studied as well as on the national highway system. The relatively higher involvement of men in collision accidents may be associated with risk-taking behavior, whereas the higher involvement of women in single-vehicle accidents may be related to lack of experience.

Further evidence for the cautious driving of women in Israel was provided in this study. Analysis of 2,232 speed observations—22 percent of which involved women—on the rural road showed that the average speed of women was 64 km/hr (with a standard deviation of 11.5 km/hr), whereas the average speed of men was 76 km/hr (with a standard deviation of 9.6 km/hr). This difference is significant at the 0.01 level.

As a further check on the balance of impacts hypothesis, the relative experience of Israeli women was also investigated. It was found that 32 percent of all driver's license holders in 1987 were women. In 1975, only 22 percent were women (11). This means that more newer drivers are women. Additionally, the distribution of years of driving experience by age group shows that for the older section of the population, the proportion of newer drivers is higher among women. As an example, Table 7 presents this distribution for the age group 35–44. Finally, although women constitute about one third (~33 percent) of the total driver population, their presence on the road was proportionally less: 23 percent for the urban road and only 15 percent for the rural site. This furnishes additional evidence of their lesser driving experience.

TABLE 7 DISTRIBUTION OF DRIVERS AGED 35–44 BY AGE OF FIRST DRIVER'S LICENSE AND SEX

	Age				
	≤24	25–29	30–34	35–39	40+
Men (%)	51.7	27.0	13.7	7.5	0.75
Women (%)	17.8	27.4	31.5	17.7	2.0

These findings of higher speeds for men on the one hand and less experience for women on the other hand provide additional support for the proposed hypothesis of a balance of impacts. The trend of less experience among women drivers may be diminishing gradually with time, as more women obtain driver's licenses earlier. This newer tendency may lead to changes that cannot be foreseen at this time in both driving patterns and accident rates. The resulting balance of impacts may also change with time.

## CONCLUSIONS

The goal of this study was to conduct a comparative evaluation of accident rates and patterns for male and female passenger

car drivers in Israel. It was found that, on the average, accident rates are similar for men and women, for both urban and rural driving conditions. No significant differences in the severity of accidents were found. Women were found to be more involved in single-vehicle accidents, whereas men were more involved in collision accidents.

When the distribution of accidents by day of the week was considered, it was found that women have a particularly low accident rate on Saturdays. In addition, it was found that their involvement rate on urban roads was highest on Thursdays, which is the main shopping day in many Israeli households.

Evidence for the lack of driving experience for women was found both in the literature and in the study data. In contrast, women were found to drive considerably more slowly on rural roads. It is suggested that the lesser experience and greater caution of women may counterbalance each other. This was therefore proposed as the reason for the similarity found in the accident rates of men and women.

Further research to sustain this evaluation may be conducted on (a) other types of road, such as secondary rural roads, (b) behavioral differences in driving patterns of men and women and their relationship to the accident patterns of the two sexes, and (c) the relationship between driving experience and both the behavior and accident rates of women as compared to those of men.

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