State of California
Department of Motor Vehicles

# TEEN AND SENIOR DRIVERS

**SEPTEMBER 1993**

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This report updates information on teen and senior drivers published in earlier California Department of Motor Vehicles' reports. Teen Driver Facts (Huston, 1986), Senior Driver Facts (Huston & Janke, 1986), and Teen and Senior Drivers (romanowicz & Gebers, 1990). The information is meant to assist Highway safety administrators in making program and policy decisions affecting teen and senior drivers, and may also be of use to the insurance industry, traffic safety researchers, and the general public.

The report also summarizes research on risk-taking and alcohol consumption among teen drivers and on the increase in impairment of driving-related abilities among senior driers. Countermeasures for teen and senior drivers are also discussed.

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# PREFACE

This report updates information on teen and senior drivers published in earlier California Department of Motor Vehicles' reports, Teen Driver Facts (Huston, 1986), Senior Driver Facts (Huston & Janke, 1986), and Teen and Senior Drivers (Romanowicz & Gebers, 1990). The primary purpose of this report is to provide traffic safety administrators with useful information for program and policy decision making. The information may also be of interest to the insurance industry and to scholars and researchers in the field of highway safety.

The relationship between age and accident risk has also been explored in recent years by numerous other researchers and the National Highway Transportation Safety Administration. These investigations have generally been based on the national Fatal Accident Reporting System data in which fatal accident rates are expressed as per capita age group indices using census data. In the few instances where national age groups' rates have been computed on a per driver basis, they are subject to errors due to unreliability of some of the age group driver license counts of some states (Federal Highway Administration, 1991). This may be one of the reasons why California's fatal and injury accident rates (per driver) begin to increase at age 70, whereas national data do not show an upswing until age 85+ (see Figure 5, National Highway Traffic Safety Administration, 1993). The present report is based on accurate estimates of the number of California drivers in each age group and also includes data on property damage accidents, injury accidents, and traffic convictions. Another distinction is that the present report is based on two sources of driver record information: (1) the California driver record file and (2) California's accident record data base (Statewide Integrated Traffic Records System). We believe these and other refinements increase the value of the report in drawing inferences about the role of age in driving competency and traffic accident risk.

The authors wish to express special thanks to Bev Christ and Doris Gibson of the Management Information Section, California Highway Patrol, for providing accident data from the Statewide Integrated Traffic Records System. Appreciation is also extended to Elizabeth Hoag of the Department of Finance for providing information pertaining to California's population and to Charlotte Rhea of the Department of Justice for providing information regarding DUI and hit-and-run arrests.

# TABLE OF CONTENTS



# LIST OF TABLES

TABLE OF CONTENTS (Continued)

LIST OF TABLES (Continued)

TABLE OF CONTENTS (Continued)

LIST OF FIGURES

TABLE OF CONTENTS (Continued)

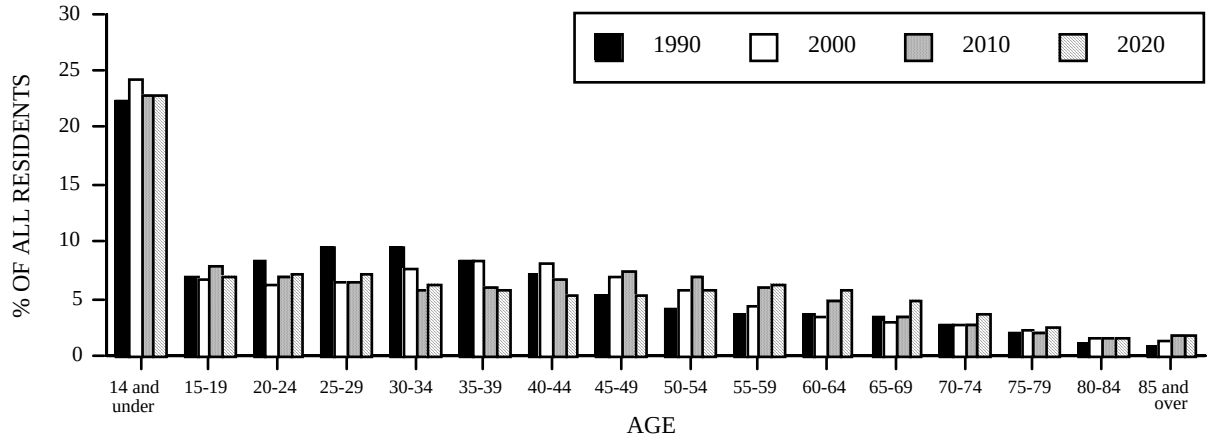
LIST OF FIGURES (Continued)

# TEEN AND SENIOR DRIVERS

## California Driver Population

The relationship between age and driving behavior has long been of interest to highway safety researchers and administrators. It is generally acknowledged that the greatest risk of accidents is among teen drivers. Although teen drivers represent the greatest problem because of their exceptionally high accident liability, elderly drivers are also at increased risk relative to those in the middle age range. The overall risk posed by elderly drivers can be expected to rise with increases in the percentage of the elderly who are licensed to drive (McKelvey & Stamatiadis, 1989) and growth in the elderly population (Williams & Carsten, 1989).

Figure 1 shows actual and projected age distributions of the California population in the years 1990, 2000, 2010, and 2020. The data are from the California Department of Finance (DOF, 1992). Over the next 30 years, the percentage of the elderly population will increase. By 2020, almost 30% of the population will be 55 or older, and 15% will be 65 or older.




Note. From California Department of Finance, 1992, Population Projections by Race/Ethnicity for California and its Counties, 1990-2040.

Figure 1. Actual and projected percentage of California population by age.

An increase in the proportion of elderly people living in suburban or rural areas, where distances to shops and other services are relatively great and public transport is either inconvenient or unavailable, has increased personal transportation needs among this

group (Transportation Research Board [TRB], 1988). The greater independence and mobility that driving offers has also contributed to an increase in the number of elderly drivers, according to TRB (1988):

> Mobility is essential to the quality of life of older persons, and the automobile is the primary means of meeting that mobility need. More than 80 percent of trips by those 65 and over are made in automobiles today, and this percentage is increasing. (p. 3)

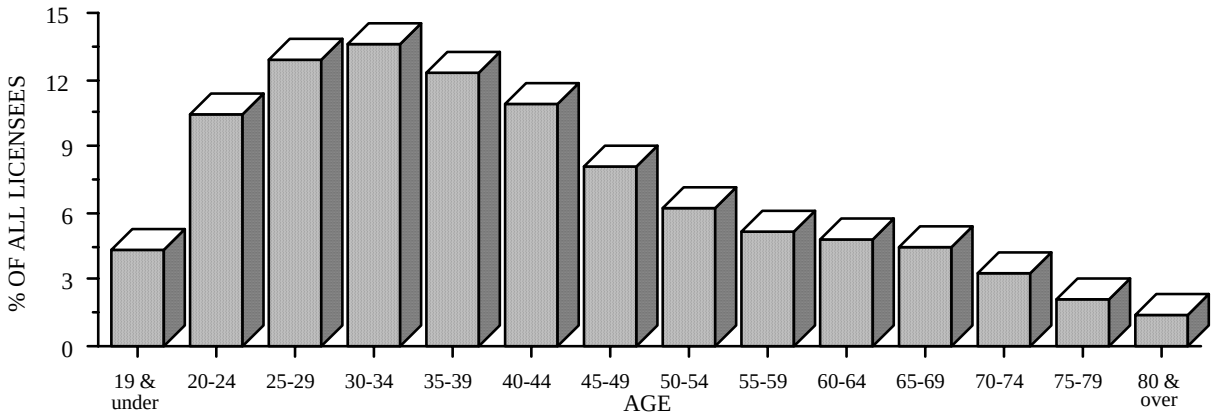
Table 1 presents the number of licensed drivers in each age group as a percentage of all California licensed drivers, as of July 1, 1991. These data, which are plotted in Figure 2, were derived from a 10% sample of California Department of Motor Vehicles' (DMV) records of those holding California driver licenses or instruction permits (DMV, 1991). Of all drivers licensed at that time, 4.3% were teens and 11.3% were aged 65 or older.

Table 1

Percentage of Licensed Drivers in 1991 by Age and Sex

| Age | Percent of all licensees | Male | | Female | |
|---|---|---|---|---|---|
| | | Percent of all male licensees | Percent of all licensees | Percent of all female licensees | Percent of all licensees |
| 16 and under | 0.52 | 0.52 | 0.28 | 0.52 | 0.24 |
| 17 | 0.91 | 0.93 | 0.49 | 0.89 | 0.42 |
| 18 | 1.27 | 1.33 | 0.70 | 1.20 | 0.56 |
| 19 | 1.59 | 1.65 | 0.87 | 1.52 | 0.71 |
| 19 and under | 4.28 | 4.43 | 2.35 | 4.12 | 1.94 |
| 20-24 | 10.48 | 10.99 | 5.82 | 9.92 | 4.66 |
| 25-29 | 12.86 | 13.30 | 7.05 | 12.37 | 5.82 |
| 30-34 | 13.57 | 13.72 | 7.27 | 13.40 | 6.30 |
| 35-39 | 12.32 | 12.27 | 6.50 | 12.38 | 5.82 |
| 40-44 | 10.90 | 10.67 | 5.65 | 11.17 | 5.25 |
| 45-49 | 8.06 | 7.96 | 4.22 | 8.18 | 3.85 |
| 50-54 | 6.22 | 6.13 | 3.25 | 6.32 | 2.97 |
| 55-59 | 5.17 | 5.11 | 2.71 | 5.25 | 2.47 |
| 60-64 | 4.80 | 4.71 | 2.49 | 4.91 | 2.31 |
| 65-69 | 4.44 | 4.21 | 2.23 | 4.71 | 2.22 |
| 70-74 | 3.32 | 3.15 | 1.67 | 3.52 | 1.66 |
| 75-79 | 2.12 | 1.99 | 1.06 | 2.27 | 1.07 |
| 80-84 | 1.04 | 0.98 | 0.52 | 1.10 | 0.52 |
| 85 and over | 0.39 | 0.40 | 0.21 | 0.38 | 0.18 |
| All ages | 100.00 | 100.00 | 52.98 | 100.00 | 47.02 |

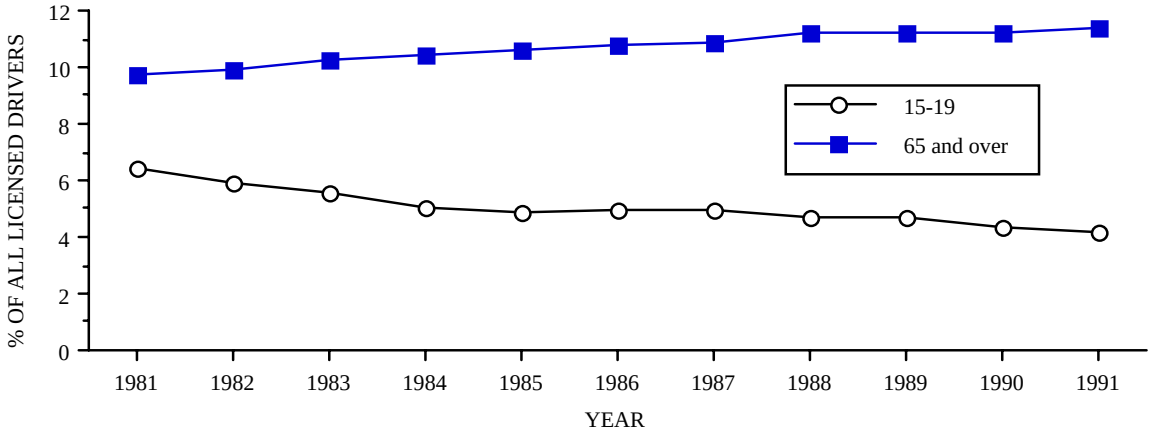
Note. From California Department of Motor Vehicles, 1991, Age and Sex Report, Sacramento, CA.




Note . From California Department of Motor Vehicles, 1991, Age and Sex Report , Sacramento, CA.

Figure 2 . Licensees in age group as a percentage of all California licensed drivers in 1991.

Figure 3 shows the number of teen and senior drivers as a percentage of the total licensed driving population by year. The data are from DMV records of California licensed drivers (DMV, 1981-1991). The trends show that, over the 10 years, the percentage of licensed drivers aged 65 or older increased from 9.8% to 11.4%, and the percentage of those aged 19 or younger decreased from 6.4% to 4.2%.




Note . From California Department of Motor Vehicles, 1981-1991, DL Information Report , Sacramento, CA.

Figure 3 . Percentage of the total licensed driving population by year and age of driver.

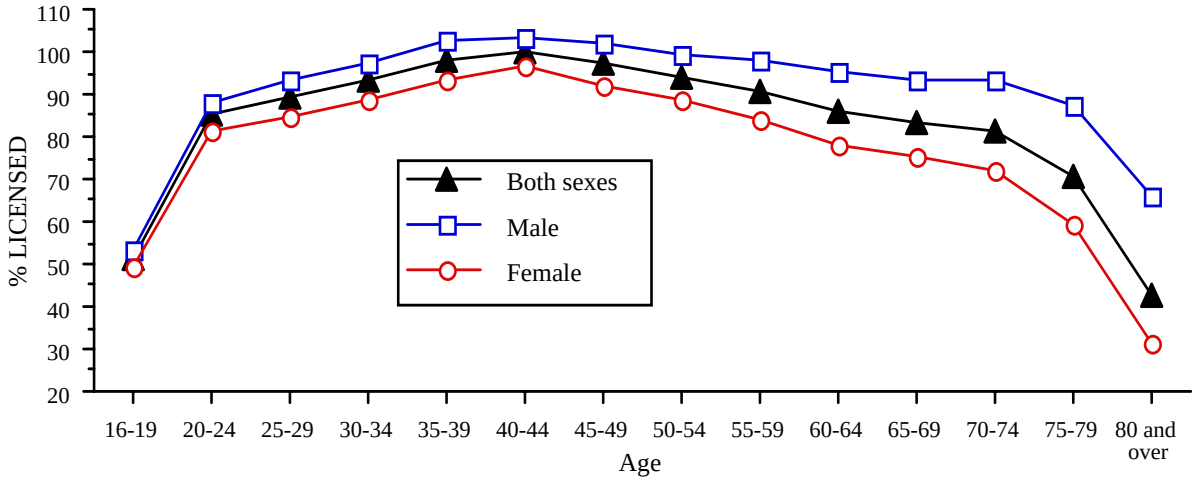
Table 2 and Figure 4 show the estimated percentage of California residents in each age group holding a driver license as of July 1, 1991. Population estimates are from DOF (1992). The licensing data, which are counts of licenses and instruction permits, are from DMV (1991). Rates over 100% are probably due to the inclusion of out-of-state residents and members of the military holding California licenses, in conjunction with underestimates of the California population. From these data we can infer that approximately 70% of persons aged 65 or older are licensed and that a greater percentage of men than of women are licensed within each age group. At age 80 and above, the proportion of the population who are licensed drops to 42.8%.

Table 2

Driver Licenses, California Residents, and License Rate in 1991 by Age and Sex

| Age | Both sexes | | | Male | | | Female | | |
|---|---|---|---|---|---|---|---|---|---|
| | Licenses[a] (thousands) | Residents[b] (thousands) | Licenses per 100 residents | Licenses (thousands) | Residents (thousands) | Licenses per 100 residents | Licenses (thousands) | Residents (thousands) | Licenses per 100 residents |
| 16 and under | 103 | 376 | 27.39 | 55 | 195 | 28.00 | 48 | 181 | 26.73 |
| 17 | 180 | 390 | 46.21 | 98 | 205 | 47.56 | 82 | 184 | 44.71 |
| 18 | 251 | 420 | 59.63 | 139 | 223 | 62.36 | 112 | 197 | 56.55 |
| 19 | 314 | 464 | 67.68 | 173 | 248 | 69.90 | 141 | 217 | 65.16 |
| 19 and under | 848 | 1,650 | 51.38 | 464 | 871 | 53.32 | 384 | 779 | 49.21 |
| 20-24 | 2,075 | 2,441 | 85.00 | 1,152 | 1,311 | 87.88 | 923 | 1,130 | 81.66 |
| 25-29 | 2,545 | 2,856 | 89.12 | 1,394 | 1,493 | 93.37 | 1,151 | 1,363 | 84.46 |
| 30-34 | 2,685 | 2,883 | 93.13 | 1,438 | 1,482 | 97.06 | 1,247 | 1,401 | 88.98 |
| 35-39 | 2,438 | 2,491 | 97.85 | 1,286 | 1,256 | 102.37 | 1,152 | 1,235 | 93.26 |
| 40-44 | 2,158 | 2,156 | 100.10 | 1,118 | 1,080 | 103.58 | 1,039 | 1,076 | 96.60 |
| 45-49 | 1,596 | 1,645 | 97.01 | 835 | 818 | 102.11 | 761 | 827 | 91.98 |
| 50-54 | 1,231 | 1,311 | 93.88 | 642 | 647 | 99.37 | 588 | 665 | 88.54 |
| 55-59 | 1,024 | 1,129 | 90.69 | 536 | 547 | 97.87 | 488 | 582 | 83.93 |
| 60-64 | 951 | 1,102 | 86.26 | 494 | 517 | 95.43 | 457 | 585 | 78.16 |
| 65-69 | 880 | 1,056 | 83.30 | 441 | 473 | 93.17 | 438 | 582 | 75.28 |
| 70-74 | 658 | 810 | 81.25 | 330 | 354 | 93.27 | 328 | 456 | 71.92 |
| 75-79 | 420 | 596 | 70.54 | 209 | 239 | 87.47 | 211 | 357 | 59.20 |
| 80 and over | 283 | 661 | 42.79 | 145 | 219 | 65.96 | 138 | 442 | 31.29 |
| All ages | 19,790 | 22,786 | 86.85 | 10,484 | 11,307 | 92.73 | 9,306 | 11,480 | 81.06 |

[a]From California Department of Motor Vehicles, 1991, Age and Sex Report, Sacramento, CA. Data include persons under age 16 holding valid California driver licenses or instruction permits. [b]From California Department of Finance, 1990 Census of Population and Housing, unpublished document, Sacramento, CA. Data include residents aged 16 and over.




Note. Licensing data are from California Department of Motor Vehicles, 1991, Sacramento, CA. Population data are from California Department of Finance, Age and Sex Report, 1990 Census of Population and Housing, unpublished document, Sacramento, CA.

Figure 4. Percentage of California residents holding a valid California driver license or instruction permit in 1991 by age and sex.

## Total Traffic Accidents and Citations

Past California studies have demonstrated that both age and gender are related to driver record (e.g., Gebers, 1990; Huston, 1986; Huston & Janke, 1986; Romanowicz & Gebers, 1990). In these studies, both young drivers and male drivers had consistently higher traffic accident and citation rates than did those who were older or female.

Illustrations of these trends are presented in Tables 3 and 4 and in Figures 5 and 6, which display average annual accident involvements and traffic citations per 100 drivers during 1989-91 by age and sex of driver. These group averages were obtained from the driver records of a 1% sample of California licensed drivers and holders of instruction permits. These data indicate that:

- For each sex, drivers aged 16-19 have the highest accident and citation rates. Accident rates peak at age 16 whereas traffic citation rates are highest at age 17.

- Accident rates for both sexes decline through about age 69 and then increase.

- Citation rates for both genders decrease with age (with the largest of the increase from age 16 to age 17).

- At all ages, male drivers have higher accident and citation rates than do female drivers.

Table 3

Average Annual Accident Involvements Per 100 Licensed Drivers by Age and Sex

| Age | Both sexes ($n$ = 194,948) | Male ($n$ = 105,075) | Female ($n$ = 89,873) |
|---|---|---|---|
| 16 | 10.70 | 12.07 | 9.14 |
| 17 | 10.17 | 11.18 | 8.94 |
| 18 | 8.85 | 10.16 | 7.32 |
| 19 | 8.51 | 9.62 | 7.21 |
| 16-19 | 9.36 | 10.77 | 7.96 |
| 20-24 | 7.97 | 8.91 | 6.79 |
| 25-29 | 6.48 | 7.37 | 5.38 |
| 30-34 | 5.58 | 6.28 | 4.73 |
| 35-39 | 5.26 | 5.97 | 4.44 |
| 40-44 | 4.89 | 5.51 | 4.20 |
| 45-49 | 4.60 | 5.43 | 3.68 |
| 50-54 | 4.29 | 5.22 | 3.24 |
| 55-59 | 4.14 | 5.01 | 3.16 |
| 60-64 | 3.76 | 4.59 | 2.85 |
| 65-69 | 3.43 | 4.29 | 2.55 |
| 70-74 | 3.72 | 4.61 | 2.71 |
| 75-79 | 4.00 | 4.67 | 3.31 |
| 80-84 | 4.31 | 5.23 | 3.34 |
| 85 and over | 4.77 | 5.80 | 3.51 |
| All ages | 5.55 | 6.41 | 4.56 |

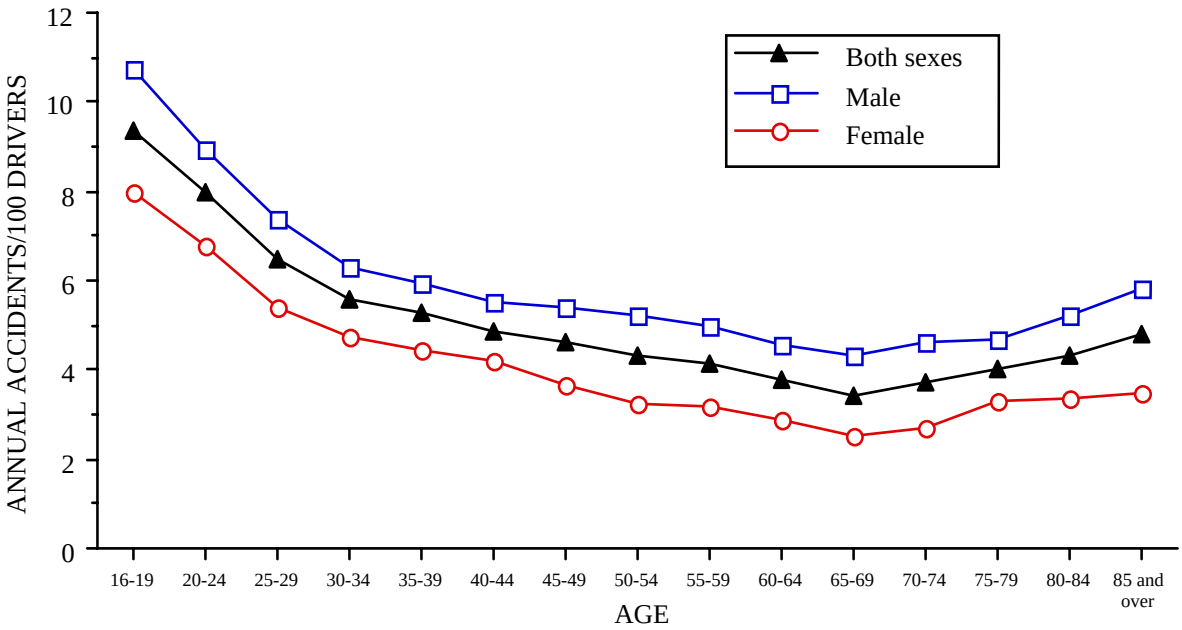
Note. Based on driver records of a 1% sample of California licensed drivers. Averages represent accidents occurring during 1989-91.

Table 4

Average Annual Citations Per 100 Licensed Drivers by Age and Sex

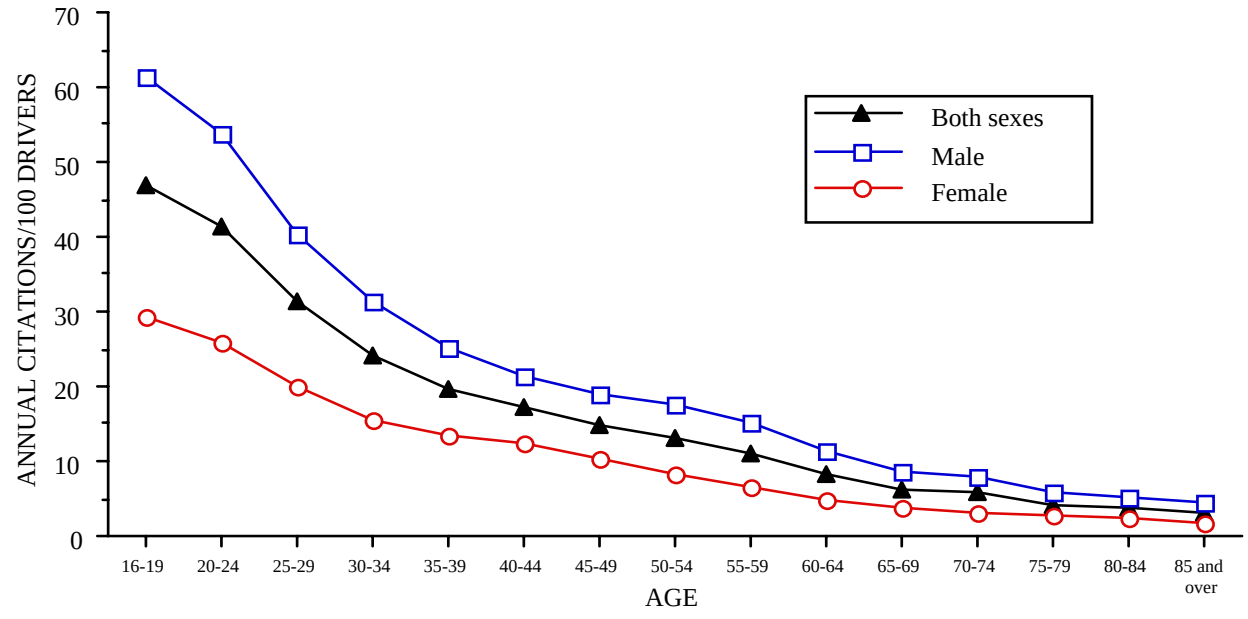
| Age | Both sexes ($n$ = 194,948) | Male ($n$ = 105,075) | Female ($n$ = 89,873) |
|---|---|---|---|
| 16 | 41.50 | 56.80 | 24.05 |
| 17 | 51.17 | 66.45 | 32.39 |
| 18 | 48.74 | 63.69 | 31.31 |
| 19 | 44.55 | 58.32 | 28.28 |
| 16-19 | 46.75 | 61.49 | 29.35 |
| 20-24 | 41.46 | 53.77 | 25.92 |
| 25-29 | 31.30 | 40.32 | 20.09 |
| 30-34 | 24.27 | 31.49 | 15.53 |
| 35-39 | 19.77 | 25.28 | 13.47 |
| 40-44 | 17.14 | 21.50 | 12.32 |
| 45-49 | 14.95 | 19.04 | 10.41 |
| 50-54 | 13.15 | 17.45 | 8.35 |
| 55-59 | 11.06 | 15.10 | 6.53 |
| 60-64 | 8.39 | 11.55 | 4.94 |
| 65-69 | 6.16 | 8.58 | 3.69 |
| 70-74 | 5.70 | 8.07 | 3.13 |
| 75-79 | 4.16 | 5.69 | 2.62 |
| 80-84 | 3.80 | 5.26 | 2.27 |
| 85 and over | 3.13 | 4.39 | 1.16 |
| All ages | 21.75 | 28.57 | 13.86 |

Note. Based on driver records of a 1% sample of California licensed drivers. Averages represent citations occurring during 1989-91.




Note. Based on driver records of a 1% sample of California licensed drivers. Averages represent accidents occurring during 1989-91.

Figure 5. Average annual accident involvements per 100 drivers by age and sex.




Note. Based on driver records of a 1% sample of California licensed drivers. Averages represent citations occurring during 1989-91.

Figure 6. Average annual citations per 100 drivers by age and sex.

The relatively low per-driver accident rates for elderly drivers does not negate the fact that their driving performance eventually declines with age. Elderly drivers' underinvolvement in accidents despite their declining driving skills indicates that they are–for the most part–aware of their limitations and therefore restrict the amount and conditions of their driving. For example, they may drive less, avoid driving at night or in bad weather, and stay off the road during heavy commute hours. In this sense, elderly drivers can be said to have good accident-avoidance skills. Nevertheless, it could be argued that since the accident rate begins to rise around age 70, this marks a point where competency mechanisms are no longer able to counteract completely age-related declines in driver competency. (Evidence for this is presented in the section titled Research on Older Drivers.)

Traffic Accidents and Citations Adjusted for Mileage

These actuarial measures represent societal risk, and as such have been widely used by insurance companies in setting auto insurance premiums. However, they do not provide a clear picture of risk during actual driving (i.e., of driver competency) because they are unadjusted for differences on variables associated with exposure to risk, such as time of travel, road type, weather condition, and the number of miles driven. To enable a comparison of age/sex groups on risk of accidents and convictions while on the road, this section of the report presents risk metrics that are adjusted for average number of miles driven, the most widely used indication of accident-risk exposure.

Studies have found that the youngest and oldest drivers have the highest mileage-adjusted accident and citation rates (Brainin, 1980; Harrington, 1971; Hildebrand & Wilson, 1990; Huston, 1986; Huston & Janke, 1986; Romanowicz & Gebers, 1990). These trends are present in Table 5 and Figures 7 and 8, which show the mileage-adjusted annual accident and citation rates per 100,000 miles during 1989-91 for California-licensed drivers. (In this case the adjustment was made by dividing average annual accident rate by average annual mileage.) Mileage data were obtained from the Nationwide Personal Transportation Study (NPTS) conducted by the Federal Highway Administration (1992). Statistical curve fitting of these data was used to derive a stable mileage estimate for each age group (see Appendix). The figures indicate that:

- In agreement with other studies, the youngest and oldest drivers have the highest mileage-adjusted accident rates.

- For both sexes, the mileage-adjusted citation rate is highest for drivers aged 16-19, the rate for young men exceeding that for young women.

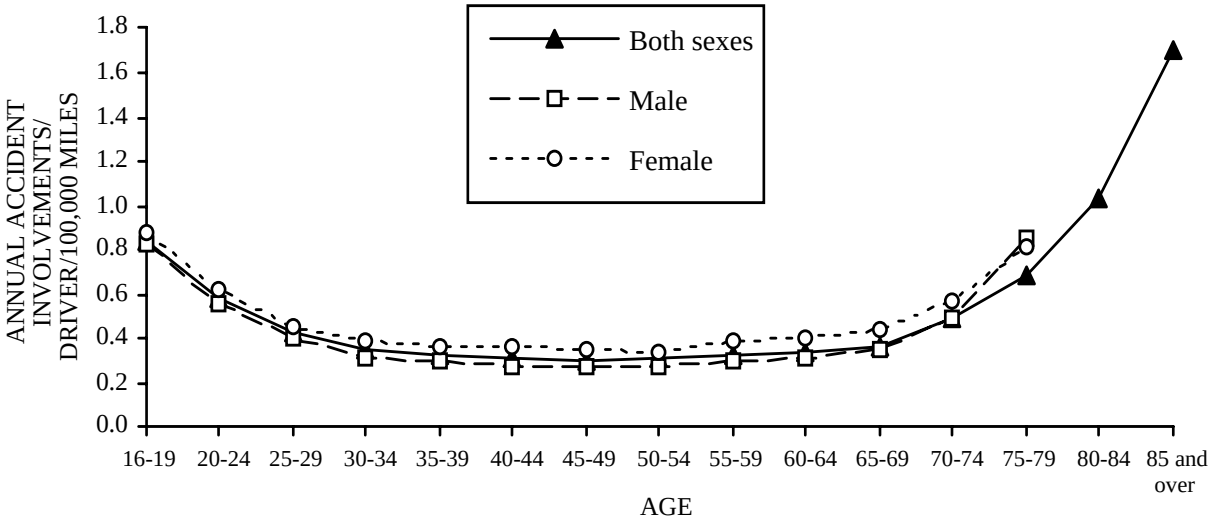
The mileage-adjusted rates presented here are lower than those shown in Huston (1986), Huston and Janke (1986), and Romanowicz and Gebers (1990). These differences may be attributable to several sources. First, as discussed by the Research Triangle Institute (1991), the 1990 NPTS procedures differed in some important ways from the procedures used for earlier NPTS surveys. For example, the number of completed interviews was 6,500 households in 1983. There were 22,317 completed household interviews in the 1990 NPTS. Second, from 1983 to 1990 the amount of annual travel increased for all age groups and both sexes, with the largest increase being for drivers between 16 and 19 years old. Third, in past reports, NPTS nationwide estimates were used for obtaining the mileage-adjusted accident and conviction rates. The current rates for the male and female categories were obtained by using the California sample contained within the NPTS data.

Table 5

Average Annual Accident Involvements and Citations per Driver per 100,000 Miles by Age and Sex

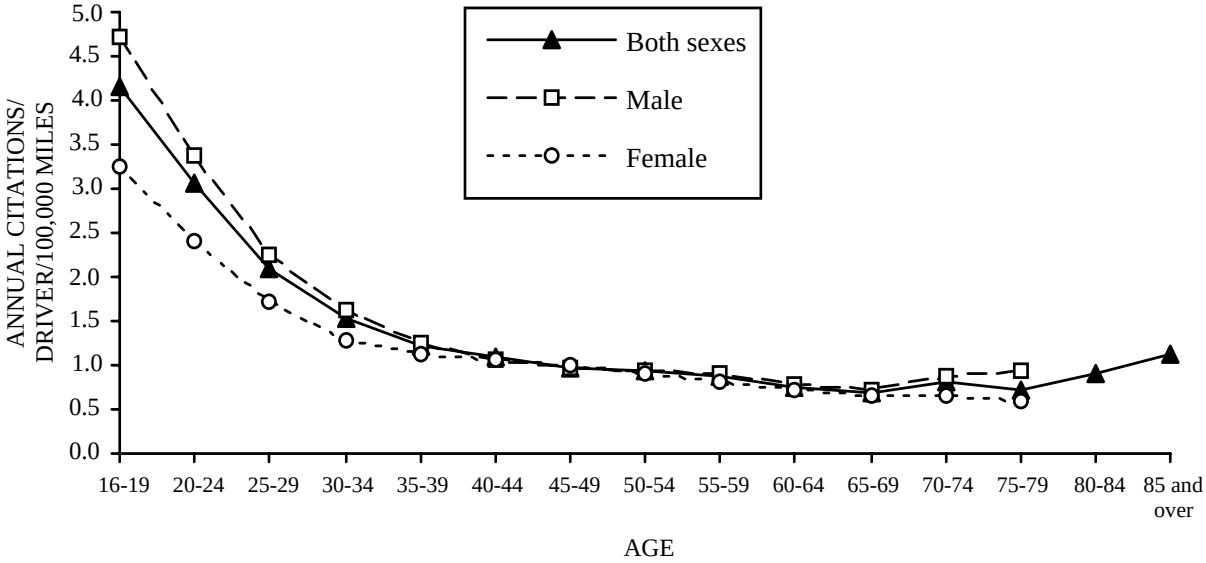
| Age | Accidents | | | Citations | | |
|---|---|---|---|---|---|---|
| | Both sexes | Male | Female | Both sexes | Male | Female |
| 16-19 | 0.84 | 0.83 | 0.88 | 4.14 | 4.72 | 3.24 |
| 20-24 | 0.59 | 0.56 | 0.63 | 3.07 | 3.38 | 2.40 |
| 25-29 | 0.43 | 0.41 | 0.45 | 2.09 | 2.24 | 1.70 |
| 30-34 | 0.35 | 0.32 | 0.39 | 1.53 | 1.62 | 1.27 |
| 35-39 | 0.33 | 0.30 | 0.37 | 1.23 | 1.26 | 1.12 |
| 40-44 | 0.31 | 0.27 | 0.37 | 1.08 | 1.07 | 1.07 |
| 45-49 | 0.30 | 0.28 | 0.35 | 0.98 | 0.97 | 0.99 |
| 50-54 | 0.31 | 0.28 | 0.34 | 0.93 | 0.94 | 0.89 |
| 55-59 | 0.33 | 0.30 | 0.39 | 0.87 | 0.90 | 0.80 |
| 60-64 | 0.34 | 0.31 | 0.41 | 0.76 | 0.78 | 0.71 |
| 65-69 | 0.37 | 0.35 | 0.44 | 0.67 | 0.71 | 0.64 |
| 70-74 | 0.50 | 0.50 | 0.57 | 0.80 | 0.88 | 0.66 |
| 75-79 | 0.69 | 0.86 | 0.82 | 0.72 | 0.94 | 0.59 |
| 80-84 | 1.03 | -- | -- | 0.91 | -- | -- |
| 85 and over | 1.71 | -- | -- | 1.12 | -- | -- |
| All ages | 0.56 | 0.43 | 0.49 | 1.39 | 1.57 | 1.24 |

Note. Based on driver records of a 1% sample of California licensed drivers. Averages represent accidents and citations occurring during 1989-1991. Mileage estimates are based on data from Federal Highway Administration, 1992, 1990 Nationwide Personal Transportation Survey: Travel Behavior Issues in the 90's, Washington, DC: U.S. Department of Transportation. For the separate male and female categories, the 75-79 group represents drivers 75 years of age and over.




Note. Based on 1% sample of California licensed drivers. Averages represent accidents occurring during 1989-91. Mileage estimates are based on data from Federal Highway Administration, 1992, 1990 Nationwide Personal Transportation Survey: Travel Behavior Issues in the 90's. Washington, DC: U.S. Department of Transportation. For the separate male and female categories, the 75-79 group represents drivers 75 years of age and over.

Figure 7. Average annual accident involvements per driver per 100,000 miles by age and sex.




Note. Based on 1% sample of California licensed drivers. Averages represent citations occurring during 1989-91. Mileage estimates are based on data from Federal Highway Administration, 1992, 1990 Nationwide Personal Transportation Survey: Travel Behavior Issues in the 90's. Washington, DC: U.S. Department of Transportation. For the separate male and female categories, the 75-79 group represents drivers 75 years of age and over.

Figure 8. Average annual citations per driver per 100,000 miles by age and sex.

Although mileage-adjusted accident rates are greatest for elderly drivers, it would be a serious mistake to conclude that, for example, male drivers aged 75 and over are more than 3 times as hazardous as male drivers aged 40-44. Such a conclusion, when drawn from a ratio of accidents to miles, depends on the assumption that accidents are proportional to miles (Janke, 1991). As that article illustrates, using data from the California Driver Fact Book (California Department of Motor Vehicles, 1981), the assumption is erroneous. Both teens and seniors (particularly the latter) drive lower mileages than mid-aged drivers, and people driving low mileages tend to accumulate more of their mileage on congested city streets with two-way traffic and no restriction of access. People driving a large number of miles, on the other hand, typically accumulate most of those miles on freeways or other divided multilane highways with limited access. Because the driving task is simpler and exposure to accidents is lower, the accident rate per mile is much lower on freeways; data from the California Business, Transportation and Housing Agency (1985) indicated that there were 2.75 times as many accidents per mile driven on non-freeways as on freeways. Thus it would be an error to assume, for example, that a person driving half the mileage of another should have half the accidents; on the contrary, they would be expected, if equally competent, to have more than this because of their greater exposure to higher-risk driving conditions (assuming that they drive a greater proportion of their miles in the city). The erroneous assumption of linearity and proportionality implicit in adjusting for mileage by dividing accidents by miles exaggerates the risk posed by low-mileage groups. However, though not perfect, it still provides a better picture of how the groups compare on level of driver competency than does the per-driver per-year risk metric.

Another non-skill factor that magnifies the crash risk of elderly drivers when it is measured using fatal or injury accident involvement rates is their vulnerability to injuries and fatalities. Evans (1991) reports that while drivers over age 50 are increasingly more likely to be killed per unit distance of driving than are 40-year-old drivers, a large factor contributing to this is not increased crash risk, but rather increased risk of death given that a crash occurs. In other words, frailty associated with aging contributes to the elderly driver's increased casualty accident risk perhaps as much as does their declining driving skill. Cerrelli (1989) has shown that when accident severity is controlled, the risk of suffering a serious injury or death does not vary appreciably by age for drivers under age 70, but rises for older drivers. He attributed this increase in risk of injury or death to elderly drivers to the physiological effects of aging. Thus, an 80-year-old driver might sustain serious injuries or even be killed in a crash that would not injure a younger person. Janke (in preparation) has confirmed the presence of a similar vulnerability factor using California casualty accident data.

## Fatal/Injury and Fatal Accidents

The average fatal-or-injury (fatal/injury) and fatal accident involvement rates (per 1,000 licensed drivers) for each age and sex group during 1991 are shown in Table 6. Accident data are from the CHP (1992) and include involvements in California accidents of unlicensed drivers and those holding out-of-state licenses. Licensing data are from DMV (1991) and include drivers with instruction permits. The reader should note that these accident data are based on the 1991 accident universe rather than on the 1% sample of driver records.

Table 6

Fatal/Injury and Fatal Accidents per 1,000 Drivers in 1991 by Age and Sex

| | Fatal/injury | | | Fatal | | |
|---|---|---|---|---|---|---|
| Age | Both sexes | Male | Female | Both sexes | Male | Female |
| 16 and under | 79.12 | 87.94 | 69.18 | 1.19 | 1.61 | 0.72 |
| 17 | 50.30 | 56.81 | 42.59 | 0.68 | 0.85 | 0.49 |
| 18 | 48.41 | 56.54 | 38.28 | 0.72 | 1.07 | 0.29 |
| 19 | 41.97 | 49.93 | 32.22 | 0.70 | 0.95 | 0.40 |
| 19 and under | 50.16 | 57.82 | 40.88 | 0.76 | 1.04 | 0.42 |
| 20-24 | 32.01 | 38.52 | 23.88 | 0.54 | 0.78 | 0.25 |
| 25-29 | 23.96 | 28.79 | 18.10 | 0.37 | 0.53 | 0.17 |
| 30-34 | 19.63 | 23.25 | 15.44 | 0.29 | 0.42 | 0.14 |
| 35-39 | 17.26 | 20.06 | 14.15 | 0.24 | 0.36 | 0.12 |
| 40-44 | 15.10 | 17.76 | 12.24 | 0.22 | 0.32 | 0.12 |
| 45-49 | 14.15 | 16.52 | 11.55 | 0.22 | 0.30 | 0.12 |
| 50-54 | 13.10 | 15.67 | 10.29 | 0.21 | 0.33 | 0.09 |
| 55-59 | 12.23 | 14.97 | 9.24 | 0.17 | 0.24 | 0.09 |
| 60-64 | 10.90 | 13.42 | 8.17 | 0.17 | 0.27 | 0.07 |
| 65-69 | 10.05 | 12.38 | 7.70 | 0.16 | 0.23 | 0.09 |
| 70-74 | 10.42 | 12.53 | 8.29 | 0.19 | 0.25 | 0.14 |
| 75-79 | 11.38 | 13.34 | 9.44 | 0.22 | 0.28 | 0.16 |
| 80-84 | 13.34 | 16.00 | 10.69 | 0.38 | 0.55 | 0.20 |
| 85 and over | 15.42 | 18.75 | 11.51 | 0.45 | 0.67 | 0.20 |
| All ages | 19.37 | 23.25 | 14.99 | 0.30 | 0.44 | 0.15 |

Note. Accident data are from California Highway Patrol, 1992, 1991 Annual Report of Fatal and Injury Motor Vehicle Traffic Accidents, Sacramento, CA. Licensing data are from California Department of Motor Vehicles, 1991, Age and Sex Report, Sacramento, CA.

Table 7 shows relative involvement (risk) indices for drivers in fatal/injury and fatal accidents during 1991, grouped by age and sex. The index for each age/sex group was computed by dividing the proportion which the group represented of all drivers involved in fatal/injury accidents by the proportion which the group represented of all licensed drivers. For example, if a certain age/sex group represented 4% of drivers

involved in fatal/injury accidents but only 2% of all licensed drivers in California, the relative involvement index for the group would be 2. This would indicate that the age/sex group was involved in twice as many accidents as would be expected, based on its representation in the total California-licensed driver population. A relative involvement index of 1 would mean that the group was neither overinvolved nor underinvolved in accidents. Caution should be used in making such interpretations because, as noted, out-of-state and unlicensed drivers involved in California accidents were included in the data. Although such drivers probably represent a relatively small part of the total group, the distortion caused by this source of error could make California licensed members of an age group look more hazardous than they actually are, if these drivers are disproportionately represented within that age group. Conversely, if many members of an age group are licensed but do not drive, this will of course reduce their relative involvement rate. This is especially likely in the case of the elderly.

Table 7

Relative Involvement in Fatal/Injury and Fatal Accidents in 1991 by Age and Sex

| Age | Group as % of all licensed drivers[a] | | | Fatal/injury | | | | | | Fatal | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Group as % of all involved drivers[b] | | | Relative involvement index[c] | | | Group as % of all involved drivers | | | Relative involvement index | | |
| | Both sexes | Male | Female | Both sexes | Male | Female | Both sexes | Male | Female | Both sexes | Male | Female | Both sexes | Male | Female |
| 16 and under | 0.52 | 0.28 | 0.24 | 2.13 | 1.25 | 0.87 | 4.09 | 4.54 | 3.57 | 2.05 | 1.47 | 0.58 | 3.94 | 5.33 | 2.39 |
| 17 | 0.91 | 0.49 | 0.42 | 2.36 | 1.45 | 0.92 | 2.60 | 2.93 | 2.20 | 2.05 | 1.39 | 0.67 | 2.26 | 2.81 | 1.60 |
| 18 | 1.27 | 0.70 | 0.56 | 3.16 | 2.05 | 1.11 | 2.50 | 2.92 | 1.98 | 3.02 | 2.49 | 0.53 | 2.39 | 3.54 | 0.95 |
| 19 | 1.59 | 0.87 | 0.71 | 3.44 | 2.25 | 1.19 | 2.17 | 2.58 | 1.66 | 3.69 | 2.75 | 0.93 | 2.32 | 3.15 | 1.31 |
| 19 and under | 4.28 | 2.35 | 1.94 | 11.09 | 7.00 | 4.09 | 2.59 | 2.99 | 2.11 | 10.81 | 8.09 | 2.72 | 2.52 | 3.45 | 1.40 |
| 20-24 | 10.48 | 5.82 | 4.66 | 17.33 | 11.58 | 5.75 | 1.65 | 1.99 | 1.23 | 18.86 | 14.95 | 3.91 | 1.80 | 2.57 | 0.84 |
| 25-29 | 12.86 | 7.05 | 5.82 | 15.91 | 10.47 | 5.43 | 1.24 | 1.49 | 0.93 | 15.69 | 12.42 | 3.27 | 1.22 | 1.76 | 0.56 |
| 30-34 | 13.57 | 7.27 | 6.30 | 13.75 | 8.73 | 5.02 | 1.01 | 1.20 | 0.80 | 12.90 | 10.01 | 2.89 | 0.95 | 1.38 | 0.46 |
| 35-39 | 12.32 | 6.50 | 5.82 | 10.98 | 6.73 | 4.25 | 0.89 | 1.04 | 0.73 | 9.91 | 7.64 | 2.27 | 0.80 | 1.18 | 0.39 |
| 40-44 | 10.90 | 5.65 | 5.25 | 8.50 | 5.18 | 3.32 | 0.78 | 0.92 | 0.63 | 8.06 | 6.01 | 2.05 | 0.74 | 1.06 | 0.39 |
| 45-49 | 8.06 | 4.22 | 3.85 | 5.89 | 3.60 | 2.29 | 0.73 | 0.85 | 0.60 | 5.81 | 4.22 | 1.59 | 0.72 | 1.00 | 0.41 |
| 50-54 | 6.22 | 3.25 | 2.97 | 4.21 | 2.63 | 1.58 | 0.68 | 0.81 | 0.53 | 4.41 | 3.55 | 0.85 | 0.71 | 1.09 | 0.29 |
| 55-59 | 5.17 | 2.71 | 2.47 | 3.27 | 2.09 | 1.18 | 0.63 | 0.77 | 0.48 | 2.85 | 2.15 | 0.70 | 0.55 | 0.80 | 0.28 |
| 60-64 | 4.80 | 2.49 | 2.31 | 2.70 | 1.73 | 0.97 | 0.56 | 0.69 | 0.42 | 2.75 | 2.19 | 0.57 | 0.57 | 0.88 | 0.25 |
| 65-69 | 4.44 | 2.23 | 2.22 | 2.31 | 1.42 | 0.88 | 0.52 | 0.64 | 0.40 | 2.39 | 1.70 | 0.68 | 0.54 | 0.76 | 0.31 |
| 70-74 | 3.32 | 1.67 | 1.66 | 1.79 | 1.08 | 0.71 | 0.54 | 0.65 | 0.43 | 2.14 | 1.39 | 0.75 | 0.64 | 0.83 | 0.45 |
| 75-79 | 2.12 | 1.06 | 1.07 | 1.25 | 0.73 | 0.52 | 0.59 | 0.69 | 0.49 | 1.55 | 0.98 | 0.57 | 0.73 | 0.93 | 0.53 |
| 80-84 | 1.04 | 0.52 | 0.52 | 0.71 | 0.43 | 0.29 | 0.69 | 0.83 | 0.55 | 1.29 | 0.93 | 0.35 | 1.24 | 1.80 | 0.68 |
| 85 and over | 0.39 | 0.21 | 0.18 | 0.31 | 0.21 | 0.11 | 0.80 | 0.97 | 0.59 | 0.58 | 0.47 | 0.12 | 1.49 | 2.21 | 0.65 |
| All ages | 100.00 | 52.98 | 47.02 | 100.00 | 63.60 | 36.40 | 1.00 | 1.20 | 0.77 | 100.00 | 76.72 | 23.28 | 1.00 | 1.45 | 0.50 |

[a]From California Department of Motor Vehicles, 1991, Age and Sex Report, Sacramento, CA [b]From California Highway Patrol, 1992, 1991 Annual Report of Fatal and Injury Motor Vehicle Traffic Accidents, Sacramento, CA. [c]Relative involvement is the accident involvement for the age/sex group as a percent of such involvement for all drivers, divided by the percent of all licensed drivers represented by that group.

To enhance understanding of what these numbers mean, it is important to point out that accident involvement rates and relative involvement indices give essentially equivalent information. That is, if almost all accident-involved drivers were members of the California-licensed driver population, then the two measures would be proportional to one another (the involvement index of a group being the accident rate of that group divided by the population accident rate).

It is also important to note that the tabled relative involvement indices for both male and female drivers at each age level reflect both age and sex differences and are not measures of age-related risk within each sex separately. For example, the 0.93 fatal/injury relative involvement index for women aged 25-29 means that women in this age group have, on the average, a fatal/injury accident rate 7% lower than that for all drivers. The relative involvement indices can be made sex-specific by dividing each age/sex group's index by the "all ages" index for that sex. For example, the fatal/injury accident involvement index for women aged 25-29 as compared to women overall is 0.93/0.77 = 1.21.

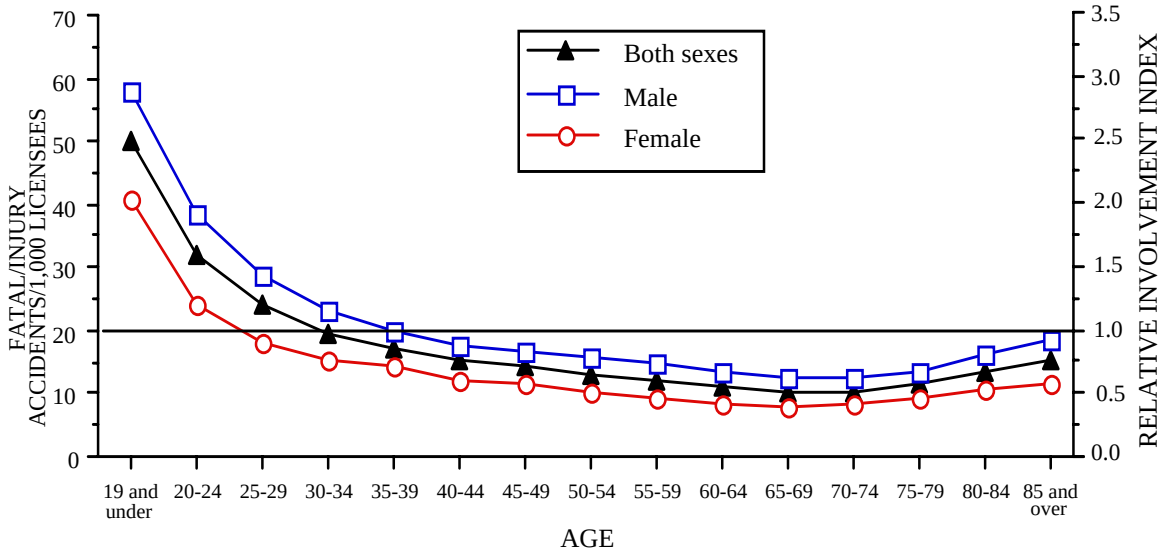
Because essentially equivalent information is given by group accident involvement rates and relative involvement indices, Figures 9 and 10 present both types of information, on separate ordinates, for fatal/injury and fatal accidents, respectively. In each figure, the left-hand ordinate represents accident involvement rate and the right-hand ordinate represents relative involvement index. These data are from Tables 6 and 7, above.

Tables 6 and 7 and Figures 9 and 10 indicate that:

- Teen drivers have the highest fatal/injury and fatal accident involvement rate/risk.

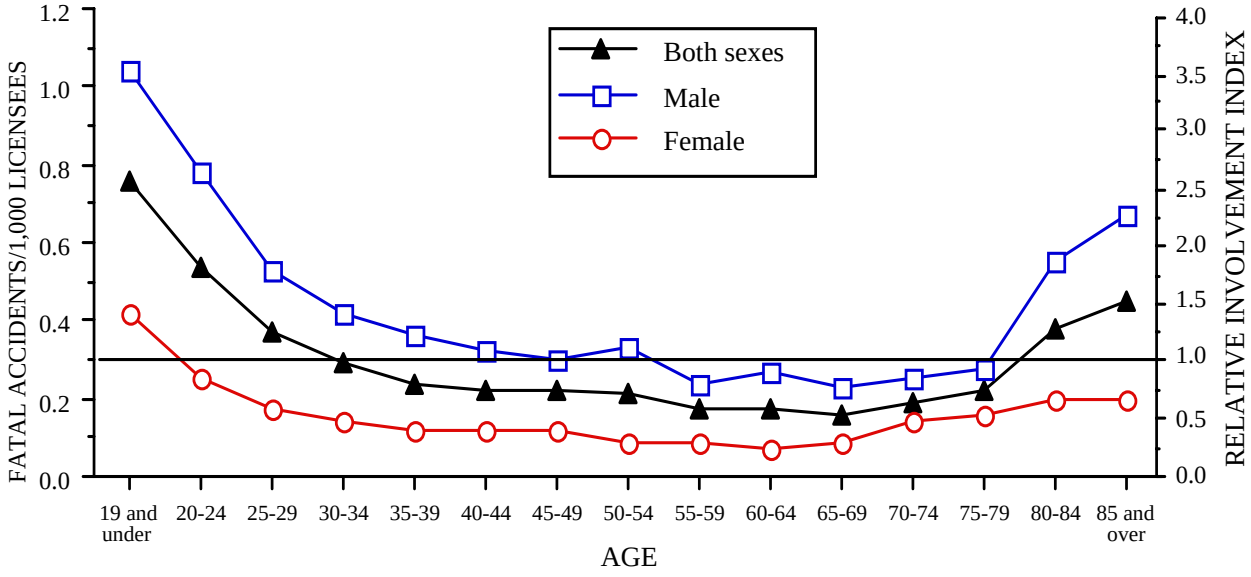
- As drivers age, their fatal/injury accident involvement decreases, reaching a low point at ages 65-69 and then rising somewhat. The increase is not steep, despite aged drivers' greater vulnerability to injury. However, this gradual increase is not seen in fatal accidents, which instead rise steeply at age 80 and beyond.

- Within each age group, male drivers have relatively more fatal/injury and fatal accident involvements than do female drivers.




Note. Accident data are from California Highway Patrol, 1992, 1991 Annual Report of Fatal and Injury Motor Vehicle Traffic Accidents, Sacramento, CA. Licensing data are from California Department of Motor Vehicles, 1991, Age and Sex Report, Sacramento, CA. The relative involvement index is the accident involvement for the age/sex group as a percent of such involvements for all drivers, divided by the percent of all licensed drivers represented by that group.

Figure 9. Fatal/injury accident involvement rate and relative involvement index in 1991 by age and sex.



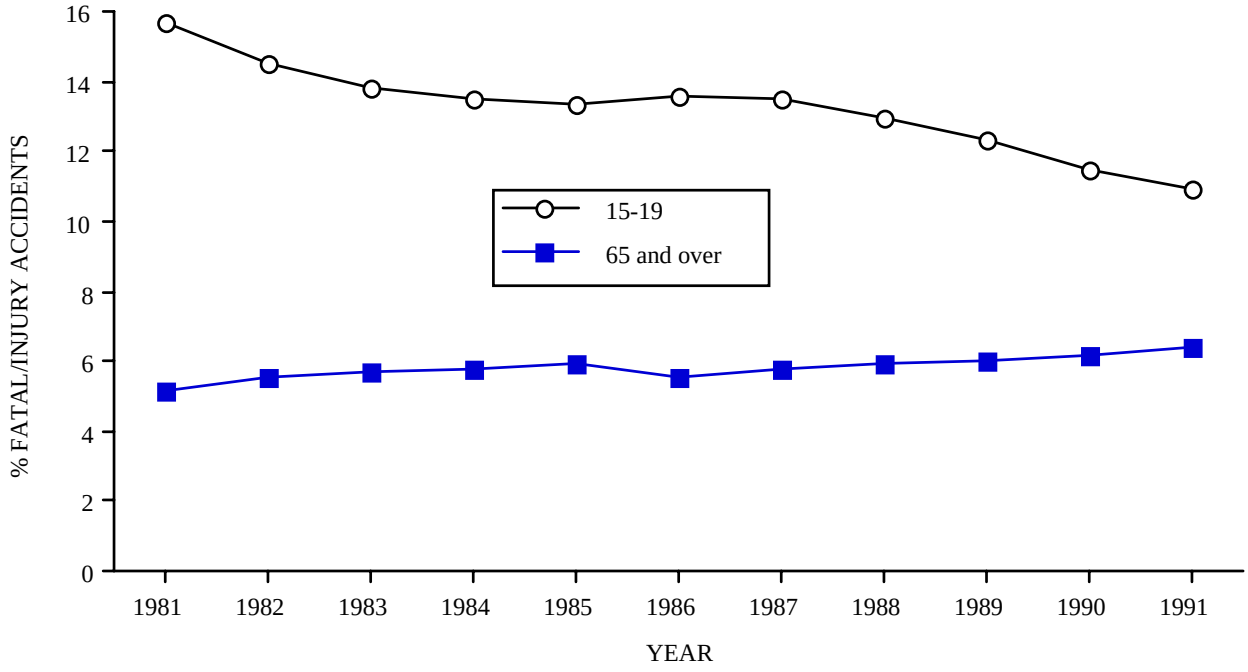

Note. Accident data are from California Highway Patrol, 1992, 1991 Annual Report of Fatal and Injury Motor Vehicle Traffic Accidents, Sacramento, CA. Licensing data are from California Department of Motor Vehicles, 1991, Age and Sex Report, Sacramento, CA. The relative involvement index is the accident involvement for the age/sex group as a percent of such involvements for all drivers, divided by the percent of all licensed drivers represented by that group.

Figure 10. Fatal accident involvement rate and relative involvement index in 1991 by age and sex.

- For all ages combined, male involvement in fatal/injury accidents is 1.6 times that for women.

- For all ages combined, male involvement in fatal accidents is 3 times that for women.

Figure 11 shows the percentage, over time, of fatal/injury accidents in which teen or senior drivers were involved, culpably or not. The accident data are from CHP (1982-1992) and the licensing data are from DMV (1981-1991). Over the 10 years, the percentage share of fatal/injury accidents increased by 23% for elderly drivers and decreased by 30% for teen drivers. These trends parallel the trends in the percentages of licensed drivers represented by these groups, as shown in Figure 3.




Note. Accident data are from California Highway Patrol, 1982-1992, 1981-1991 Annual Report of Fatal and Injury Motor Vehicle Traffic Accidents, Sacramento, CA. Licensing data are from California Department of Motor Vehicles, 1981-1991 DL Information Report, Sacramento, CA.

Figure 11. Percentage of fatal/injury accidents by year and age of driver.

Fatal/Injury and Fatal Accidents Adjusted for Mileage

Table 8 and Figures 12 and 13 show the mileage-adjusted fatal/injury and fatal accident involvements per driver per 100,000 miles during 1991 by age and sex. The mileage adjustments were obtained by applying the same procedures described in the section on mileage-adjusted total accidents to the involvement rates in Table 6.

The mileage-adjusted rates show the following:

- As was the case for total accidents, the youngest and oldest drivers have the highest mileage-adjusted fatal/injury and fatal accident rates.

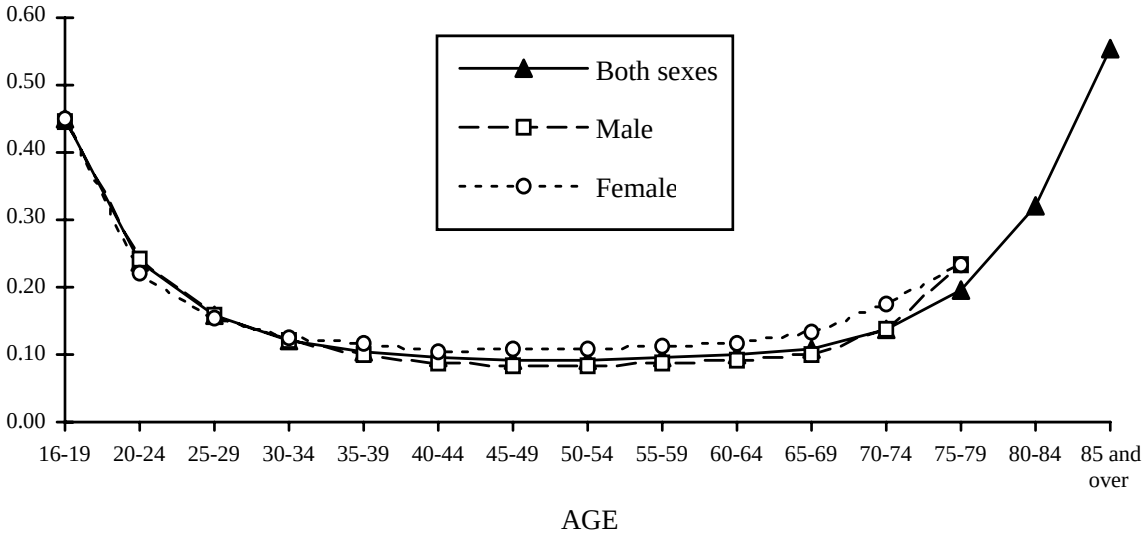
- For both sexes, the mileage-adjusted fatal/injury and fatal accident rates decline through about age 64 but rise sharply for elderly drivers.

Table 8

Mileage-Adjusted Fatal/Injury and Fatal Accidents

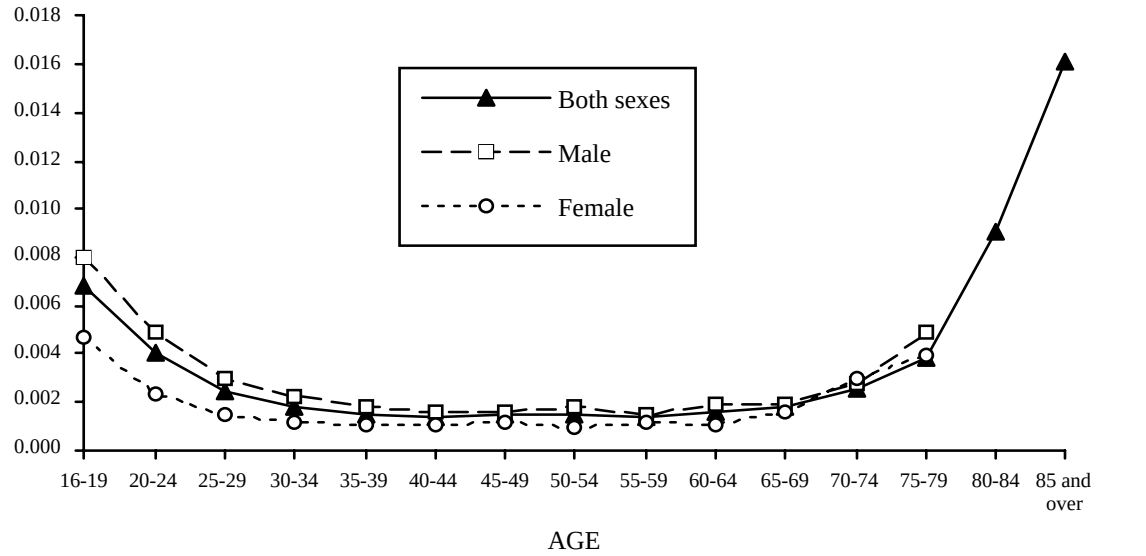
| Age | Fatal/injury | | | Fatal | | |
|---|---|---|---|---|---|---|
| | Both sexes | Male | Female | Both sexes | Male | Female |
| 16-19 | 0.449 | 0.444 | 0.451 | 0.007 | 0.008 | 0.005 |
| 20-24 | 0.237 | 0.242 | 0.221 | 0.004 | 0.005 | 0.002 |
| 25-29 | 0.159 | 0.160 | 0.153 | 0.002 | 0.003 | 0.001 |
| 30-34 | 0.123 | 0.120 | 0.126 | 0.002 | 0.002 | 0.001 |
| 35-39 | 0.107 | 0.100 | 0.117 | 0.001 | 0.002 | 0.001 |
| 40-44 | 0.095 | 0.088 | 0.107 | 0.001 | 0.002 | 0.001 |
| 45-49 | 0.094 | 0.084 | 0.109 | 0.001 | 0.002 | 0.001 |
| 50-54 | 0.094 | 0.085 | 0.109 | 0.001 | 0.002 | 0.001 |
| 55-59 | 0.097 | 0.089 | 0.113 | 0.001 | 0.001 | 0.001 |
| 60-64 | 0.099 | 0.091 | 0.118 | 0.002 | 0.002 | 0.001 |
| 65-69 | 0.109 | 0.102 | 0.134 | 0.002 | 0.002 | 0.002 |
| 70-74 | 0.139 | 0.137 | 0.174 | 0.003 | 0.003 | 0.003 |
| 75-79 | 0.198 | 0.231 | 0.232 | 0.004 | 0.005 | 0.004 |
| 80-84 | 0.320 | -- | -- | 0.009 | -- | -- |
| 85 and over | 0.551 | -- | -- | 0.016 | -- | -- |
| All ages | 0.191 | 0.152 | 0.167 | 0.004 | 0.003 | 0.002 |

Note. Accident data are from California Highway Patrol, 1992, 1991 Annual Report of Fatal and Injury Motor Vehicle Traffic Accidents, Sacramento, CA. Mileage estimates are based on data from Federal Highway Administration, 1992, 1990 Nationwide Personal Transportation Survey: Travel Behavior Issues in the 90's, Washington, DC: U.S. Department of Transportation. For the separate male and female categories, the 75-79 group represents drivers 75 years of age and over.




Note. Accident data are from California Highway Patrol, 1992, 1991 Annual Report of Fatal and Injury Motor Vehicle Traffic Accidents, Sacramento, CA. Mileage estimates are based on data from Federal Highway Administration, 1992, 1990 Nationwide Personal Transportation Survey: Travel Behavior Issues in the 90's, Washington, DC: U.S. Department of Transportation. For the separate male and female categories, the 75-79 group represents drivers 75 years of age and over.

Figure 12. Fatal/injury accident involvements per driver per 100,000 miles during 1991 by age and sex.




Note. Accident data are from California Highway Patrol, 1992, 1991 Annual Report of Fatal and Injury Motor Vehicle Traffic Accidents, Sacramento, CA. Mileage estimates are based on data from Federal Highway Administration, 1992, 1990 Nationwide Personal Transportation Survey: Travel Behavior Issues in the 90's, Washington, DC: U.S. Department of Transportation. For the separate male and female categories, the 75-79 group represents drivers 75 years of age and over.

Figure 13. Fatal accident involvements per driver per 100,000 miles during 1991 by age and sex.

Had-Been-Drinking (HBD) Drivers in Fatal/Injury and Fatal Accidents

Table 9 presents the HBD fatal/injury and HBD fatal accident involvement rates for licensed drivers in 1991 by age and sex. The HBD accident data are from CHP (1992) and the licensing data are from DMV (1991). (The reader is cautioned that, due to the small number of HBD fatal accident involvements for the youngest and oldest drivers, particularly women, involvement rates for these drivers are unstable and might vary considerably from year to year.) The relative involvement indices for drivers in HBD fatal/injury and HBD fatal accidents by age and sex are presented in Table 10.

HBD fatal/injury and HBD fatal accident involvement rates (per 10,000 licensed drivers) and involvement indices are plotted by age and sex in Figures 14 and 15, respectively. The data are from Tables 9 and 10. Again, the left-hand ordinate represents rate and the right-hand ordinate represents relative risk.

Tables 9 and 10 and Figures 14 and 15 indicate that:

- Drivers aged 24 or younger are the group most involved in HBD fatal/injury and HBD fatal accidents.

- Drivers aged 65 or older are the group least involved in HBD fatal/injury and HBD fatal accidents.

- Within each age group, male drivers show much more HBD accident involvement than do female drivers.

- Involvement of teen male drivers in HBD fatal/injury accidents is over 4 times that of teen female drivers.

- Involvement of teen male drivers in HBD fatal accidents is 6 times that of teen female drivers.

Table 9

Had-Been-Drinking (HBD) Drivers in Fatal/Injury and Fatal Accidents Compared to All Drivers Involved in such Accidents, and to All Licensed Drivers, by Age and Sex

| Accident type / Age | Number of accident-involved drivers | | | Number of accident-involved HBD drivers | | | % of accident-involved drivers identified as HBD | | | Accident-involved HBD drivers per 10,000 licensees | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Both sexes | Male | Female | Both sexes | Male | Female | Both sexes | Male | Female | Both sexes | Male | Female |
| Fatal/injury | | | | | | | | | | | | |
| 16 and under | 8,150 | 4,798 | 3,352 | 254 | 196 | 58 | 3.12 | 4.09 | 1.73 | 24.66 | 35.92 | 11.97 |
| 17 | 9,057 | 5,547 | 3,510 | 395 | 319 | 76 | 4.36 | 5.75 | 2.17 | 21.94 | 32.67 | 9.22 |
| 18 | 12,128 | 7,860 | 4,268 | 896 | 775 | 121 | 7.39 | 9.86 | 2.84 | 35.77 | 55.75 | 10.85 |
| 19 | 13,188 | 8,639 | 4,549 | 1,133 | 983 | 150 | 8.59 | 11.38 | 3.30 | 36.06 | 56.81 | 10.63 |
| 19 and under | 42,523 | 26,844 | 15,679 | 2,678 | 2,273 | 405 | 6.30 | 8.47 | 2.58 | 31.59 | 48.96 | 10.56 |
| 20-24 | 66,412 | 44,375 | 22,037 | 7,905 | 6,925 | 980 | 11.90 | 15.61 | 4.45 | 38.10 | 60.11 | 10.62 |
| 25-29 | 60,980 | 40,149 | 20,831 | 7,029 | 5,984 | 1,045 | 11.53 | 14.90 | 5.02 | 27.62 | 42.92 | 9.08 |
| 30-34 | 52,697 | 33,442 | 19,255 | 5,606 | 4,629 | 977 | 10.64 | 13.84 | 5.07 | 20.88 | 32.18 | 7.84 |
| 35-39 | 42,086 | 25,791 | 16,295 | 3,787 | 3,087 | 700 | 9.00 | 11.97 | 4.30 | 15.53 | 24.01 | 6.08 |
| 40-44 | 32,583 | 19,862 | 12,721 | 2,508 | 2,061 | 447 | 7.70 | 10.38 | 3.51 | 11.62 | 18.43 | 4.30 |
| 45-49 | 22,585 | 13,792 | 8,793 | 1,438 | 1,186 | 252 | 6.37 | 8.60 | 2.87 | 9.01 | 14.21 | 3.31 |
| 50-54 | 16,127 | 10,070 | 6,057 | 944 | 807 | 137 | 5.85 | 8.01 | 2.26 | 7.67 | 12.56 | 2.33 |
| 55-59 | 12,529 | 8,019 | 4,510 | 611 | 524 | 87 | 4.88 | 6.53 | 1.93 | 5.97 | 9.78 | 1.78 |
| 60-64 | 10,361 | 6,625 | 3,736 | 472 | 402 | 70 | 4.56 | 6.07 | 1.87 | 4.96 | 8.14 | 1.53 |
| 65-69 | 8,837 | 5,461 | 3,376 | 332 | 284 | 48 | 3.76 | 5.20 | 1.42 | 3.77 | 6.44 | 1.09 |
| 70-74 | 6,851 | 4,134 | 2,717 | 205 | 167 | 38 | 2.99 | 4.04 | 1.40 | 3.12 | 5.06 | 1.16 |
| 75-79 | 4,781 | 2,788 | 1,993 | 90 | 71 | 19 | 1.88 | 2.55 | 0.95 | 2.14 | 3.40 | 0.90 |
| 80-84 | 2,736 | 1,641 | 1,095 | 36 | 30 | 6 | 1.32 | 1.83 | 0.55 | 1.76 | 2.92 | 0.59 |
| 85 and over | 1,198 | 786 | 412 | 17 | 13 | 4 | 1.42 | 1.65 | 0.97 | 2.19 | 3.10 | 1.12 |
| All ages | 383,286 | 243,779 | 139,507 | 33,658 | 28,443 | 5,215 | 8.78 | 11.67 | 3.74 | 17.01 | 27.13 | 5.60 |
| Fatal | | | | | | | | | | | | |
| 16 and under | 123 | 88 | 35 | 10 | 9 | 1 | 8.13 | 10.23 | 2.86 | 0.97 | 1.65 | 0.21 |
| 17 | 123 | 83 | 40 | 17 | 16 | 1 | 13.82 | 19.28 | 2.50 | 0.94 | 1.64 | 0.12 |
| 18 | 181 | 149 | 32 | 49 | 40 | 9 | 27.07 | 26.85 | 28.13 | 1.96 | 2.88 | 0.81 |
| 19 | 221 | 165 | 56 | 65 | 59 | 6 | 29.41 | 35.76 | 10.71 | 2.07 | 3.41 | 0.43 |
| 19 and under | 648 | 485 | 163 | 141 | 124 | 17 | 21.76 | 25.57 | 10.43 | 1.66 | 2.67 | 0.44 |
| 20-24 | 1,130 | 896 | 234 | 382 | 336 | 46 | 33.81 | 37.50 | 19.66 | 1.84 | 2.92 | 0.50 |
| 25-29 | 940 | 744 | 196 | 343 | 303 | 40 | 36.49 | 40.73 | 20.41 | 1.35 | 2.17 | 0.35 |
| 30-34 | 773 | 600 | 173 | 246 | 214 | 32 | 31.82 | 35.67 | 18.50 | 0.92 | 1.49 | 0.26 |
| 35-39 | 594 | 458 | 136 | 161 | 129 | 32 | 27.10 | 28.17 | 23.53 | 0.66 | 1.00 | 0.28 |
| 40-44 | 483 | 360 | 123 | 120 | 107 | 13 | 24.84 | 29.72 | 10.57 | 0.56 | 0.96 | 0.13 |
| 45-49 | 348 | 253 | 95 | 83 | 72 | 11 | 23.85 | 28.46 | 11.58 | 0.52 | 0.86 | 0.14 |
| 50-54 | 264 | 213 | 51 | 40 | 36 | 4 | 15.15 | 16.90 | 7.84 | 0.32 | 0.56 | 0.07 |
| 55-59 | 171 | 129 | 42 | 32 | 27 | 5 | 18.71 | 20.93 | 11.90 | 0.31 | 0.50 | 0.10 |
| 60-64 | 165 | 131 | 34 | 24 | 20 | 4 | 14.55 | 15.27 | 11.76 | 0.25 | 0.41 | 0.09 |
| 65-69 | 143 | 102 | 41 | 16 | 14 | 2 | 11.19 | 13.73 | 4.88 | 0.18 | 0.32 | 0.05 |
| 70-74 | 128 | 83 | 45 | 10 | 10 | 0 | 7.81 | 12.05 | 0.00 | 0.15 | 0.30 | 0.00 |
| 75-79 | 93 | 59 | 34 | 9 | 7 | 2 | 9.68 | 11.86 | 5.88 | 0.21 | 0.34 | 0.09 |
| 80-84 | 77 | 56 | 21 | 6 | 5 | 1 | 7.79 | 8.93 | 4.76 | 0.29 | 0.49 | 0.10 |
| 85 and over | 35 | 28 | 7 | 1 | 1 | 0 | 2.86 | 3.57 | 0.00 | 0.13 | 0.24 | 0.00 |
| All ages | 5,992 | 4,597 | 1,395 | 1,614 | 1,405 | 209 | 26.94 | 30.56 | 14.98 | 0.82 | 1.34 | 0.22 |

Note. From California Highway Patrol, 1992, 1991 Annual Report of Fatal and Injury Motor Vehicle Traffic Accidents, Sacramento, CA. Percentages are based on the number of licensed drivers within age/sex group. Licensing data used to compute percentages are from California Department of Motor Vehicles, 1991, Age and Sex Report, Sacramento, CA.

Table 10

Relative Involvement in Had-Been-Drinking (HBD) Fatal/Injury
and HBD Fatal Accidents by Age and Sex

| Age | Group as % of all licensed drivers[a] | | | Fatal/injury | | | | | | Fatal | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Group as % of all involved drivers[b] | | | Relative involvement index[c] | | | Group as % of all involved drivers | | | Relative involvement index | | |
| | Both sexes | Male | Female | Both sexes | Male | Female | Both sexes | Male | Female | Both sexes | Male | Female | Both sexes | Male | Female |
| 16 and under | 0.52 | 0.28 | 0.24 | 0.75 | 0.58 | 0.17 | 1.45 | 2.11 | 0.70 | 0.62 | 0.56 | 0.06 | 1.19 | 2.02 | 0.25 |
| 17 | 0.91 | 0.49 | 0.42 | 1.17 | 0.95 | 0.23 | 1.29 | 1.92 | 0.54 | 1.05 | 0.99 | 0.06 | 1.16 | 2.01 | 0.15 |
| 18 | 1.27 | 0.70 | 0.56 | 2.66 | 2.30 | 0.36 | 2.10 | 3.28 | 0.64 | 3.04 | 2.48 | 0.56 | 2.40 | 3.53 | 0.99 |
| 19 | 1.59 | 0.87 | 0.71 | 3.37 | 2.92 | 0.45 | 2.12 | 3.34 | 0.62 | 4.03 | 3.66 | 0.37 | 2.54 | 4.18 | 0.52 |
| 19 and under | 4.28 | 2.35 | 1.94 | 7.96 | 6.75 | 1.20 | 1.86 | 2.88 | 0.62 | 8.74 | 7.68 | 1.05 | 2.04 | 3.28 | 0.54 |
| 20-24 | 10.48 | 5.82 | 4.66 | 23.49 | 20.57 | 2.91 | 2.24 | 3.53 | 0.62 | 23.67 | 20.82 | 2.85 | 2.26 | 3.58 | 0.61 |
| 25-29 | 12.86 | 7.05 | 5.82 | 20.88 | 17.78 | 3.10 | 1.62 | 2.52 | 0.53 | 21.25 | 18.77 | 2.48 | 1.65 | 2.66 | 0.43 |
| 30-34 | 13.57 | 7.27 | 6.30 | 16.66 | 13.75 | 2.90 | 1.23 | 1.89 | 0.46 | 15.24 | 13.26 | 1.98 | 1.12 | 1.82 | 0.31 |
| 35-39 | 12.32 | 6.50 | 5.82 | 11.25 | 9.17 | 2.08 | 0.91 | 1.41 | 0.36 | 9.98 | 7.99 | 1.98 | 0.81 | 1.23 | 0.34 |
| 40-44 | 10.90 | 5.65 | 5.25 | 7.45 | 6.12 | 1.33 | 0.68 | 1.08 | 0.25 | 7.43 | 6.63 | 0.81 | 0.68 | 1.17 | 0.15 |
| 45-49 | 8.06 | 4.22 | 3.85 | 4.27 | 3.52 | 0.75 | 0.53 | 0.84 | 0.19 | 5.14 | 4.46 | 0.68 | 0.64 | 1.06 | 0.18 |
| 50-54 | 6.22 | 3.25 | 2.97 | 2.80 | 2.40 | 0.41 | 0.45 | 0.74 | 0.14 | 2.48 | 2.23 | 0.25 | 0.40 | 0.69 | 0.08 |
| 55-59 | 5.17 | 2.71 | 2.47 | 1.82 | 1.56 | 0.26 | 0.35 | 0.58 | 0.10 | 1.98 | 1.67 | 0.31 | 0.38 | 0.62 | 0.13 |
| 60-64 | 4.80 | 2.49 | 2.31 | 1.40 | 1.19 | 0.21 | 0.29 | 0.48 | 0.09 | 1.49 | 1.24 | 0.25 | 0.31 | 0.50 | 0.11 |
| 65-69 | 4.44 | 2.23 | 2.22 | 0.99 | 0.84 | 0.14 | 0.22 | 0.38 | 0.06 | 0.99 | 0.87 | 0.12 | 0.22 | 0.39 | 0.06 |
| 70-74 | 3.32 | 1.67 | 1.66 | 0.61 | 0.50 | 0.11 | 0.18 | 0.30 | 0.07 | 0.62 | 0.62 | 0.00 | 0.19 | 0.37 | 0.00 |
| 75-79 | 2.12 | 1.06 | 1.07 | 0.27 | 0.21 | 0.06 | 0.13 | 0.20 | 0.05 | 0.56 | 0.43 | 0.12 | 0.26 | 0.41 | 0.12 |
| 80-84 | 1.04 | 0.52 | 0.52 | 0.11 | 0.09 | 0.02 | 0.10 | 0.17 | 0.03 | 0.37 | 0.31 | 0.06 | 0.36 | 0.60 | 0.12 |
| 85 and over | 0.39 | 0.21 | 0.18 | 0.05 | 0.04 | 0.01 | 0.13 | 0.18 | 0.07 | 0.06 | 0.06 | 0.00 | 0.16 | 0.29 | 0.00 |
| All ages | 100.00 | 52.98 | 47.02 | 100.00 | 84.51 | 15.49 | 1.00 | 1.60 | 0.33 | 100.00 | 87.05 | 12.95 | 1.00 | 1.64 | 0.28 |

[a]From California Department of Motor Vehicles, 1991, Age and Sex Report, Sacramento, CA. [b]From California Highway Patrol, 1992, 1991 Annual Report of Fatal and Injury Motor Vehicle Traffic Accidents, Sacramento, CA. [c]Relative involvement is the accident involvement for the age/sex group as a percent of such involvement for all drivers, divided by the percent of all licensed drivers represented by that group.

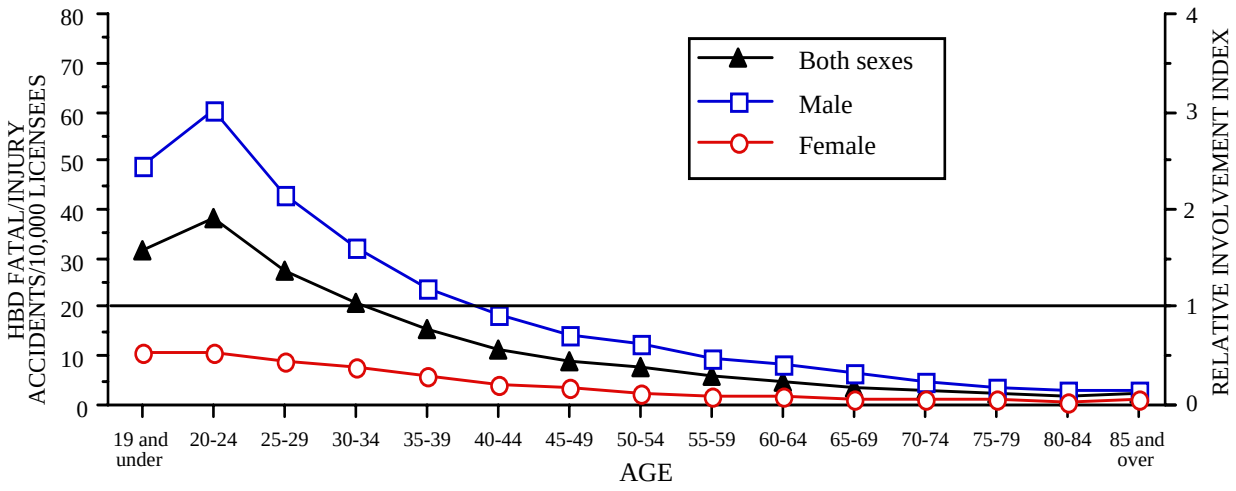



Figure 14. Had-been-drinking (HBD) fatal/injury accident involvement rate and relative involvement index in 1991 by age and sex.

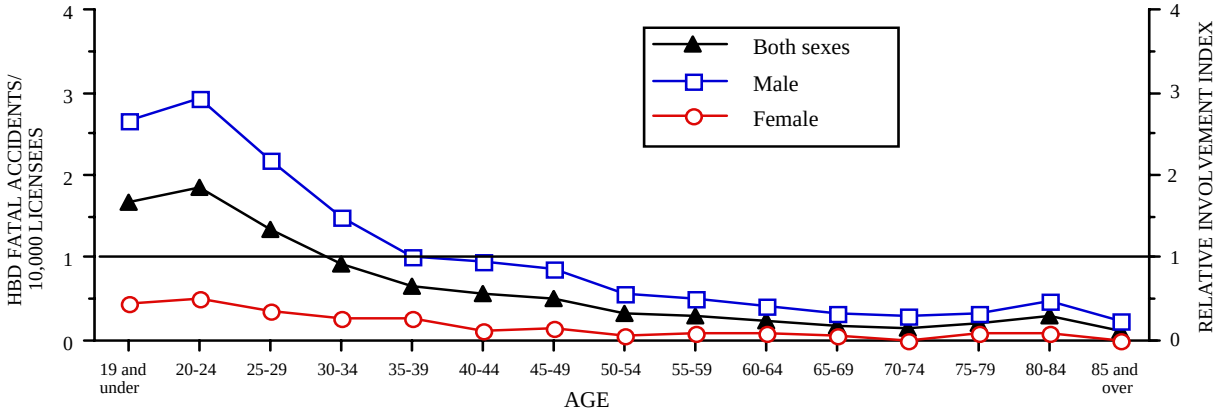



Figure 15. Had-been-drinking (HBD) fatal accident involvement rate and relative involvement index in 1991 by age and sex.

## Primary Collision Factors in Casualty Accidents

Tables 11 and 12 present the frequency and percentage distributions, respectively, of fatal/injury and fatal accidents during 1991 by primary collision factor, age, and sex of driver at fault. Table 13 presents the same accident information for both sexes combined. Data for these tables were obtained from CHP's Statewide Integrated Traffic Records System (SWITRS).

Table 11

Fatal/Injury and Fatal Accidents in 1991 by
Primary Collision Factor Within Age and Sex of Driver at Fault

| Accident type<br>Sex | Primary collision factor[a] | All ages | 19 and under | 20-29 | 30-39 | 40-49 | 50-59 | 60-69 | 70-79 | 80 and over |
|---|---|---|---|---|---|---|---|---|---|---|
| Fatal/injury | | | | | | | | | | |
| Male | All factors | 114,150 | 16,168 | 42,184 | 25,465 | 13,097 | 6,884 | 5,106 | 3,670 | 1,576 |
| | Alcohol/drugs | 21,541 | 1,667 | 9,746 | 5,947 | 2,519 | 1,001 | 490 | 143 | 28 |
| | Unsafe speed | 31,879 | 5,481 | 11,828 | 7,062 | 3,609 | 1,728 | 1,183 | 717 | 271 |
| | Wrong side of road | 3,949 | 819 | 1,419 | 726 | 397 | 236 | 170 | 130 | 52 |
| | Passing/lane change | 5,056 | 665 | 1,757 | 1,217 | 630 | 387 | 245 | 121 | 34 |
| | Improper turn | 8,670 | 1,649 | 3,085 | 1,682 | 918 | 518 | 411 | 274 | 133 |
| | Right-of-way | 19,369 | 2,575 | 5,927 | 3,709 | 2,218 | 1,510 | 1,404 | 1,362 | 664 |
| | Signs/signals | 9,377 | 1,384 | 3,416 | 1,892 | 952 | 599 | 492 | 444 | 198 |
| | Other moving violations | 11,072 | 1,457 | 3,884 | 2,484 | 1,414 | 706 | 578 | 392 | 157 |
| | All others | 3,237 | 471 | 1,122 | 746 | 440 | 199 | 133 | 87 | 39 |
| Female | All factors | 56,991 | 8,453 | 17,521 | 12,994 | 7,382 | 3,785 | 3,080 | 2,710 | 1,066 |
| | Alcohol/drugs | 3,840 | 259 | 1,442 | 1,290 | 535 | 174 | 91 | 43 | 6 |
| | Unsafe speed | 14,698 | 2,569 | 4,890 | 3,384 | 1,772 | 853 | 600 | 478 | 152 |
| | Wrong side of road | 1,828 | 378 | 525 | 369 | 226 | 116 | 88 | 86 | 40 |
| | Passing/lane change | 2,258 | 324 | 734 | 518 | 306 | 161 | 120 | 78 | 17 |
| | Improper turn | 5,543 | 1,042 | 1,697 | 1,145 | 676 | 364 | 283 | 249 | 87 |
| | Right-of-way | 15,618 | 2,163 | 4,227 | 3,242 | 2,094 | 1,173 | 1,105 | 1,106 | 508 |
| | Signs/signals | 5,644 | 702 | 1,660 | 1,221 | 729 | 441 | 409 | 353 | 129 |
| | Other moving violations | 6,046 | 806 | 1,906 | 1,449 | 830 | 391 | 308 | 255 | 101 |
| | All others | 1,516 | 210 | 440 | 376 | 214 | 112 | 76 | 62 | 26 |
| Fatal | | | | | | | | | | |
| Male | All factors | 2,441 | 329 | 972 | 512 | 268 | 130 | 98 | 77 | 55 |
| | Alcohol/drugs | 1,166 | 117 | 526 | 283 | 147 | 55 | 22 | 13 | 3 |
| | Unsafe speed | 353 | 71 | 151 | 71 | 23 | 15 | 10 | 8 | 4 |
| | Wrong side of road | 160 | 26 | 58 | 23 | 15 | 9 | 8 | 15 | 6 |
| | Passing/lane change | 73 | 10 | 28 | 10 | 9 | 5 | 6 | 4 | 1 |
| | Improper turn | 218 | 38 | 63 | 50 | 26 | 15 | 11 | 6 | 9 |
| | Right-of-way | 140 | 15 | 32 | 23 | 15 | 8 | 17 | 13 | 17 |
| | Signs/signals | 149 | 31 | 47 | 23 | 7 | 13 | 10 | 9 | 9 |
| | Other moving violations | 103 | 11 | 35 | 18 | 15 | 5 | 9 | 5 | 5 |
| | All others | 79 | 10 | 32 | 11 | 11 | 5 | 5 | 4 | 1 |
| Female | All factors | 661 | 98 | 204 | 140 | 81 | 36 | 42 | 43 | 17 |
| | Alcohol/drugs | 180 | 15 | 66 | 60 | 20 | 6 | 7 | 5 | 1 |
| | Unsafe speed | 72 | 21 | 31 | 8 | 6 | 2 | 2 | 0 | 2 |
| | Wrong side of road | 60 | 9 | 20 | 11 | 11 | 2 | 3 | 2 | 2 |
| | Passing/lane change | 44 | 6 | 15 | 7 | 7 | 6 | 1 | 2 | 0 |
| | Improper turn | 95 | 23 | 24 | 14 | 12 | 11 | 4 | 5 | 2 |
| | Right-of-way | 91 | 10 | 19 | 12 | 12 | 6 | 8 | 17 | 7 |
| | Signs/signals | 52 | 6 | 9 | 11 | 6 | 2 | 11 | 6 | 1 |
| | Other moving violations | 53 | 7 | 14 | 13 | 7 | 1 | 4 | 6 | 1 |
| | All others | 14 | 1 | 6 | 4 | 0 | 0 | 2 | 0 | 1 |

Note. From California Highway Patrol Statewide Integrated Traffic Records System (SWITRS), 1991.

[a]The factor "other moving violations" consists of infractions for impeding traffic, following too closely, violating pedestrian right-of-way, starting/backing, improper driving, and falling asleep. The factor "all others" consists of the infractions pedestrian right-of-way violation, hazardous parking, unsafe equipment, other hazards, and "not stated."

Table 12

Percentage of Fatal/Injury and Fatal Accidents in 1991 by
Primary Collision Factor Within Age and Sex of Driver at Fault

| Accident type / Sex | Primary collision factor[a] | All ages | 19 and under | 20-29 | 30-39 | 40-49 | 50-59 | 60-69 | 70-79 | 80 and over |
|---|---|---|---|---|---|---|---|---|---|---|
| Fatal/injury | | | | | | | | | | |
| Male | All factors | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| | Alcohol/drugs | 18.9 | 10.3 | 23.1 | 23.4 | 19.2 | 14.5 | 9.6 | 3.9 | 1.8 |
| | Unsafe speed | 27.9 | 33.9 | 28.0 | 27.7 | 27.6 | 25.1 | 23.2 | 19.5 | 17.2 |
| | Wrong side of road | 3.5 | 5.1 | 3.4 | 2.9 | 3.0 | 3.4 | 3.3 | 3.5 | 3.3 |
| | Passing/lane change | 4.4 | 4.1 | 4.2 | 4.8 | 4.8 | 5.6 | 4.8 | 3.3 | 2.2 |
| | Improper turn | 7.6 | 10.2 | 7.3 | 6.6 | 7.0 | 7.5 | 8.0 | 7.5 | 8.4 |
| | Right-of-way | 17.0 | 15.9 | 14.1 | 14.6 | 16.9 | 21.9 | 27.5 | 37.1 | 42.1 |
| | Signs/signals | 8.2 | 8.6 | 8.1 | 7.4 | 7.3 | 8.7 | 9.6 | 12.1 | 12.6 |
| | Other moving violations | 9.7 | 9.0 | 9.2 | 9.8 | 10.8 | 10.3 | 11.3 | 10.7 | 10.0 |
| | All others | 2.8 | 2.9 | 2.7 | 2.9 | 3.4 | 2.9 | 2.6 | 2.4 | 2.5 |
| Female | All factors | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| | Alcohol/drugs | 6.7 | 3.1 | 8.2 | 9.9 | 7.2 | 4.6 | 3.0 | 1.6 | 0.6 |
| | Unsafe speed | 25.8 | 30.4 | 27.9 | 26.0 | 24.0 | 22.5 | 19.5 | 17.6 | 14.3 |
| | Wrong side of road | 3.2 | 4.5 | 3.0 | 2.8 | 3.1 | 3.1 | 2.9 | 3.2 | 3.8 |
| | Passing/lane change | 4.0 | 3.8 | 4.2 | 4.0 | 4.1 | 4.3 | 3.9 | 2.9 | 1.6 |
| | Improper turn | 9.7 | 12.3 | 9.7 | 8.8 | 9.2 | 9.6 | 9.2 | 9.2 | 8.2 |
| | Right-of-way | 27.4 | 25.6 | 24.1 | 24.9 | 28.4 | 31.0 | 35.9 | 40.8 | 47.7 |
| | Signs/signals | 9.9 | 8.3 | 9.5 | 9.4 | 9.9 | 11.7 | 13.3 | 13.0 | 12.1 |
| | Other moving violations | 10.6 | 9.5 | 10.9 | 11.2 | 11.2 | 10.3 | 10.0 | 9.4 | 9.5 |
| | All others | 2.7 | 2.5 | 2.5 | 2.9 | 2.9 | 3.0 | 2.5 | 2.3 | 2.4 |
| Fatal | | | | | | | | | | |
| Male | All factors | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| | Alcohol/drugs | 47.8 | 35.6 | 54.1 | 55.3 | 54.9 | 42.3 | 22.4 | 16.9 | 5.5 |
| | Unsafe speed | 14.5 | 21.6 | 15.5 | 13.9 | 8.6 | 11.5 | 10.2 | 10.4 | 7.3 |
| | Wrong side of road | 6.6 | 7.9 | 6.0 | 4.5 | 5.6 | 6.9 | 8.2 | 19.5 | 10.9 |
| | Passing/lane change | 3.0 | 3.0 | 2.9 | 2.0 | 3.4 | 3.8 | 6.1 | 5.2 | 1.8 |
| | Improper turn | 8.9 | 11.6 | 6.5 | 9.8 | 9.7 | 11.5 | 11.2 | 7.8 | 16.4 |
| | Right-of-way | 5.7 | 4.6 | 3.3 | 4.5 | 5.6 | 6.2 | 17.3 | 16.9 | 30.9 |
| | Signs/signals | 6.1 | 9.4 | 4.8 | 4.5 | 2.6 | 10.0 | 10.2 | 11.7 | 16.4 |
| | Other moving violations | 4.2 | 3.3 | 3.6 | 3.5 | 5.6 | 3.8 | 9.2 | 6.5 | 9.1 |
| | All others | 3.2 | 3.0 | 3.3 | 2.1 | 4.1 | 3.8 | 5.1 | 5.2 | 1.8 |
| Female | All factors | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| | Alcohol/drugs | 27.2 | 15.3 | 32.4 | 42.9 | 24.7 | 16.7 | 16.7 | 11.6 | 5.9 |
| | Unsafe speed | 10.9 | 21.4 | 15.2 | 5.7 | 7.4 | 5.6 | 4.8 | 0.0 | 11.8 |
| | Wrong side of road | 9.1 | 9.2 | 9.8 | 7.9 | 13.6 | 5.6 | 7.1 | 4.7 | 11.8 |
| | Passing/lane change | 6.7 | 6.1 | 7.4 | 5.0 | 8.6 | 16.7 | 2.4 | 4.7 | 0.0 |
| | Improper turn | 14.4 | 23.5 | 11.8 | 10.0 | 14.8 | 30.6 | 9.5 | 11.6 | 11.8 |
| | Right-of-way | 13.8 | 10.2 | 9.3 | 8.6 | 14.8 | 16.7 | 19.0 | 39.5 | 41.2 |
| | Signs/signals | 7.9 | 6.1 | 4.4 | 7.9 | 7.4 | 5.6 | 26.2 | 14.0 | 5.9 |
| | Other moving violations | 8.0 | 7.1 | 6.9 | 9.3 | 8.6 | 2.8 | 9.5 | 14.0 | 5.9 |
| | All others | 2.1 | 1.0 | 2.9 | 2.9 | 0.0 | 0.0 | 4.8 | 0.0 | 5.9 |

Note. From California Highway Patrol Statewide Integrated Traffic Records System (SWITRS), 1991.

[a]The factor "other moving violations" consists of infractions for impeding traffic, following too closely, violating pedestrian right-of-way, starting/ backing, improper driving, and falling asleep. The factor "all others" consists of the infractions pedestrian right-of-way violation, hazardous parking, unsafe equipment, other hazards, and "not stated."

Figures 16 and 17 plot the percentages from Table 13. It is apparent from Table 13 and Figure 16 that:

- Speed is most often the primary collision factor in fatal/injury accidents for male drivers of all ages combined, but its percentage contribution decreases as driver age increases.

- Violation of right-of-way is most often the primary collision factor in fatal/injury accidents for female drivers of all ages combined, and its percentage contribution increases as driver age increases.

The primary causes of, and age-related trends for, fatal accidents are somewhat different from those for fatal/injury accidents. The increased importance, in fatal accidents, of alcohol/drug use as a primary collision factor is notable. Table 13 and Figure 17 show that:

- Alcohol/drug use is most often the primary collision factor in fatal accidents of both sexes.

- Alcohol/drug use is the primary cause of fatal accidents for all but the oldest age groups (70 and above), peaking for the 30-39 age group and then decreasing with increasing age.

- Improper turns and right-of-way violations are primary causes of fatal accidents for female drivers twice as often as for male drivers.

- Right-of-way violation is the primary collision factor in fatal accidents of drivers aged 70 and over.

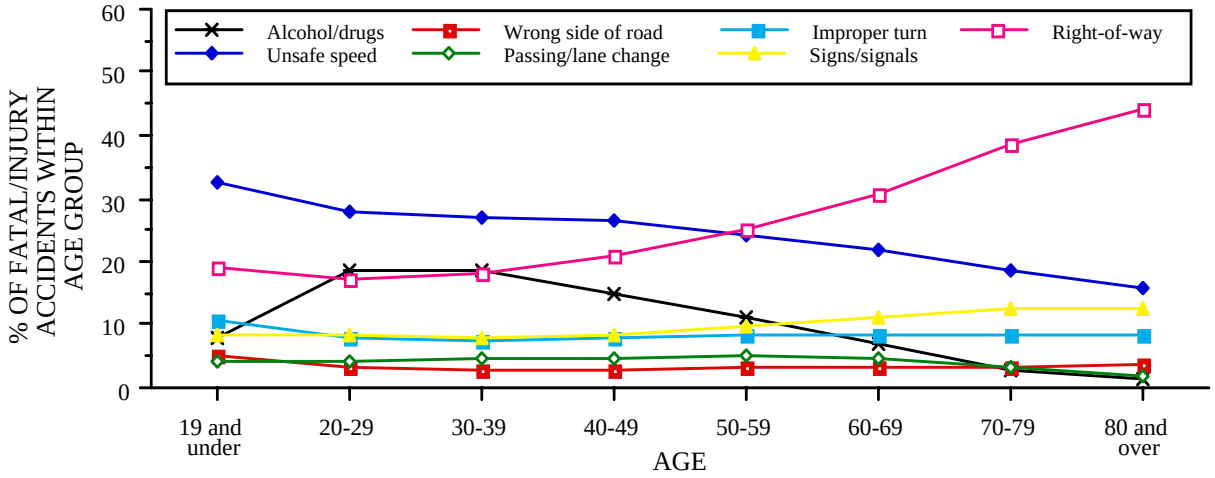
Table 13

Percentage of Fatal/Injury and Fatal Accidents in 1991 by Primary Collision Factor Within Age of Driver at Fault

| Accident type<br>Primary collision factor[a] | All ages | 19 and under | 20-29 | 30-39 | 40-49 | 50-59 | 60-69 | 70-79 | 80 and over |
|---|---|---|---|---|---|---|---|---|---|
| Fatal/injury | | | | | | | | | |
| All factors | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| Alcohol/drugs | 14.8 | 7.8 | 18.7 | 18.8 | 14.9 | 11.0 | 7.1 | 2.9 | 1.3 |
| Unsafe speed | 27.2 | 32.7 | 28.0 | 27.2 | 26.3 | 24.2 | 21.8 | 18.7 | 16.0 |
| Wrong side of road | 3.4 | 4.9 | 3.3 | 2.8 | 3.0 | 3.3 | 3.2 | 3.4 | 3.5 |
| Passing/lane change | 4.3 | 4.0 | 4.2 | 4.5 | 4.6 | 5.1 | 4.5 | 3.1 | 1.9 |
| Improper turn | 8.3 | 10.9 | 8.0 | 7.4 | 7.8 | 8.3 | 8.5 | 8.2 | 8.3 |
| Right-of-way | 20.4 | 19.2 | 17.0 | 18.1 | 21.1 | 25.1 | 30.6 | 38.7 | 44.4 |
| Signs/signals | 8.8 | 8.5 | 8.5 | 8.1 | 8.2 | 9.7 | 11.0 | 12.5 | 12.4 |
| Other moving violations | 10.0 | 9.2 | 9.7 | 10.2 | 11.0 | 10.3 | 10.8 | 10.1 | 9.8 |
| All others | 2.8 | 2.8 | 2.6 | 2.9 | 3.2 | 2.9 | 2.6 | 2.3 | 2.5 |
| Fatal | | | | | | | | | |
| All factors | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| Alcohol/drugs | 43.4 | 30.9 | 50.3 | 52.6 | 47.9 | 36.7 | 20.7 | 15.0 | 5.6 |
| Unsafe speed | 13.7 | 21.5 | 15.5 | 12.1 | 8.3 | 10.2 | 8.6 | 6.7 | 8.3 |
| Wrong side of road | 7.1 | 8.2 | 6.6 | 5.2 | 7.4 | 6.6 | 7.9 | 14.2 | 11.1 |
| Passing/lane change | 3.8 | 3.7 | 3.7 | 2.6 | 4.6 | 6.6 | 5.0 | 5.0 | 1.4 |
| Improper turn | 10.1 | 14.3 | 7.4 | 9.8 | 10.9 | 15.7 | 10.7 | 9.2 | 15.3 |
| Right-of-way | 7.4 | 5.9 | 4.3 | 5.4 | 7.7 | 8.4 | 17.9 | 25.0 | 33.3 |
| Signs/signals | 6.5 | 8.7 | 4.8 | 5.2 | 3.7 | 9.0 | 15.0 | 12.5 | 13.9 |
| Other moving violations | 5.0 | 4.2 | 4.2 | 4.8 | 6.3 | 3.6 | 9.3 | 9.2 | 8.3 |
| All others | 3.0 | 2.6 | 3.2 | 2.3 | 3.2 | 3.0 | 5.0 | 3.3 | 2.8 |

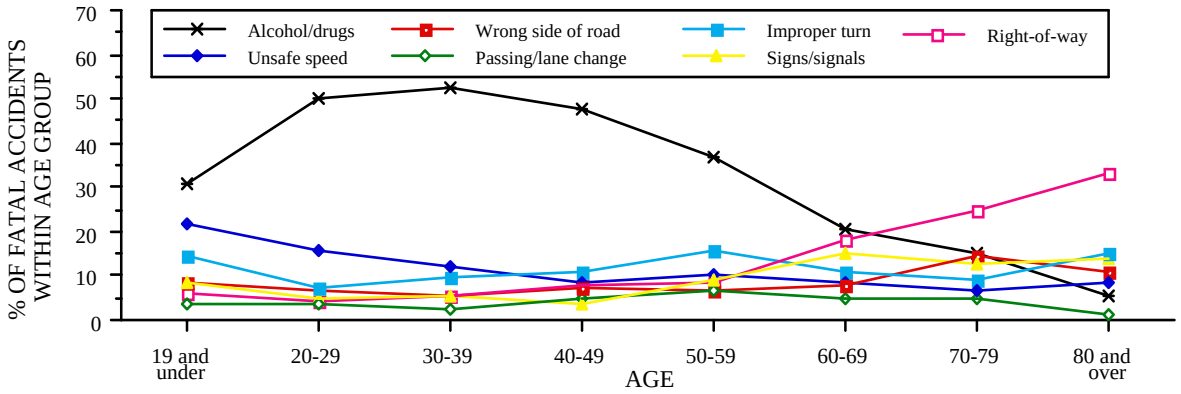
Note. From California Highway Patrol Statewide Integrated Traffic Records System (SWITRS), 1991.

[a]The factor "other moving violations" consists of infractions for impeding traffic, following too closely, violating pedestrian right-of-way, starting/backing, improper driving, and falling asleep. The factor "all others" consists of the infractions pedestrian right-of-way violation, hazardous parking, unsafe equipment, other hazards, and "not stated."




Note. From California Highway Patrol Statewide Integrated Traffic Records System (SWITRS ), 1991. Percents within age group do not add to 100 because only the most common collision factors were considered.

Figure 16. Percentage of responsible fatal/injury accidents within age group in 1991 by primary collision factor and age of driver at fault.




Note . From California Highway Patrol Statewide Integrated Traffic Records System (SWITRS), 1991. Percents within age group do not add to 100 because only the most common collision factors were considered.

Figure 17. Percentage of responsible fatal accidents within age group in 1991 by primary collision factor and age of driver at fault.

## Traffic Violation Patterns and Age

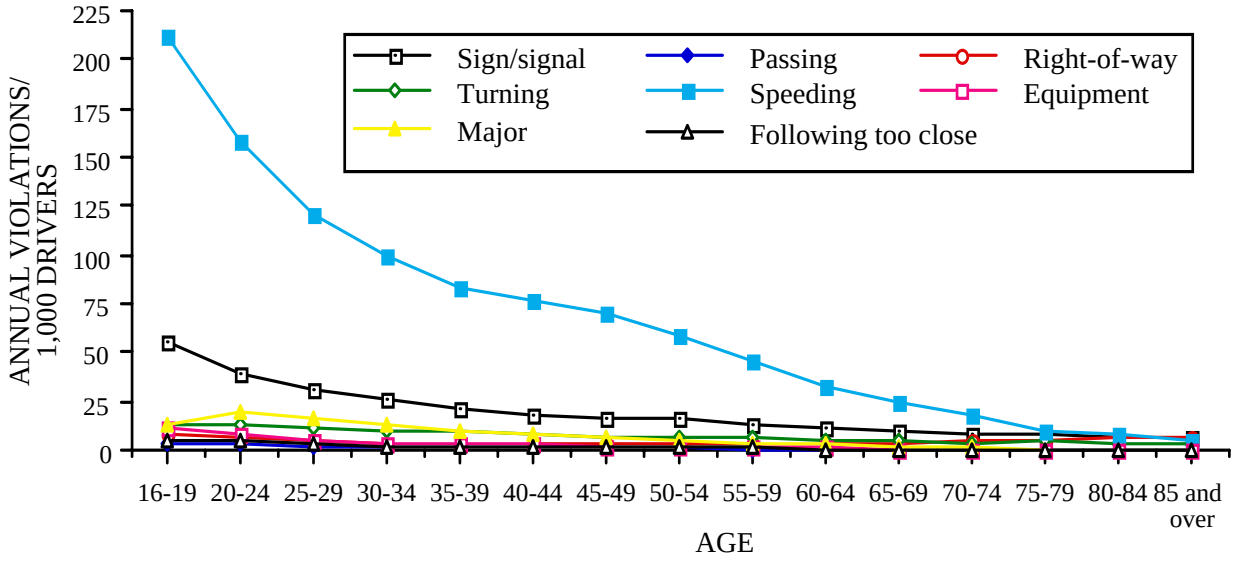
Court reports (abstracts) of traffic citations sent to the California Department of Motor Vehicles contain information on all violations recorded on traffic citations arising from one traffic stop, whenever one or more of the cited violations resulted in a conviction or traffic violator school citation dismissal. Using these data, Table 14 and Figure 18 show the rate (per 1,000 drivers) of selected violations occurring in California from 1989-91 by violation type and driver age. Table 15 and Figure 19 show the mileage-adjusted violation rate (per driver per 100,000 miles).

Table 14

Average Annual Violations per 1,000 Drivers by Violation Type and Driver Age

| Age | Violation type | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Signs/ signals | Passing | Right-of-way | Turning | Speeding | Equipment | Major | Following too close | Total |
| 16-19 | 55.3 | 3.3 | 8.2 | 13.4 | 212.7 | 11.5 | 13.8 | 5.0 | 323.2 |
| 20-24 | 39.7 | 3.3 | 5.8 | 12.9 | 158.4 | 7.7 | 19.1 | 4.1 | 251.0 |
| 25-29 | 30.2 | 2.3 | 4.4 | 10.9 | 121.2 | 4.9 | 15.8 | 3.0 | 192.7 |
| 30-34 | 25.8 | 2.2 | 3.4 | 10.2 | 98.8 | 4.0 | 13.3 | 2.3 | 160.0 |
| 35-39 | 21.3 | 1.6 | 3.4 | 9.2 | 83.8 | 2.8 | 9.0 | 1.7 | 132.8 |
| 40-44 | 18.2 | 1.6 | 3.6 | 7.5 | 76.8 | 2.6 | 8.8 | 1.3 | 120.4 |
| 45-49 | 17.1 | 1.8 | 3.1 | 6.9 | 69.5 | 2.2 | 6.0 | 1.5 | 108.1 |
| 50-54 | 15.5 | 1.2 | 3.4 | 7.0 | 58.4 | 2.1 | 5.0 | 1.2 | 93.8 |
| 55-59 | 13.5 | 0.8 | 3.3 | 6.9 | 46.3 | 1.4 | 3.7 | 1.0 | 76.9 |
| 60-64 | 10.6 | 0.8 | 2.9 | 4.5 | 32.3 | 1.0 | 3.2 | 0.4 | 55.7 |
| 65-69 | 9.1 | 0.5 | 2.9 | 4.7 | 24.2 | 0.7 | 1.8 | 0.2 | 44.1 |
| 70-74 | 7.9 | 0.5 | 4.1 | 3.7 | 17.8 | 0.5 | 1.0 | 0.2 | 35.7 |
| 75-79 | 7.4 | 0.2 | 5.6 | 4.2 | 10.2 | 0.2 | 0.4 | 0.2 | 28.4 |
| 80-84 | 7.1 | 0.1 | 5.8 | 3.8 | 8.4 | 0.0 | 0.3 | 0.1 | 25.6 |
| 85 and over | 5.9 | 0.0 | 6.7 | 3.4 | 4.2 | 0.8 | 0.0 | 0.0 | 21.0 |
| All ages | 20.8 | 1.5 | 4.2 | 7.8 | 77.5 | 3.2 | 7.7 | 1.7 | 124.6 |

Note. Based on the driver records of a 1% sample of licensed California drivers. Averages are for violations occurring during 1989-91.




Note. Based on the driver records of a 1% sample of licensed California drivers. Averages are for violations occurring during 1989-91.

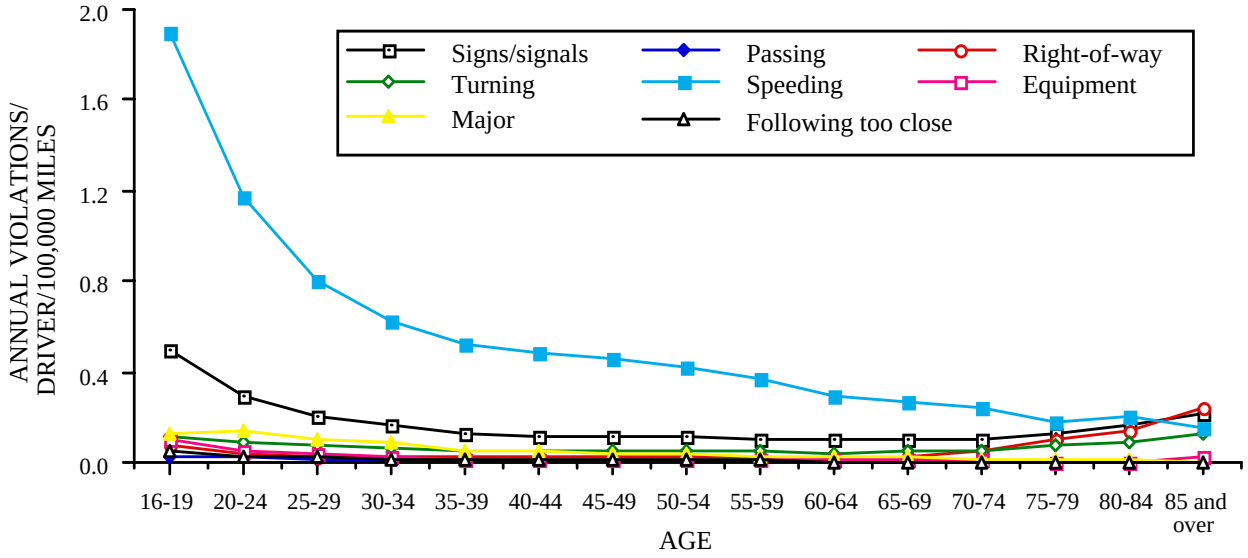
Figure 18. Average annual traffic violations per 1,000 drivers by violation type and driver age.

Table 15

Average Annual Violations per Driver per 100,000 Miles

| Age | Violation type | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Signs/ signals | Passing | Right-of-way | Turning | Speeding | Equipment | Major | Following too close |
| 16-19 | 0.4945 | 0.0295 | 0.0733 | 0.1198 | 1.9020 | 0.1028 | 0.1234 | 0.0447 |
| 20-24 | 0.2934 | 0.0244 | 0.0429 | 0.0954 | 1.1708 | 0.0569 | 0.1412 | 0.0303 |
| 25-29 | 0.2002 | 0.0152 | 0.0292 | 0.0722 | 0.8033 | 0.0325 | 0.1047 | 0.0199 |
| 30-34 | 0.1618 | 0.0138 | 0.0213 | 0.0640 | 0.6197 | 0.0251 | 0.0834 | 0.0144 |
| 35-39 | 0.1316 | 0.0099 | 0.0210 | 0.0569 | 0.5179 | 0.0173 | 0.0556 | 0.0105 |
| 40-44 | 0.1146 | 0.0101 | 0.0227 | 0.0472 | 0.4837 | 0.0164 | 0.0554 | 0.0082 |
| 45-49 | 0.1131 | 0.0119 | 0.0205 | 0.0456 | 0.4595 | 0.0145 | 0.0397 | 0.0099 |
| 50-54 | 0.1107 | 0.0086 | 0.0243 | 0.0500 | 0.4171 | 0.0150 | 0.0357 | 0.0086 |
| 55-59 | 0.1072 | 0.0064 | 0.0262 | 0.0548 | 0.3677 | 0.0111 | 0.0294 | 0.0079 |
| 60-64 | 0.0965 | 0.0073 | 0.0264 | 0.0410 | 0.2942 | 0.0091 | 0.0291 | 0.0036 |
| 65-69 | 0.0984 | 0.0054 | 0.0314 | 0.0508 | 0.2617 | 0.0076 | 0.0195 | 0.0022 |
| 70-74 | 0.1056 | 0.0067 | 0.0548 | 0.0495 | 0.2380 | 0.0067 | 0.0134 | 0.0027 |
| 75-79 | 0.1285 | 0.0035 | 0.0972 | 0.0729 | 0.1771 | 0.0035 | 0.0069 | 0.0035 |
| 80-84 | 0.1702 | 0.0024 | 0.1391 | 0.0911 | 0.2014 | 0.0000 | 0.0072 | 0.0024 |
| 85 and over | 0.2109 | 0.0000 | 0.2395 | 0.1216 | 0.1502 | 0.0286 | 0.0000 | 0.0000 |
| All ages | 0.1836 | 0.0132 | 0.0371 | 0.0688 | 0.6840 | 0.0282 | 0.0680 | 0.0150 |

Note. Based on the driver records of a 1% sample of licensed California drivers. Averages are for violations occurring during 1989-91.




Note. Based on 1% sample of California licensed drivers. Averages represent accidents occurring during 1989-91. Mileage estimates are based on data from Federal Highway Administration, 1992, 1990 Nationwide Personal Transportation Survey: Travel Behavior Issues in the 90's. Washington, DC: U.S. Department of Transportation.

Figure 19. Average annual traffic violations per driver per 100,000 miles by violation type and driver age.

Table 16 displays each violation type as a percentage of the total violations within each age group. This clarifies age differences in the pattern of violations by providing a profile of each age group's traffic violation frequency adjusted for age differences in overall traffic citation rate.

Table 16

Violation Type as a Percentage of Total Violations by Driver Age

| Violation type | Age | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 16-19 | 20-24 | 25-29 | 30-34 | 35-39 | 40-44 | 45-49 | 50-54 | 55-59 | 60-64 | 65-69 | 70-74 | 75-79 | 80-84 | 85 & over |
| Signs/signals | 17.11 | 15.82 | 15.67 | 16.13 | 16.04 | 15.12 | 15.82 | 16.52 | 17.56 | 19.03 | 20.63 | 22.13 | 26.06 | 27.73 | 28.10 |
| Passing | 1.02 | 1.31 | 1.19 | 1.38 | 1.20 | 1.33 | 1.67 | 1.28 | 1.04 | 1.44 | 1.13 | 1.40 | 0.70 | 0.39 | 0.00 |
| Right-of-way | 2.54 | 2.31 | 2.28 | 2.13 | 2.56 | 2.99 | 2.87 | 3.62 | 4.29 | 5.21 | 6.58 | 11.48 | 19.72 | 22.66 | 31.90 |
| Turning | 4.15 | 5.14 | 5.66 | 6.38 | 6.93 | 6.23 | 6.38 | 7.46 | 8.97 | 8.08 | 10.66 | 10.36 | 14.79 | 14.84 | 16.19 |
| Speeding | 65.81 | 63.11 | 62.90 | 61.25 | 63.10 | 63.79 | 64.29 | 62.26 | 60.21 | 57.99 | 54.88 | 49.86 | 35.92 | 32.81 | 20.00 |
| Equipment | 3.56 | 3.08 | 2.54 | 2.50 | 2.11 | 2.16 | 2.04 | 2.24 | 1.82 | 1.80 | 1.59 | 1.40 | 0.70 | 0.00 | 3.81 |
| Major | 4.27 | 7.61 | 8.20 | 8.31 | 6.78 | 7.31 | 5.55 | 5.33 | 4.81 | 5.75 | 4.08 | 2.80 | 1.41 | 1.17 | 0.00 |
| Following too close | 1.54 | 1.63 | 1.56 | 1.44 | 1.28 | 1.08 | 1.39 | 1.28 | 1.30 | 0.72 | 0.45 | 0.56 | 0.70 | 0.39 | 0.00 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

Note. Based on the driver records of a 1% sample of California licensed drivers. Averages are for accidents occurring during 1989-91. Percentages may not add to 100 due to rounding.

Tables 15 and 16 provide evidence that rates of different violations and overall traffic violation patterns are related to driver age. Both the unadjusted and mileage-adjusted rates show the following:

- Teens have the highest total violation rates, and elderly drivers have the lowest.

- The rate of speeding violations, especially, is highest among teens and decreases with age.

- Teen drivers also have the highest rate of signs/signals infractions.

- The rates of major violations–driving under the influence of alcohol or drugs, hit and run, and reckless driving–are highest for drivers under 25 and lowest for elderly drivers.

- For the age group 70 and above, right-of-way violations are the most common type and exceed those of most other groups, with their rate enhanced when adjusted for mileage.

The following relationships are evident from the percentages in Table 16:

- Speeding is by far the most frequent violation type for most age groups, but its percentage contribution decreases as driver age increases.

- Signs/signals infractions are the second most common type of violation for most age groups.

- Signs/signals, right-of-way, and turning violations show an increasing percentage share of the total as driver age increases. Together, these types account for 61% of the violations of drivers aged 75-79, 65% of the violations of drivers aged 80-84, and 76% of the violations of drivers aged 85 or more.

- Major violations, which constitute less than 9% of the violations within each age group, peak in their percentage contribution for drivers under age 35. They are a negligible percentage of the total for drivers aged 75 or more.

The above parallels the trend of primary causes of fatal/injury accidents for younger and older drivers as displayed in Table 13 and Figure 16. For example, speed is most often the primary collision factor in fatal/injury accidents, but it decreases in importance as driver age increases. Right-of-way and sign/signal infractions increase in importance as primary factors as drivers age.

Arrests for Driving under the Influence of Alcohol/Drugs (DUI) and Hit-and-Run

Table 17 displays the relative involvement indexes for misdemeanor and felony arrests for DUI and hit-and-run violations in 1991 by driver age. Arrest data are from the California Department of Justice (DOJ, 1992). The relative involvement indices, plotted in Figure 20, indicate that:

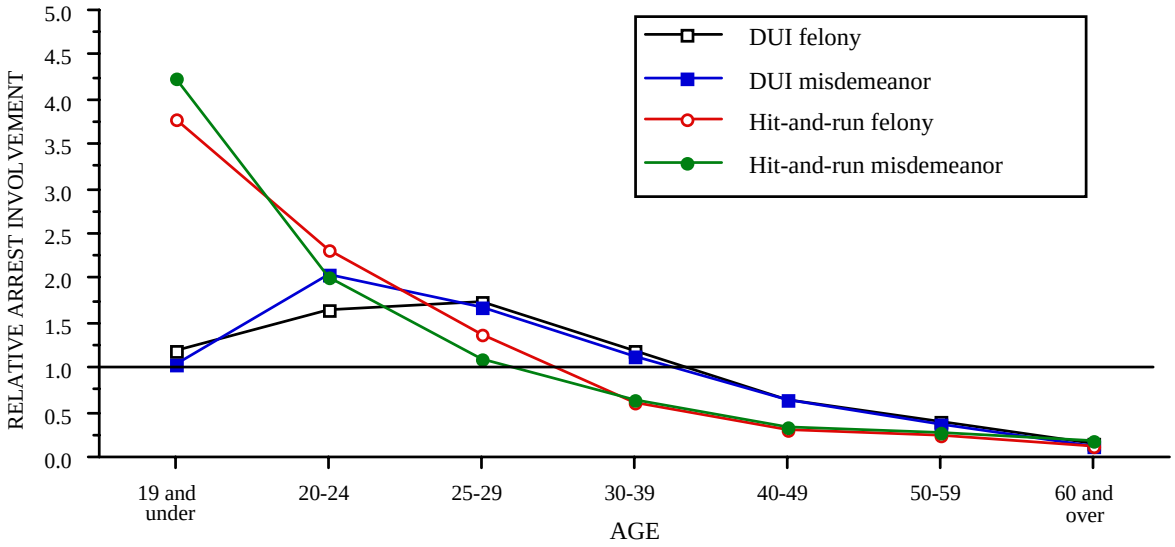
- Although in California the possession of alcohol is not legal until age 21, teens have the third highest relative involvement risk of DUI felony (i.e., DUI with bodily injury) arrest.

Table 17

Relative Involvement in Arrests for Driving Under the Influence of Alcohol/Drugs (DUI) and for Hit-and-Run in 1991 by Age

| Age | % of licensed drivers[a] | DUI | | | | | | Hit-and-run | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Felony | | | Misdemeanor | | | Felony | | | Misdemeanor | | |
| | | Number[b] | % | Relative involvement index[c] | Number | % | Relative involvement index | Number | % | Relative involvement index | Number | % | Relative involvement index |
| 16 and under | 0.56 | 60 | 0.44 | 0.78 | 863 | 0.23 | 0.41 | 109 | 4.24 | 7.59 | 438 | 5.02 | 8.97 |
| 17 | 0.96 | 109 | 0.79 | 0.82 | 1,844 | 0.50 | 0.52 | 61 | 2.38 | 2.47 | 302 | 3.46 | 3.60 |
| 18 | 1.37 | 277 | 2.01 | 1.47 | 5,830 | 1.57 | 1.15 | 124 | 4.83 | 3.54 | 406 | 4.65 | 3.41 |
| 19 | 1.80 | 375 | 2.72 | 1.52 | 9,531 | 2.56 | 1.43 | 123 | 4.79 | 2.67 | 413 | 4.74 | 2.64 |
| 19 and under | 4.68 | 821 | 5.96 | 1.27 | 18,068 | 4.86 | 1.04 | 417 | 16.24 | 3.47 | 1,559 | 17.87 | 3.82 |
| 20-24 | 10.53 | 2,426 | 17.62 | 1.67 | 79,365 | 21.34 | 2.03 | 593 | 23.09 | 2.19 | 1,850 | 21.21 | 2.01 |
| 25-29 | 13.28 | 2,990 | 21.72 | 1.64 | 82,930 | 22.30 | 1.68 | 419 | 16.32 | 1.23 | 1,324 | 15.18 | 1.14 |
| 30-39 | 25.68 | 4,071 | 29.57 | 1.15 | 106,189 | 28.55 | 1.11 | 447 | 17.41 | 0.68 | 1,428 | 16.37 | 0.64 |
| 40-49 | 18.36 | 1,681 | 12.21 | 0.66 | 43,903 | 11.80 | 0.64 | 159 | 6.19 | 0.34 | 531 | 6.09 | 0.33 |
| 50-59 | 11.31 | 627 | 4.55 | 0.40 | 15,978 | 4.30 | 0.38 | 61 | 2.38 | 0.21 | 215 | 2.47 | 0.22 |
| 60 and over | 16.15 | 332 | 2.41 | 0.15 | 7,453 | 2.00 | 0.12 | 55 | 2.14 | 0.13 | 256 | 2.94 | 0.18 |
| All ages | 100.00 | 11,970 | 100.00 | 1.00 | 315,442 | 100.00 | 1.00 | 2,304 | 100.00 | 1.00 | 7,615 | 100.00 | 1.00 |

[a]From California Department of Motor Vehicles, 1991, Age and Sex Report, Sacramento, CA. [b]From California Department of Justice, 1992, 1991 Statewide Criminal Justice Profile, Sacramento, CA. [c]Relative involvement is arrest involvement in the age/sex group as a percent of such involvements for all drivers, divided by the percent of all licensed drivers represented by that group.




Note. Arrest data are from California Department of Justice, 1992, 1991 Statewide Criminal Justice Profile, Sacramento, CA. Licensing data are from Department of Motor Vehicles, 1991, Age and Sex Report, Sacramento, CA. The relative involvement index is the arrest involvement for the age group as a percent of such involvement for all drivers, divided by the percent of all licensed drivers represented by that group.

Figure 20. Relative involvement in 1991 arrests for driving under the influence of alcohol/drugs (DUI) or hit-and-run.

- DUI arrest risk increases for post-teens and begins a steady decline at about age 25.

- DUI arrest risk increases for post-teens and begins a steady decline at about age 25.

- Teens have the highest relative involvement risk for both types of hit-and-run arrests. (This finding reflects DUI behavior to some degree, because hit-and-run violations are frequently committed by drivers identified by the officer as having been drinking.)

- Hit-and-run arrest risk declines steeply with age.

# RESEARCH AND COUNTERMEASURES

## Research on Young Drivers

Earlier sections of this report, and numerous other studies, have established that young drivers are overinvolved in traffic accidents. Causative or confounding variables that have been studied in relation to this finding include driving experience, exposure to accident risk, miles driven, alcohol/drug consumption, perceptual abilities, personality structure, and attitudinal traits, such as risk-taking propensity.

Exposure and lack of experience account for some of the overinvolvement of young drivers; however, most of the evidence suggests that risk-taking is a–if not the–major factor underlying the high accident rate among teens (Jonah, 1986).

- Compared to other male drivers, young male drivers are more willing to take risks and are more likely to perceive hazardous situations as being less dangerous than they actually are (Finn & Bragg, 1986).

- Although drivers under the age of 25 have the fastest simple reaction and choice reaction times (Quimby & Watts, 1981), they respond to filmed traffic hazards more slowly than do mid-age drivers. This was believed by the study authors to be caused by young drivers' frequent failure to recognize situations as being potentially hazardous.

- Male drivers aged 18-24 perceive themselves as being less likely than other drivers their age to be involved in an accident, while other male drivers perceive their accident risk to be similar to that of their age peers (Finn & Bragg, 1986). This suggests that young male drivers overestimate their capabilities.

- Illustrating changes in risk perception that come with age and experience, young male drivers rated certain traffic situations as less risky than did mid-age and older male drivers, especially situations involving darkness, graded or curved roadways, and rural environments (Tränkle, Gelau, & Metker, 1990). In the same study, young female drivers rated only situations involving darkness and intersections as less dangerous than did mid-age and older female drivers.

- Teens tend to underestimate the danger in high-risk situations and to overestimate the danger in low- to medium-risk driving situations (Matthews & Moran, 1986).

- Teens who engage in higher-risk activities outside the driving situation tend to have a higher incidence of traffic accident involvement, whether they are actually driving the vehicle or just riding as a passenger (Beirness & Simpson, 1988). This suggests that risky driving may be part of a more general syndrome of risk-taking behavior.

- The overinvolvement of teen drivers in traffic accidents is not explained to any major degree by lack of driving experience alone (Levy, 1990). This conclusion is in agreement with the body of evidence indicating an increased risk-taking propensity for juveniles.

Alcohol consumption is thought to be another causal factor in the accident overinvolvement of teens. Teen drivers, being below the legal drinking age in most states (including California), are less likely than drivers in older age groups to drink and drive. But those who do drink and drive are at much greater risk of serious accidents than are older drivers who have the same concentrations of alcohol in their blood (Mayhew, Donelson, Beirness, & Simpson, 1986; Simpson, 1985). Research studies indicate that:

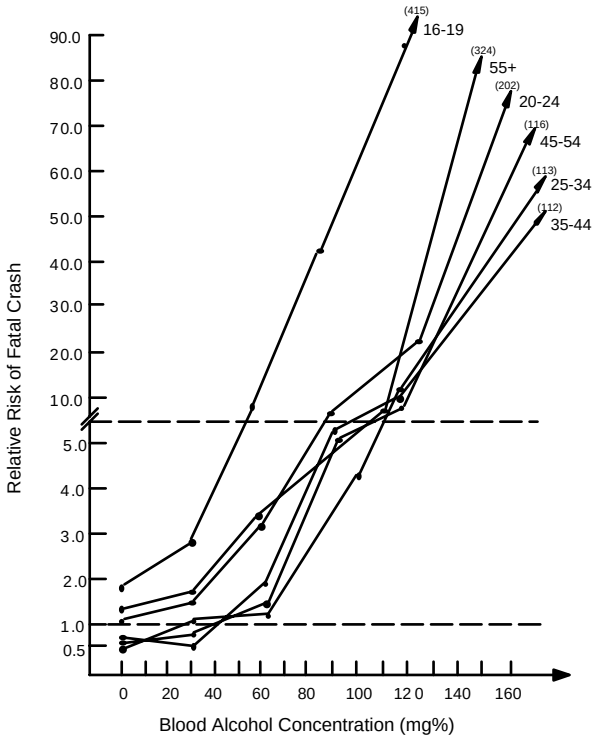
- Young drivers are overinvolved in alcohol-related driving fatalities (Carlson, 1972), in part because they are overrepresented among those who drive at night when alcohol-caused accidents are more likely to occur.

- Since young people are more socially active than others, especially at night, they have more opportunities to drink and then drive (Carlson, 1972).

- Teen drivers identified as HBD have, on the average, a lower blood alcohol concentration (BAC) than do other HBD drivers (Zylman, 1973), possibly because young drivers who are learning to drive and learning to drink are at greater risk when participating in these activities at the same time. This suggests that they are more likely than other drivers to show impairment at relatively low BAC levels.

Figure 21 shows the relative risk of fatal crashes as a function of BAC and age. The plot, taken from a Canadian study by Simpson (1985), illustrates that:

- Teens have a higher risk of a fatal crash than do other age groups at all BAC levels.
- As BAC increases, relative risk of a fatal crash increases within each age group.
- Risk of a fatal crash rises with BAC more steeply for teens than for other age groups.




Note. From "Polydrug Effects and Traffic Safety" by H. Simpson, 1985, Alcohol, Drugs, and Driving: Abstracts and Reviews, 1,(1-2), p. 23.

Figure 21. Relative risk of fatal crash as a function of BAC and age.

Accident Countermeasures for Young Drivers

As noted above, several factors are believed to contribute to the high accident rates for young drivers. In an attempt to mitigate the effect of these factors, many states have implemented countermeasures to improve the driving practices and attitudes of young novice drivers. The following studies support the effectiveness of some of these countermeasure programs:

- Harrington (1971) evaluated three types of countermeasures: (1) raising the licensing age to 18; (2) identifying the accident-prone driver prior to licensing; and (3) giving formal driver training and education. Although no alternative was very effective, there was some evidence that driver training reduced the rate of fatal/injury accidents for licensed female drivers. In a recent Oregon study, Jones and McCormac (1989) also found that while there was no overall evidence of a significant driver training effect, young women receiving behind-the-wheel driver training showed a trend toward lower accident rates.

- In analyzing data from three large cities with curfew ordinances that limited the late-night activities of persons under age 18 in public places, Preusser, Williams, Lund, and Zador (1990) found a 23% reduction in motor vehicle injuries for 13-17-year-olds as passengers, drivers, pedestrians, and bicyclists during the curfew hours.

- In analyzing data from four states with driving curfews, Preusser, Williams, Zador, and Blomberg (1982) found that accidents during curfew hours involving 16-year-old drivers were reduced by 69% in Pennsylvania, 62% in New York, 40% in Maryland, and 25% in Louisiana. The study also provided evidence that longer curfew hours produce greater reductions in accidents involving young drivers.

- In assessing the Maryland Provisional License Program inaugurated in January 1979, McKnight, Hyle, and Albrecht (1983) reported that nighttime driving restrictions had failed to reduce accidents during the curfew hours. However, daytime accidents were reduced by 5%, and traffic convictions were reduced by 10%, among young drivers operating on a provisional license.

- Dreyer and Janke (1979) studied randomly assigned high school students given, in addition to standard training components, eight hours of practice on an off-road driving range (same number of total training hours). The range group had

significantly (33%) fewer total accidents during the year following the beginning of training, as compared to students undergoing standard training with no range practice. There was no difference in licensure rate or time to licensure. However, the sophisticated driving range used was very costly, and it was pointed out that general use of such facilities might be infeasible.

- Stock, Weaver, Ray, Brink, and Sadof (1983) evaluated two types of high school driver training against a no-training condition and found that there were significant (though small) accident and violation reductions for the training groups when the analysis was limited to those subsequently licensed during the first 6 months following training. This difference diminished over the next 18 months. As a negative effect, training was also found to have caused earlier licensing and, consequently, increased accident exposure among participants in general (both licensed and unlicensed), which counteracted any overall traffic safety benefit of training. The tendency for driver training to increase licensure of teenagers was documented in earlier studies by Robertson and Zador (1977) and Robertson (1980).

- In their study of California's Provisional Driver Licensing Program, implemented in October 1983, Hagge and Marsh (1988) found, among other positive outcomes, evidence suggesting that provisional licensing reduced by 5.3% the rate of traffic accidents among the statewide population of 15-17-year-olds.

- New Zealand and Victoria, Australia (Traffic Injury Research Foundation of Canada, 1991) have developed graduated licensing programs for novice drivers that gradually and systematically lift the initial licensing restrictions. The Victoria program applies to all new drivers, whereas the New Zealand system applies to novice drivers under age 26. Firth and Perkins (1991) reported a significant reduction in accidents following New Zealand's program when comparing monthly accident frequencies for 15-19-year-olds with those for the population aged 25 and above. Published data of the impact of the Australia's program is not yet available (Traffic Injury Research Foundation of Canada, 1991).

- Hingson, Heeren, Howland, and Winter (1991) found evidence that lowering BAC limits for teen drivers in Maine, New Mexico, North Carolina, and Wisconsin reduced nighttime fatal accidents among adolescents in those states.

- The National Highway Traffic Safety Administration (NHTSA) evaluated a Maryland "zero-tolerance" law that made it illegal for drivers under age 21 (i.e., below the legal "drinking age") to operate a motor vehicle at a BAC level of 0.02% or higher (cited in Kedjidjian, 1993). The standard was chosen to be .02 rather than zero because of practical measurement limitations. NHTSA reported that, statewide, there was an 11% reduction in accidents involving drivers under 21 who had been drinking after zero tolerance went into effect. Additionally, NHTSA reported that in six Maryland test counties implementing public awareness campaigns, the number of alcohol-related traffic accidents involving young drivers dropped an additional 30% beyond the statewide reduction.

This brief review shows that countermeasures directed toward young drivers often result in only marginal reductions in accident rates. Perhaps the most important highway safety research question is why some youths are, and others are not, amenable to changing their driving behaviors in different contexts.

Peck (1985) offered the following rationale for the failure of driver training to result in demonstrable accident reduction:

> *Risk perception and choice implicitly involve an attitude or sense of personal vulnerability and, in fact, [lack of] recognition of vulnerability may be the single most important mechanism underlying risk taking. . . . By invoking "personal vulnerability" as a maturational characteristic which increases with age, one might explain why risky driving decreases substantially at age 25-30. Unless one has a sufficient sense, cognitively and effectively, of being vulnerable to catastrophic events, there is little motivation to drive cautiously and defensively. If this conjecture has any validity, it leads to the pessimistic conclusion that not much can be done to short-circuit the process. In other words, it may not be possible for any feasible countermeasure to make most 18-year-olds respond to the driving tasks like most 30-year-olds other than the passage of 12 years. (p. 60)*

Based on a review of current literature on age versus experience as related to risk of crash involvement, Mayhew and Simpson (1990) reached a conclusion that appears to substantiate Peck's conjecture. They found that increased experience was more likely to be related to decreased accident rates among elderly drivers than it was among younger drivers, with age being more important than driving experience in predicting accident risk among younger drivers, particularly men. The authors suggested that the negative effects of greater risk-taking, aggressiveness, and competitiveness characteristic of

young drivers, especially men, may actually counterbalance any positive effect of experience.

Research on Elderly Drivers

As discussed previously, both unadjusted and mileage-adjusted total accident involvement rates begin to increase at around 70 years of age. In the case of the former measure, the increase is only to the level of middle-aged drivers (from a low point at ages 65-69), but older drivers' accident involvement rate divided by mileage increases to a level equal to that for teens. While factors unrelated to disability have been discussed in connection with this increase, the material presented in this section summarizes research studies on the effect of age-related physical and mental conditions that tend to degrade driving skills and are in part responsible for elders' higher accidents-per-mile rates.

Studies addressing the relationship between aging and accident risk have found that a substantial number of accidents involving elderly drivers are at least partially attributable to worsening vision, poor physical coordination, cognitive confusion, or other age-related physical and mental impairments (Transportation Research Board, 1988; U. S. Department of Transportation, 1989). It is emphasized, however, that chronological age per se is not a very good measure of accident risk for individuals, because elders vary considerably in driving skills, physical/mental abilities, point of onset of decline, and rate of decline.

Worsening vision is a major factor contributing to the increasing accident rate associated with aging, because most of the sensory input required for driving is visual (Bailey & Sheedy, 1988). Numerous studies have determined that elders typically have reduced peripheral vision, a decline in nighttime acuity, and increased difficulty in accommodation (focusing on close objects). Specifically, the vision studies found that:

- Decline in visual acuity generally accelerates after age 50 (Corso, 1971), slowing the elderly driver's reaction to traffic signals, signs, and other driving-related visual events (Allen, 1985).

- Elders perceive lower levels of light intensity, due to browning of the lens and reduction in the diameter of the pupil. The vision of many elderly people may be

roughly equivalent to what a young person with normal vision would see while wearing dark sunglasses at night (Allen, 1985).

- Glare sensitivity, causing slower recovery from headlights and other reflecting sources, increases between ages 40 and 70 (Fozard, Wolf, Bell, McFarland, & Podolsky, 1977).

- As people age, they are less able to distinguish visual detail (Fozard et al., 1977) and to adapt to changes in light intensity (Kalish, 1982). Both of these handicaps create problems for elderly drivers when entering or exiting poorly-lighted tunnels (Winter, 1985).

- Peripheral vision narrows with increasing age (Kalish, 1982). Drivers with visual field loss in both eyes have twice the rates of accidents and convictions as do drivers with normal visual fields (Johnson & Keltner, 1983).

- Drivers with peripheral-vision impairment have more self-reported accidents, and make more driving errors in simulated driving than normally sighted drivers. In addition, accident risk increases as a function of severity of visual field loss (Szlyk, Severing, & Fishman, 1991).

For all these reasons, elders commonly voluntarily limit or give up night driving and driving under conditions of reduced visibility (Planek, Condon, & Fowler, 1968). In a more recent study, Kosnik, Sekuler, and Kline (1990) questioned elderly people about problems they encountered in performing routine visual tasks and found that most of them admitted their visual deficiencies. Additionally, the results of the study showed that elders who had recently given up driving reported more visual problems than did persons who continued to drive.

Driving, as a complex decision-making process, is also influenced by numerous cognitive and perceptual factors. Many studies have found that the ability to process information slows as people age, making it more difficult for elderly drivers to perceive and react to hazardous driving situations. For example:

- With advancing age, people have greater difficulty in organizing information from multiple sources, due to declining short-term memory (Milone, 1985).

- Quimby and Watts (1981) found that elderly drivers have slower responses to filmed hazards than do mid-age drivers. They attributed this to elderly drivers' having a combination of slower motor functions and impaired perceptual and cognitive skills (i.e., difficulty both in identifying relevant cues and in ignoring irrelevant information).

- With respect to visual attention, Owsley, Ball, Sloane, Roenker and Bruni (1991) measured the three primary mechanisms underlying a restricted useful field of view (UFOV): 1) reduced speed of processing visual information, 2) reduced ability to ignore distracters, and 3) reduced ability to divide attention. They found that drivers with a restricted UFOV had 3 to 4 times the accident risk, and were 15 times more likely to be involved in an intersection accident, than other drivers.

- The likelihood of being judged responsible for an accident is greater for drivers aged 65 and over than for drivers aged 36 to 50 (Cooper, 1990a). Elderly drivers' overrepresentation in at-fault accidents may be due in large part to their making more errors in perception, judgment, decision-making, maneuvering, and reaction to hazards, even though almost all elderly drivers report their driving ability to be average or above average (Cooper, 1990b).

- In assessing driving performance with an interactive computer-video, Schiff and Oldak (1993) found very little overall difference between age groups in response time when reacting to an expected event, but drivers over 65 years of age generally required significantly more time to respond when the event was unexpected.

With advancing age, drivers also tend to have a greater frequency of medical problems that increase their accident risk or influence them to stop driving. Examples are dementia, cardiovascular disease, diabetes, stroke, episodes of loss of consciousness, Parkinson's disease, and ailments that affect flexibility, including arthritis and bursitis. Also, medications prescribed for some health problems can have an adverse effect on driving ability. Recent research on medical impairment includes the following:

- Elderly drivers with dementia are involved in over twice as many crashes and are more often judged to be at fault in accidents than similar drivers without dementia. Additionally, the vast majority of dementia patients involved in accidents

subsequently continue to drive, and over 1/3 of these have at least one more accident (Cooper, Tallman, Tuokko, & Beattie, 1993).

- Stewart, Moore, Marks, May and Hale (1993) found that a brief loss of vision, macular degeneration (deterioration of central vision and color perception), stroke, Parkinsonism, and eye problems caused by declining general health were significantly related to cessation of driving. They also found that irregular heartbeat, cold feet or legs, bursitis, and protein in the urine (a common sign of renal disease) were significantly related to accident involvement for those who continued to drive.

- Elderly drivers perform worse on maneuvers, vehicle handling, safe practices, observing, and driver processing (i.e., gap selection, lane changes, and speed control) compared to younger drivers. This difference in performance is due in large part to elders' loss of joint and skeletal flexibility, particularly in the shoulders, torso, and neck (Shaffron, Ostrow, & McPherson, 1991). Fortunately, many elderly drivers can improve shoulder flexibility and trunk rotation through exercise (Ostrow, Shaffron, & McPherson, 1992).

Accident Countermeasures for Elderly Drivers

Although many elderly drivers have deficiencies that impair their driving, in general they are able to effectively limit their accident risk by driving more slowly and cautiously and by limiting the amount and conditions of their driving. Nevertheless, these deficiencies, if not adequately compensated for, do increase accident liability. This, together with the projected great increase in number of elderly drivers, has led to proposals and implementation of accident countermeasure programs targeting these drivers.

- California initiated a mature driver improvement (MDI) program that allows drivers aged 55 and above to update their driving skills by completing a driver improvement course. A series of annual studies (Berube & Hagge, 1990; Foster, 1991, 1992; Stylos & Janke, 1989) have shown no consistent evidence that MDI participants represent a lower accident risk than do corresponding comparison drivers. However, the MDI program may have reduced the rate of traffic violation convictions of course graduates.

- McKnight, Simone, and Weidman (1982) evaluated a training program for elderly drivers in four states, including California. The program content included such topics as rules of the road, adverse driving conditions and common hazards, elderly driver characteristics and accident experience, and physical conditions that relate to driving performance (e.g., vision, hearing, reaction time, and medication). The program was effective in increasing knowledge of safe driving practices, traffic rules and regulations, hazardous driving situations, and the effects of aging on driving. However, no significant differences in accident and violation rates were found between the training and control groups.

- Kelsey, Janke, Peck, and Ratz (1985) found that clean-record drivers aged 70 or older who were offered a 2-year license extension by mail, thereby avoiding all renewal tests, had significantly fewer accidents than did a comparison group of age peers who were required to go to DMV field offices and take these tests. At the very least, this finding indicated no adverse effect of omitting renewal testing for elderly drivers, given the tests then current. (It should be noted that considerations other than driving performance led to the placing of an age ceiling of 69 on eligibility for license extension [or renewal by mail] in California.)

- Malfetti and Winter (1990) proposed guidelines for a graded license for selected elderly drivers that would be similar to a restricted license, and would be adapted to the driver's mode of living, driving needs, and driving ability. The graded license would allow impaired elders to operate a motor vehicle only under conditions that would not exceed their abilities. This system would identify and treat high-risk drivers without penalizing safe drivers of the same age.

- Improvements in the driving environment, such as better lighting and clearer, more strategically placed signs and signals, would go a long way toward making the roadway safer for elderly drivers (Allen, 1985).

- A Highway Safety Forum sponsored by the National Safety Council in 1989 resulted in recommendations to enhance vehicle controls and displays, improve occupant protection, and perhaps tailor vehicles–"corrective cars"–especially to elders' response characteristics (Rogers, 1989). Also recommended were larger letter sizes on signs and redundant use of traffic signs for drivers with memory impairment (Michael, 1989).

- Gebers and Peck (1992) found that a record of accidents and convictions is associated with a higher risk of subsequent accidents for elderly drivers. The authors recommended that the initiation of license control actions against such drivers be based on fewer driver record incidents than for younger drivers. They also suggested that a point system based on age could serve as an early warning system for identifying drivers who may have physical or mental problems requiring investigation and possible reexamination.

- Janke (1980) found that the accident involvement rate of self-reported medically impaired drivers was significantly higher than that of a random sample of population drivers. Additionally, those medically impaired drivers who reported having lapses of consciousness had an accident involvement rate greater than that of the impaired group as a whole. The results of this study suggest that requiring driver license applicants to report whether they have an existing medical condition has a beneficial traffic-safety effect in identifying those at higher-than-average risk.

- Popkin, Stewart, and Lacey (1983) examined the impact of an initial medical review on the driver records of individuals identified as having medical impairments. The results indicated that persons in most of the impairment groups (cardiovascular diseases, diabetes/endocrine illnesses, vision impairments, and mental problems) were at significantly lower accident risk following the medical review.

It should be noted that the human-factor problems of aging may have, to some extent, technological solutions. Since all drivers, regardless of age, sometimes function well below an optimal level of mental alertness and physical efficiency, it can be expected that technological advances designed to counteract the impairments of aging will make the driving task easier and safer for all drivers (Malfetti, 1985).

A longitudinal study by Evans (1993), which lends support to this, found that fatality rates for male drivers of a given age systematically decline with increasing birth year (e.g., 20-year-olds born in 1970 have lower fatality rates than do 20-year-olds born in 1960). Although the same decline was not found for female drivers, Evans expects this trend to emerge as the percentage of women with driver licenses approaches that for men. He predicted that the fatality rates of a group of presently young male drivers will generally decline as they age and will not show any measurable increase until they

reach about 70 years of age. Evans (1991) expects the risk level of drivers in general to decline in response to positive changes in factors that contribute to traffic safety, such as roadways and vehicle designs, legislation, law enforcement, education, social norms, and medical and emergency care. He also speculated that additional improvements in highway safety will come from behavioral changes regarding hygiene, diet, exercise, and alcohol and tobacco use.

Another study, by Janke (in preparation), provides evidence for a marked decline in fatal/injury accident risk for the oldest (90+) drivers over a period of 10 years. This may be taken as supporting the commonly expressed opinion that "elderly people are not as old as they used to be."

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