An Examination of the Relationship Between Passenger, Driver, and Situational Characteristics in Fatal Crashes

MA Thesis

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Table of Contents

Abstract

Both the youngest and oldest drivers in our society are overrepresented amongst fatal crashes. As such, there is a need for prevention strategies which may reduce crashes in each cohort. Passenger presence is one factor that has been shown to be both an obstruction and an aid in reducing fatal crashes. This study aimed at determining which types of passenger characteristics and driving conditions benefited either teen (16-19 years of age) or elderly drivers (65 years of age or older). The effects of passengers in fatal crashes in the FARS database through 1975-2003 were examined. Results showed that whether a passenger was useful for various age groups differed for driving circumstances both inside and outside of the vehicle. Overall elderly and middle age drivers experienced a protective effect for the presence of a passenger whereas teen drivers experienced an increase risk for unsafe driving behaviours when a passenger was present. An analysis of gender and age of both passenger and driver suggested that the relationship of these variables might be an important consideration. It was also found that certain situational variables such as weather and time of day may moderate the degree to which a passenger is effective. Implications of these findings are discussed.

An Examination of the Relationship Between Passenger, Driver, and Situational Characteristics in Fatal Crashes

Traffic fatalities represent a serious problem in Canada and other modern nations imposing great emotional and financial burdens on the families of those involved. When accounting for driver exposure the distribution of driver crashes appears to be bimodal with young and old drivers experiencing a higher crash risk than middle age drivers (Ryan, Legge, & Rosman, 1998). Most studies examining traffic fatalities have focused on younger drivers, as their over involvement in such crashes is a persistent problem around the globe (Doherty, Andrey, & MacGregor, 1998). Young drivers are the age group most likely to be involved in fatal crashes (Williams, 2003; Doherty, Andrey, & MacGregor, 1998; Chipman, MacGregor, Smiley, & LeeGosselin, 1993), and have the highest driver fatality to population and crash to population ratios (Williams, 2003; Doherty, Andrey, & MacGregor, 1998).

Similarly, in the past several decades older drivers have consistently been over represented in fatal car crashes (Brouwer & Ponds, 1994). Census data (1998) predicts a drastic increase beginning in 2010 in adults above the age of 65. With more elderly able to drive and a growing number of elderly females choosing to drive (Bauer, Adler, Kuskowski, & Rottunda, 2003) it appears that this cohort will be of increasing importance early in the new millennium. Coincidently, a plethora of studies have also emerged examining the role of elderly drivers in fatal crashes and the types of prevention strategies that may be beneficial in reducing this problem.

Several points create concern in regards to fatal crashes in the elderly. Firstly, fatal motor vehicle crashes are the leading cause of accidental death for individuals

ranging from 65 to 74 years of age and the second leading cause of accidental deaths for those over the age of 75 (Lilley, Arie, & Chilvers, 1995). Secondly, elderly drivers are more at risk to be killed or seriously injured than younger individuals in crashes (Evans, 1988; Bédard, Guyatt, Stones and Hirdes 2002; Dellinger, Kresnow, White, & Sehgal, 2004), as age associated deterioration and pathological disease may contribute to hospitalizations, as well as secondary infections (Sklar, Demarest, & McFeeley, 1989). Finally, although older adults are less likely to drive, have a lower license rate (Dellinger, Kresnow, White, & Sehgal, 2004), and drive at low speeds over short distances (Chipman, MacGregor, Smiley, & LeeGosselin, 1992; Williams & Carson,1989), older drivers still experience more fatal crashes per mile driven than their younger cohorts (Lilley, Arie, & Chilvers, 1995).

By 2015, Bédard, Stones, Guyatt, & Hirdes (2001) predict that young drivers/passengers under 30 years of age will represent the same proportion of fatalities as older drivers/passengers above 65 years of age, (27 percent each). As such, 54 percent of all driver and passenger fatalities will involve individuals younger than 30 or older than 65. Given such postulations both young and old drivers were of particular interest in the present study.

A caveat is in order before continuing. The general literature on driving, especially for the elderly, is predominantly worded in negative terms. There exists an overemphasis on selecting those who should not drive as opposed to enabling older drivers (O'Neill, 2000). It is not this study's intention to suggest that neither the elderly nor young are not fit to drive. Indeed it follows that the vast majority of drivers in these age groups drive in a responsible and safe manner. It is this study's intention to provide

information which may aid educational programs and thus prevent future crashes for young and old drivers.

Presence of passengers

Early evidence regarding passengers suggested that for the most part passengers exerted a protective effect on drivers. Vollrath, Meilinger, and Krüger (2002) examined German police data on crashes in order to determine driver responsibility. Results showed that drivers who drove alone were more at risk to be responsible for a crash than those who drove with passengers. The authors noted that the magnitude of this effect was comparable to driving with low alcohol dosages. Results also showed that the strongest protective effect for passengers, with an odds ratio 0.366, occurred when the crash was a result of driver impairment. However, when passengers and driver characteristics are examined in more detail, research has shown that not all drivers are affected by passengers in the same manner and that certain age groups such as teens have a higher crash risk when travelling with passengers (Doherty, Andrey, and MacGregor, 1998).

Williams (2003) explored several crash risks unique to teens including the presence of passengers. Williams claimed that it is a very high risk situation for young drivers (age 16-17) to have passengers present, especially multiple passengers. Of particular concern was that 50% of all fatal crashes for drivers aged 16 and 17 involved passengers under the age of 20 and in which no adult was present in the vehicle. Data from the Nationwide Personal Transportation Survey and System General Estimates from the National Automotive Sampling System has shown that in general passengers have the strongest negative effect on drivers aged 16-17, a strong negative effect for 18-19 year olds, and a small positive protective effect for drivers aged 30-59 (Williams, 2003).

Vollrath, Meilinger, and Krüger (2002) found a similar effect as passengers were shown to have the strongest protective effect for older drivers (above 50) and the least protective factor for drivers between 18 and 24 years of age. Preusser, Ferguson, and Williams (1998) analyzed FARS data between 1990 to 1995 and found passengers to provide a protective effect for individuals above the age of 30, a neutral effect for individuals from 25-29 years of age, and a negative effect for individuals 24 years and younger, especially when the passenger was another teenager and when multiple passengers were present. The authors speculated that these negative effects may have been caused by distractions created by the passengers. In addition, the passengers may have encouraged risk-taking behaviours.

The mechanisms by which passenger presence increases or decreases crash risk are not well understood. Researchers have suggested that "to maximize safe driving it is desirable to enhance the role of passengers in situations where they may play a beneficial role and minimize the potential negative effect they have in others" (Bédard & Meyers, 2004). Additionally researchers have also suggested that studies would benefit from the inclusion of both driver and passenger characteristics in order to examine possible interaction effects (Ulleberg, 2004). Driving consists of various situations, tasks, time periods, and intents which all may interact with the presence of passengers in the vehicle. As such, crash risk of drivers with passengers can be expected to differ with regards to the nature of the passenger and driver relationship (Williams, 2003). One should note that the drastic crash increase for young drivers with passengers does not occur with all types of passengers. Williams noted that studies have confirmed that young males acknowledge that they drive more cautiously when their parents are present as opposed to

driving with younger friends. Studies have also shown that young male drivers drive more cautiously when accompanied by young women as opposed to a young male. Schlag and Schupp (1998) (as cited by Vollrath, Meilinger, & Kruger, 2002) found that female passengers in the front seat provided more of a protective effect than male passengers. Evidence also appears to suggest that passengers may be more beneficial during the day than at night. Doherty, Andrey, and MacGregor (1998) noted a possible interaction with night time and passengers for younger drivers. However, Vollrath, Meilinger, and Krüger (2002) found that passengers were more protective during twilight than darkness/daylight and in freely moving traffic than slow moving. There are a variety of situations which may impact upon whether or not a passenger is effective. Studies would benefit from examining these situations in conjunction with particular driver and passenger characteristics thus gaining an understanding of how each factor contributes to a crash. It is the current study's aim to identify passenger circumstances which may either increase or decrease negative driving behaviours.

Differences between young and elderly drivers: skill versus style

Elander, West, and French (1993) explained driver error in automobile crashes as comprised of a two fold structure, driving skill and driving style. Driving skill "refers to the smoothness and safety of driving in actual traffic, through the use of one's knowledge, abilities and resources, and is generally believed to be strongly influenced by one's learning and experience" (Brouwer & Ponds, 1994). This would include one's ability to keep one's automobile under control. It is believed that through practice and training one should be able to improve one's skills. Driving skill however also requires an internal component such as perceptual ability (i.e., vision) and reaction time, factors

which often may not be improved through practice. The second correlate, driving style, refers to "the way individuals choose to drive or driving habits that have become established over a period of years". Factors included are driving speed or choosing to engage in risky manoeuvres. Driving style is often related to attitudes or beliefs of the driver. Unsafe driving styles according to Elander, West, and French (1993) may arise from two key values. "First, it may be that drivers have different attitudes to driving, including their concern over the possibility of a crash. Second, drivers may differ with regard to their beliefs about what constitutes good and bad driving and about their own level of skill". It is also possible that driving style may encompass both a general component outside of driving (i.e. risk taking behaviour), as well as a learned component specific to driving.

Hutton, Sibley, Harper, and Hunt (2002) have a similar theory which describes two factors that influence driver error, contingency traps and consequence traps. Contingency traps occur when the driver is unable to recognize hazardous cues in the environment or fails to realize that they are hazardous. Thus in this respect contingency traps appear to occur as a result of driver skill. A consequence trap occurs when a driver commits an unsafe behaviour because he/she believes that the probability of a negative outcome is small. Conversely, the consequence trap appears to be linked with one's driving style.

Evidence suggests that young drivers have a negative driving skill and driving style in relation to middle age drivers. For instance, Elander, West, and French (1993) explained how young drivers were more likely to be involved in crashes with low blood alcohol content than older drivers. It is suggested that as alcohol is more likely to impair

non automatized skills and since the younger drivers have only recently learned to drive their driving skill is affected more than that of their older cohorts who have overlearned their driving behaviours (Willaims, 2003, Elander, West, & French, 1993). Young drivers are also more likely to receive driving fines (Lourens, Vissers, & Jessurun, 1999), suggesting that their driving abilities are not yet finely tuned (driving skill) or that they have a disregard for certain driving laws (driving style). On the other hand the elderly appear to mainly lack driving skill.

Zhang, Fraser, Lindsay, Clarke and Mao (1998) examined age specific patterns of behaviour in both young and old drivers. It was concluded that younger drivers were more likely to demonstrate excess risk for (1) risk taking behaviours and conditions, such as alcohol or drug use, speeding, fatigue/falling asleep, and inexperience, (2) young drivers also were involved in more fatal crashes during the summer weekends and nights, and (3) they also exhibited a greater risk for single vehicle collisions and overtaking manoeuvres. Older drivers were noted for (1) medical and physical conditions as well as inattention and inexperience, (2) driver actions, for example, improper turning, failure to yield right-of-way, (3) the occurrence of crashes on weekdays and during the day, and (4) collisions at intersection and vehicle sideswipes.

It should be noted that the lack of driving skill in the elderly is most commonly attributed to psychological or physiological deterioration (i.e., lower reactions times or problems in vision), whereas young drivers lack of skill is attributed to less driving experience. It is important however that one takes into consideration the great variability that exists among older drivers regarding such changes. Variability in driving performance is more pronounced amongst the elderly than any other age cohort.

Possible causes of poor driving style in young drivers

Turner & McClure (2004) suggested that the challenge for public health officials involved constructing strategies which would help reduce risk taking behaviours in drivers. It appears that these risky behaviours largely account for the negative driving style present in young drivers. Popular prevention techniques such as graduated licensing programs have aimed at reducing high risk behaviours and increasing low risk behaviours through such means as the presence of passengers (Lam, 2003). The presence of passengers may reduce or increase various dangerous driving behaviours such as speeding, night time driving errors, and impaired driving as a situation varies.

A sizeable amount of literature examines the role of risk-taking behaviour with respect to crashes. In a review of the literature it was found that risk-taking behaviour did correlate positively with a variety of injuries including crashes (Turner, McClure, & Pirozzo, 2004). Turner and McClure (2004) analyzed drivers who had been in crashes versus controls who were crash free. After controlling for gender, age, marital status, education, employment status, and occupation, results showed that both risk acceptance and driver aggression were associated with a higher crash risk. Surprisingly thrill-seeking was not found to be associated with crashes. The authors suggested that it is possible that thrill seekers have a higher driver skill which in turn allows them more leeway in driving. This also may explain why McKnight and McKnight (2003) did not find a correlation between thrill-seeking behaviour and crashes. However, the presence of risky driving behaviour may outweigh excellent driving skill in certain situations. In a study by Williams and O'Neil (1974) it was found that race car drivers had higher rates of traffic offences than controls.

The evidence suggests that for the most part individuals who engage in risky behaviours do so in such a way that a variety of risky behaviours are displayed. Generally young drivers are viewed as exhibiting a wide range of risky driving behaviour (Ulleberg & Torbjorn, 2003). Older drivers on the other hand are less frequently involved in accidents regarding risky behaviour such as driving awhile intoxicated or in a hurry (Hakamies-Blomqvist, 1993). When involved in fatal crashes it is more common to find young drivers involved in vehicle-object collisions or non collision crashes (Zhang, Fraser, Lindsay, Clarke, & Mao, 1998), such crashes are typical of a more reckless driving style.

Several personality factors are associated with poor driving behaviour many of which appear to be linked with risk-taking behaviours. Thoroughness or driving in a cautious manner and carefully considering the impact of one's decisions reduces crash risk (Elander, West, & French, 1993). Conversely, the presence of antisocial tendencies or a Type A behaviour pattern is associated with higher crash involvement (Miles & Johnson, 2003). The findings on antisocial personality are remarkably consistent in linking the trait to automobile crashes (Elander, West, & French, 1993).

In examining the thought process associated with driving violations Parker, Manstead, Stradling, Reason, and Baxter (1992) suggested that certain steps be taken to reduce a driver's attitudes regarding risky behaviour. However in situations where risky behaviour has become a fixed pattern drivers may require constant suggestions over a period of time. It is the current study's belief that through continuous and repetitive passenger feedback that these fixed risky behaviours and attitudes may be circumvented.

Hutton, Sibley, Harper, and Hunt (2002) described how through non evaluative passenger feedback (i.e., instead of saying "you're driving too close", the passenger would simply describe the drivers' distance from the car in front) driver error for inappropriate following distance, mirror checking, and hazard checking was reduced. The authors also found that speeding was not improved through passenger feedback. However other studies have shown that drivers may slow down when a passenger is present. The authors speculated that this finding occurred because speeding may not always be perceived as negatively as other hazardous behaviour. The study was somewhat limited in that it only used two participants and the observers were aware that they were required to provide feedback. In reality passengers may not be as active in providing feedback towards drivers. This is a common problem in such studies. Nevertheless, the finding suggesting that certain negative behaviours may be reduced through passenger feedback is promising.

Ulleberg (2004) examined what factors were related to a Norwegian adolescent passenger's willingness to speak out in regards to an unsafe driver (their friend). Various passenger characteristics and beliefs such as powerlessness in influencing drivers, acceptance of riding with an unsafe driver, perceived costs of addressing unsafe driver, risk perception, driver's risk behaviour in traffic, and the passengers' ability to speak out were taken into consideration. Results showed that females were more likely than males to speak out regarding dangerous driving when they felt at risk. This may have been partly due to the fact that males viewed more negative costs to addressing the driver, felt less confident in their abilities to influence drivers, were more likely to accept the risk of

unsafe drivers, and perceived less risk of being injured than females. The results also showed that passengers with high anxiety were more likely to speak out.

The relationship between age and crash involvement has been well established. Higher driving speeds are associated with more crash involvement and traffic convictions. In general it is found that young drivers are more at risk to speed than middle age drivers and the elderly are less at risk to speed than middle age drivers (Elander, West, & French, 1993; Chipman, MacGregor, Smiley, & LeeGosselin, 1992). This is what one would expect given that greater confidence in one's driving ability and less concern for other's feedback regarding driving or about the consequences for risky driving contribute to whether or not one speeds (Elander, West, & French, 1993).

Reckless driving by young drivers is not always the primary cause of crashes. McKnight and McKnight (2003) note that in most non-fatal crashes thrill seeking or speeding was not responsible for the crash. The authors found that the overwhelming number of crashes resulted from a failure to employ routine safety practices and failure to recognize the danger in doing so. One needs to keep in mind that these results do not take into account fatal crashes in which it likely that such variables as speeding and drinking may play a more important role.

Eighteen percent of teenagers aged 16-17 who were fatality injured in crashes during 1995-2001 had been drinking (Williams, 2003). This statistic however, is much lower than a few decades ago. Teenage drivers appear to drink and drive less than adults and yet they experience a higher crash risk when they do drink (Keall, Frith, & Patterson, 2004; Williams, 2003). This suggests that alcohol may have more of an effect upon young adults in regards to impairing driving ability. Evaluation of the role of alcohol

may be difficult however as not all drivers involved in fatal crashes are tested for alcohol (Preusser, Ferguson, & Williams, 1998). Assessing the impact of passengers in regards to alcohol may be difficult as passengers may be more likely to have had a drink (Keall, Frith, & Patterson, 2004) and also the environment inside of the car may be more distracting. As such, it is expected that the impaired passenger will not provide help.

Possible causes of poor driving skill in elderly drivers

A variety of age associated changes and disabilities are responsible for the decline in driver skill experienced by the elderly. Cognitive impairment, dementia, visual impairment, prescription drugs, and medical conditions are possible contributing factors to such a decline in skills.

Cognitive impairment is especially a problem because unlike other impairments the individual may lack insight into his/her condition (Ball, Owsley, Stalvey, Roenker, Sloane, & Graves, 1998). As elderly driver crashes often occur at uncontrolled intersections, Zhang, Fraser, Lindsay, Clarke and Mao (1998) have suggested that various driver actions such as disobeying traffic signals, improper turning, and failing to yield right-of-way may be partly a result of cognitive decline in the elderly. "Overall, the weight of evidence supports the view that a generalized ability to switch attention rapidly is an important component of safe driving" (Elander, West, & French, 1993). It is well established in the literature that older drivers experience difficulty in problem solving under certain circumstances. As one ages one's ability to spontaneously switch from one method of problem solving to another becomes more difficult (Brouwer & Ponds, 1994).

Further supporting cognitive decline as a likely cause in crashes, Stutts, Stewart, and Martell (1998) found that drivers who performed in the bottom 10% of certain

cognitive tests were associated with a 50% higher crash involvement. The authors cite failures in information processing, inattention, and distraction as possible causes.

It has been found that the presence of dementia drastically increases the risk of being involved in a car crash (Cooper, Tallman, Tuokko, Beattie, 1993). The authors also found that 80% of the dementia drivers who were in a crash in their study continued to drive for up to three years following the event, suggesting that many of these drivers did not realize or believe that their driving was a problem.

The presence of various psychoactive drugs taken by the elderly may have negative effects upon cognitive functioning (O'Neill, 2000). Analgesics, antihypertensives, and tranquilizers, although not often considered psychoactive, may play a large role in impairment (Wallace, 1997). Polypharmacy, psychoactive medication and Benzodiazepines may also negatively affect one's ability to drive. (O'Neill, 2000). These various drugs may dull one's physical and mental capabilities required for driving.

Indeed the presence of passengers has been shown to be an effective prevention technique in certain circumstances. Passengers have been used as a precautionary measure with individuals who have mild levels of dementia but are still able to drive as well as with certain graduated licensing programs. Not only will the presence of a passenger aid the driver in difficult situations but as O'Neill (2000) notes the co-pilot will provide beneficial information regarding whether the driver's condition has deteriorated and whether driving may need to be restricted or a physician assessment may be required.

Visual impairment is another leading concern regarding elderly driving. Research supports the notion that poor vision will increase the risk of being in a crash (McGwin, Cahpman, & Owsley, 2000). As individuals age they experience a decline in visual

functions such as acuity, visual field and the deterioration of night vision. (Brouwer & Ponds 1994). Drivers with a restricted view of sight are especially at risk to become involved in intersection crashes (Elander, West, & French, 1993).

The elderly may also have a higher risk for a variety of medical disorders. These disorders may affect one's driving ability. A small but growing amount of literature supports the notion that older drivers may experience a decline in driving safety due to age-related disease (O'Neill, 2000). Drivers suffering from strokes, Parkinson's disease, delirium, depression, mild dementia, syncope, sleep apnea, cataracts, diabetes, and various arthritis may all benefit from treatment (O'Neill, 2000).

Partly due to the aforementioned factors, there are several types of crashes which elderly drivers are more at risk to experience. Failure to yield right of way, failure to heed signs, difficulties at right turns and U turns, problems reversing the vehicle and difficulties with right angle collisions (Ryan, Legge, & Rosman, 1998) are troublesome areas for the elderly. Many of these problems may be attributed to vision deterioration (Lilley, Arie, & Chilvers, 1995) as well as problems in attention or perception.

Parker, McDonald, Rabbitt, and Sutcliffe (2000) measured elderly driver error based on driver self reports. The authors describe the elderly as committing violations which are non emotion based, such as disregarding the speed limit late at night (a violation which may be unintentional) as opposed to more emotional violations such as following closely behind another car or giving chase to another vehicle. However the most common reported mistakes by the elderly involved lapses in concentration. Such lapses include misreading signs or going into the wrong lane when approaching an intersection. This fits with the aforementioned cognitive deterioration described.

However, these findings also suggest that the elderly appear to have satisfactory emotional control.

Bédard and Meyers (2004) examined what types of driver error were more common in elderly/young drivers whom drove with either a passenger or alone. Results showed that the presence of passengers was associated with fewer crashes related to travelling off the lane/road, speeding, other careless action, inexperience, following, and driving the wrong way. The presence of passengers was associated with more crashes related to obeying signs/warnings/right of way, turning, and lane changing. The presence of passengers was not associated with crashes related to passing. This research also found that in general the presence of passengers was detrimental for young adults whereas passengers generally presented a beneficial effect for drivers above the age of 65.

The reason why older drivers experience a protective effect from passengers is not clear (Preusser, Ferguson, & Williams, 1998). It may have to do with the characteristics of drivers who drive alone as opposed to driving with passengers or the characteristics of the situations. Or perhaps, the elderly are more attentive when transporting passengers or the passengers may assist older drivers in detecting and responding to hazardous situations (Preusser, Ferguson, & Williams, 1998). It appears that the general benefit of passengers may result from their ability to detect hazardous situations and bringing them to the attention of drivers.

Gender of Driver

In general females are viewed as safer drivers than males at most ages (Stutts & Martell, 1992; Doherty, Andrey, & MacGregor, 1998). Bédard, Guyatt, Stones and

Hirdes (2002) examined the contribution of driver, crash, and vehicle characteristics to fatal injuries sustained by drivers with fixed objects. Results showed that the majority of fatal crashes involved male drivers under the age of thirty. Females had fewer fatal crashes per mile driven and per licensed drivers than males at all ages (Williams, 2003). This may be in part to lower risk-taking behaviours that they display. For instance on average women drive at a slower speed than males (Chipman, MacGregor, Smiley, & LeeGosselin, 1992). The reason for more male crashes may also be attributed to more males driving, for longer distances, and longer time periods (Chipman, MacGregor, Smiley, & LeeGosselin, 1992). As such men have a higher level of exposure to crashes than females.

Laapotti and Keskinen (1998) examined fatal crashes in young Finnish males and females. Results showed that young males were more likely to exhibit risky driving habits as their fatal crashes tended to involve only their own car. Excess speed and alcohol played major roles in contributing to the crashes. In general excess speed and driving under the influence of alcohol were rare for females involved in fatal crashes. Slippery roads were among the best predictors for fatal crashes. This study suggests a lack of proper driving style in males and a lack of driving skill in females. Laapotti and Keskinen (1998) note that the factors which influence poor driving styles in males may be difficult to treat through traditional measures, such as driver education. It is possible that passengers may serve to either increase or decrease such negative driving styles (i.e. speeding infractions) under certain circumstances.

Night and Situational Driving

It has been suggested that whether a passenger is effective in reducing one's crash risk may depend on certain situational factors. For instance researchers have found that time of day/light conditions and weather conditions may moderate the degree to which passengers are a distraction towards a driver (Stutts, Reinfurt, Staplin, & Rodgman, 2001). As such it is important that studies take into consideration such factors when assessing passenger effectiveness.

The time of day for a fatal crash appears to differ among elderly and young drivers (Mortimer & Fell, 1989). Young drivers experience a larger number of crashes during the evening (Williams, 2003; Doherty, Andrey, & MacGregor, 1998). It is unclear as to whether this is a case of young drivers having higher exposure levels during night time or that young drivers have more difficulty driving at night. Williams (2003) cites several reasons night time driving may be more hazardous: (1) the driving task becomes more difficult, (2) newly licensed drivers will have not practiced at night as often as during day, (3) fatigue is more common, and (4) recreational driving, which is viewed as higher risk and sometimes involving alcohol use, is more common at night. In fact fatal crash risk is three times as high during the night for 16 year olds, and four times as high for middle age drivers (Williams 2003).

Research has suggested that elderly drivers attempt to limit their driving to "safe conditions" such as during the day, choosing a familiar route, and avoiding heavy traffic or bad weather (Ball, Owsley, Stalvey, Roenker, Sloane, & Graves, 1998; Kington, Reuben, Rogowski, & Lillard, 1994, Hakamies-Blomqvist, 1993). Elderly with visual impairments or who had been in a crash in the past five years were more likely to exhibit

avoidance than elderly without vision impairments or previous crashes, suggesting that elderly limit their exposure in difficult situations. Conversely young drivers tend to have more crashes during the night (Doherty, Andrey, & MacGregor, 1998). It remains to be seen how time of day might interact with passenger characteristics.

Hypothesis

It has been suggested that because most elderly crashes involve lapses in attention or driving errors and that younger driving crashes involve traffic violations different interventions should be used on each population (Parker, McDonald, Rabbitt, Sutcliffe, 2000). However, if one could find an intervention which would alert drivers of potential dangers and discourage traffic violations, one could potentially combat both of these problems. It appears that the presence of passengers may be able to partly accomplish such a task. The potential of passengers to reduce risky behaviours and alert of possible danger serves both the younger and elderly driving populations.

Three main issues were addressed in the current study, (1) the effects of an adult passenger upon one's driving behaviour, (2) the relationship between driver and passenger characteristics, and (3) the effect of a passenger under different driving conditions. The first issue deals with whether or not an adult passenger in the front seat (co-pilot) reduces the odds of a driver committing in an unsafe driving action. It was thought that passengers would be useful for elderly and middle age drivers but not for young drivers. Specifically, those driver factors pertaining to driving style such as speeding would be committed at a higher rate when a passenger was present with a young driver. The second issue concerned the relationship between driver and passenger in regards to gender and age. It was felt that young males driving with other young males as

passengers would experience a great increase in unsafe driving behaviours related to a negative driving style (i.e., speeding, reckless driving), however this effect would not be as strong for young female drivers. This gender relationship should only be present for young drivers, whereas middle age and older drivers should experience similar passenger effects regardless of passenger type. The third issue was whether or not a passenger was more effective at reducing the occurrence of unsafe driving behaviours during certain situations. For this question time of day, light, surface conditions and weather were specifically examined. It was thought that a passenger's effectiveness would vary based on the above situations, although the direction of the relationship was not specified.

Method

Database

The Fatal Accident Reporting System (FARS) is an extensive database available to the public in which all fatal traffic crashes in the USA have been recorded through police reports. FARS contains data on all fatal traffic crashes within the 50 states, the District of Columbia, and Puerto Rico. The data system was conceived, designed, and developed by the National Center for Statistics and Analysis (NCSA) to assist the traffic safety community in identifying traffic safety problems, developing and implementing vehicle and driver countermeasures, and evaluating motor vehicle safety standards and highway safety initiatives (National Center for Statistics and Analysis Website, 2004). Crash data contains dozens of variables such as, age, gender, drivers/passengers consumption of alcohol, time of day, weather conditions at the time of the crash, vehicle model and type of manoeuvre performed by a driver's vehicle during crash et cetera. The FARS database's greatest advantage is its sheer size and availability, as "few databases

contain sufficient information to perform meaningful analyses and are readily available to most researchers" (Bédard, Guyatt, Stones & Hirdes, 2002). The statistical power of such a database allows us to examine variables which may occur only a fraction of a percentage of the time.

Participants

The current study sought to examine fatal crashes in the FARS database involving both the presence and absence of passengers from 1975 to 2003. As research has shown, certain cohorts, primarily the elderly, tend to benefit more from passengers than other drivers. It has also been suggested that certain passenger types may be more likely to exert a protective effect such as females (Ulleberg, 2004) or adults above the age of 29 (Williams, 2003). Drivers were categorized into age groups of 16-19 (young/teen), 30-60 (middle aged), and 65 plus (old/elderly). Drivers in between these groups were excluded from analysis (20-29, 60-65), in order to assure that the groups were clearly distinguishable from one another. Crashes involving a single vehicle and multiple vehicles were also included.

In an effort to reduce atypical crashes, certain vehicles were excluded from the analysis. Exclusions included motorcycles, mopeds, buses, farm equipment, construction equipment, and other vehicles that could have accounted for abnormal passenger or driving conditions. Only passenger vehicles as categorized by FARS' body type variable (BODY_TYP = 1-11) were used. For a list of the BODY_TYP classes and vehicles please see appendix A. However, as screening criteria was by vehicle and not crash it is possible that some of our crashes involved these vehicles.

It has been suggested that an increased number of passengers may be associated with more alcohol consumption in drivers (Preusser, Ferguson, & Williams, 1998) thus conflicting possible study results. Chen, Baker, Braver, and Li (2000) have suggested that in order to properly analyze passenger effects on fatal accidents one may need to control for alcohol consumption by driver. As such only crashes in which the FARS driver drinking variable (DR_DRINK = 0) had concluded that the driver had not been drinking were used in the analysis. The main dependent variable was whether or not a particular driver factor was present as indicated by a value of 20-60 under the FARS variable DR_CF1, DR_CF2, DR_CF3, or DR_CF4 (see appendix B for all driver factors). These driver factors are indicative of an unsafe driving maneuver and as such were of interest, as passengers may serve to correct such factors.

Single rather than multiple passengers were examined in order to avoid possible interaction effects between multiple passengers (an exception to this rule was for the child/children passenger category explained later). Additionally, multiple passengers may create a social environment inside the car that is far more distracting or influencing than would otherwise be with a single passenger. This is a strength to the current study as many studies which have investigated the effects of passengers have included multiple passengers thus confounding the results. A flow chart regarding the organization of FARS data is outlined in appendix C.

Analysis

Question 1: General effects of an adult passenger

The first set of analyses examined whether having an adult passenger in the front seat of a vehicle would reduce the odds of a driver experiencing a driver related factor

from 20-60 as coded in FARS. It should be noted that driver factors were only examined individually if they occurred in at least .055% of crashes for a particular age group. The analysis used three types of drivers as independent variables. Those with a single passenger 18 years or older in the front seat (adult passenger condition), those with one or more passengers 13 years of age or younger with no passengers above the age of 18 (child/children passenger condition), and finally the reference condition in which no passengers were present. It was assumed that only an adult in the front seat with no distracting passengers would aid the driver. A logistical regression was run to control for time of day and gender of driver. To control for time of day crashes were divided into 4 categories: between midnight and 6am, 6am and noon, noon and 6pm, and 6pm till midnight. Several regressions for each age group were run, the first being on whether any driver factor from 20-60 was present followed by several individual regressions for the most common driver factors for each age group.

Question 2: Relationship between driver and passenger

The second set of analyses examined the relationship between driver and passenger as a function of both age and gender. A logistic regression was used with the independent variable being the combination between genders of both driver and passenger as well as age of passenger. Each driver was coded by gender while each passenger was coded by age (above 30 or less than 25) as well as gender. These ages were chosen as the 25 and below category is a group with high risk behaviours. Only crashes for which either no passenger or a single passenger was present were used. Nine groups based on the above criteria were constructed, four for male drivers with both old and young male and female passengers, four for female drivers with both old and young

male and female passengers, and one reference condition in which a driver could be either male or female with no passenger. Due to the small sample sizes for some of these groups only the four most frequent driver factors at each age group were used for dependent variables.

Question 3: Effectiveness of passenger by situation

For the third and final set of analyses, it was sought to examine whether or not the presence of a passenger would reduce the odds of experiencing any driver factor from 20-60 under certain environmental conditions outside of the vehicle. Only the overall driver factors from 20-60 were examined as some driver factors were infrequent and thus reduced statistical power. For this analysis the three age groups were split up and compared the presence of an adult passenger in the front seat during various times of the day, weather conditions, surface conditions, and lighting conditions. Finally, it was examined whether or not having an adult passenger present was related to making an avoidant manoeuvre or being involved in a crash at a junction. For all of these analyses logistical regressions were run to control for time of day (except when time of day was the direct variable of study) and gender of driver. Appendix D lists all of these variables and which levels were used.

Results

After eliminating drivers who did not drive a passenger vehicle and/or had been drinking alcohol, data examining 1,245,729 individuals or 706,062 drivers were available for analysis. The remaining drivers were separated into three age groups: teen drivers (16-19 years of age) n = 114346, middle age drivers (30-60 years of age) n = 245432, and older drivers (aged 65 to 98 years of age) n = 102577.

Descriptive Statistics:

Table 1 shows a general trend for male drivers to be more likely to be involved in a fatal crash. This trend was present in each of the three age groups, with the gender split most prevalent in the younger group. Driver factors were not always coded for each driver, table 2 provides data on the percentage of drivers for each age category who had at least one driver factor coded.

Table 3 (weather condition), table 4 (time of day), table 5 (lighting condition), and table 6 (surface condition) all display situational factors of the fatal crashes. It is possible that the usefulness of passengers may depend on these situational factors. For weather the three most prevalent weather conditions where chosen: clear, rainy, and snowy. All three groups experienced the vast majority of crashes in clear conditions (over 80% for all groups). Time of day was categorized as between midnight and 6am, 6am-noon, noon-6pm, and 6pm-midnight. Results showed that age groups varied largely by time of crash. Teen drivers experienced over 65% of crashes between noon and midnight, while older drivers experienced almost all crashes (over 80%) between 6am and 6pm. Similar results were found when analyzing lighting conditions. While the majority of crashes in each group were during daylight older drivers were still much more likely to experience crashes during daylight (80.9%) with younger drivers only experiencing 46.7% of crashes during daylight. For road surface conditions the age groups showed a similar pattern of crashes with all ages experiencing most crashes (approximately 80%) during dry surface conditions.

The first section of the analyses examined the effects of having an adult, child/children, or no passenger present in relation to experiencing driver factors 20-60 as

coded in FARS. Tables 7, through 9 show the most common driver factors over the three age groups along with a comparison of drivers at all ages.

Figure 1 displays the most common driver factors by age group. It should be noted that data for failure to keep in proper lane or running off road (28) have only been collected since 1982. It was found that failing to keep in the proper lane (28) and driving too fast for conditions or in excess of posted speed limit (44) were the most common factors recorded averaging across all ages, with rates of 17.73% and 17.51% per crash respectively.

When examining each group separately a few interesting findings emerged. Younger drivers committed both "failure to keep in proper lane or running off road" (28) and "driving too fast for conditions or in excess of posted speed limit" (44) at a higher rate than the general population (respectively 31.22% & 24.87%). To a lesser extent younger drivers also operated the vehicle in an erratic, recklessly, carelessly or in a negligent manner or operated at erratic or suddenly changing speeds (36) more often (9.95%) than the general population (6.51%). Driver related factor 38 (failure to yield right of way) was reported in 9.32% for young drivers as opposed to 11.45% for all drivers.

Middle aged drivers (30-60) showed a similar pattern of driver factors in relation to all drivers. This may be in part due to the fact that the middle age driver group comprises approximately 30% of all drivers, thus a large overlap exists. Table 8 shows the general finding that most driver factors were slightly less likely to be present for a middle aged driver.

Elderly drivers 65 years or older showed a much higher rate of failure to yield right of way (38) at 28.36% than the general population (11.45%). Elderly drivers also had somewhat higher rates of failure to obey traffic actual signs, traffic control devices or traffic officers, failure to observe safety zone traffic laws (39) at 10.79% and making an improper turn (48) at 3.34% than drivers in general. The elderly were much less likely to exhibit driving too fast for conditions or in excess of posted speed limit (44) at 6.22%.

Question 1: General Effects of an Adult Passenger

The analysis began by assessing the relationship of an adult passenger, child/children passenger, and no passenger situation in relation to a driver's odds of a reported driver factor.

Figure 2 shows the relationship of having either an adult or child/children passenger present in reference to having no passenger present for all 3 age groups across the most common driver factors. Table 10 shows this relationship for teen drivers (age 16-19). Results showed that overall across all driver factors having an adult passenger present increased the risk for having a driver factor (OR = 1.170, $p < .01$). Results showed that an adult passenger was only helpful to young drivers for reducing driver factor 51, driving on the wrong side of the road, (OR = 0.541, $p < .01$). An adult passenger seemed to be especially hazardous for increasing one's risk of experiencing the following driver factors: 58 (overcorrecting) (OR = 1.728, $p < .01$), 48 (making an improper turn) (OR = 1.856, $p < .01$), 52 (operator inexperience) (OR = 1.728, $p < .01$), 27 (improper or erratic lane changing) (OR = 1.788, $p < .01$), and 24 (operating without required equipment) (OR = 2.006, $p < .01$). The results for having a child/children passenger present are also displayed in the table but should be interpreted with caution as

there was a much smaller sample size than for an adult passenger which may partly explain the result of fewer significant findings. Except for a reduction in improper turns (48) (OR = 0.650, p <.05), having a child/children passenger did not provide any benefits.

Table 11 displays an odds ratio analysis for adult and child/children passengers in relation to having no passenger present in middle aged drivers aged 30-64. Unlike young drivers, middle age drivers with child/children passengers did not have as low of a sample size. Overall having an adult passenger present reduced the odds of experiencing a driver factor (OR = 0.869, p <.01). Having an adult passenger present was associated with a lower risk of driving on wrong side of road (51) (OR = 0.456, p <.01), operating the vehicle in a reckless manner (36) (OR = 0.850, p <.01), failing to keep in the proper lane (28) (OR = 0.858, p <.01), driving too fast (44) (OR = 0.787, p <.01), and following improperly (26) (OR = 0.721, p <.01). An adult passenger increased the risk for failing to yield right of way (38) (OR = 1.263, p < .01), failure to obey traffic control devices or laws (39) (OR = 1.176, p < .01), making an improper turn (48) (OR = 1.349, p <.01), and especially over correcting (58) (OR = 1.984, p <.01). Results for a child/children passenger are also displayed in the table.

Table 12 outlines the relationship of adult or child/children passenger in relation to no passengers for elderly drivers (65 or above). Given the small sample size of child/children passengers, this result section focuses on the effects of having an adult passenger present. Overall an adult passenger was found to reduce the overall risk of experiencing a driver factor (OR = 0.894, p <.01). It was found that an adult passenger was most beneficial at reducing the odds of driving on the wrong side of the road (51) (OR = 0.433, p <.01). Adult passengers also aided for failure to keep in proper lane (28)

(OR = 0.742, p <.01), driving too fast (44) (OR = 0.789, p <.01), operating the vehicle in an erratic manner (36) (OR = 0.872, p <.01), following improperly (26) (OR = 0.774, p <.01), passing with insufficient distance (35) (OR = 0.687, p <.01), and making an improper entry to or exit from trafficway (30) (OR = 0.809, p <.05). Adult passengers increased the risk for failure to yield right of way (38) (OR = 1.263, p <.01), making an improper turn (48) (OR = 1.349, p <.01), failure to obey traffic control devices or laws (39) (OR = 1.176, p <.01), and especially overcorrecting (58) (OR = 2.035, p <.01).

Question 2: Relationship Between Passenger and Driver Characteristics

The second set of analyses examined the relationship between gender of driver in relation to age and gender of passenger. Figure 3 displays this relationship for having any driver factor. Tables 13-17 examine this relationship in young drivers for all driver factors as well as driving too fast (44), failure to keep in proper lane (28), operating vehicle in an erratic manner (36), and failure to yield right of way (38). Table 13 displays the general pattern of young male drivers to be especially at risk for a driver factor when driving with other young males. Results also showed that for the first three driver factors driving too fast (44), failure to keep in proper lane (28), and operating vehicle in an erratic manner (36), older females typically provided the strongest protective effect while young males (especially when driving with another young male) provided an increased risk for a driver factor. The only exception to this rule was for the fourth driver factor 38 (failing to yield the right of way), in which an opposite pattern of results was found.

Figure 4 examines the age/gender relationship for any driver factor for middle age drivers. Table 18 shows a general trend for both young and old male passengers to

increase one's risk of having a reported driver factor. Results also showed that for failure to keep in proper lane (28) neither the type of passenger nor did type of driver appear to have a strong effect. For driving too fast (44) and operating the vehicle in an erratic manner (36) a male passenger appeared to increase one's risk of experiencing such a factor. Female drivers were more at risk for experiencing failure to yield right of way (38) with type of passenger appearing to have little effect.

Figure 5 examines gender and age relationships for the oldest drivers in regards to experiencing a driver factor. Tables 23-27 examine failure to keep in proper lane (28), driving too fast (44), failure to yield right of way (38), and failure to obey traffic control devices or laws (39). Table 23 shows a general trend for females to be more likely to have a reported driver factor. Results showed that for the most part the type of passenger had little effect upon one's risk for a driver factor across the four individual driver factors.

Question 3: Situational Effects for Passengers

Tables 28- 31 examines the final question, that is under what conditions is having a passenger present (above 18 in front seat) most helpful. Table 28 shows the odds of experiencing any driver factor in relation to clear weather, as compared to rain and snow. Results in general supported that passengers are just as effective in the rain as in clear conditions. It was found that older drivers may benefit more from passengers in rainy than clear conditions (OR = 0.816, $p < .01$). In the snow passengers tended to increase one's risk for having a driver factor in relation to clear weather except for older drivers in which there was no difference.

Table 29 shows the odds of having a driver factor present in relation to time of day. For the analysis midnight to 6am was used as the reference group. Results showed that in general a passenger was most effective during the hours of 6pm till midnight (OR = 0.712, p <.01). One exception to this finding was that older drivers did not show a large decreased risk. An interesting finding was that passengers were not nearly as effective for older drivers during day hours as opposed to night, with 6am till noon OR of 1.983 (p <.01) and noon till 6pm OR of 1.992 (p <.01). Middle aged and younger drivers also had a similar finding for 6am till noon although this finding was not as pronounced.

Table 30 further examines time of day by examining lighting condition. For this question daylight was used as the reference group. Results showed that a passenger was more effective for all drivers during dark conditions (OR = 0.753, p <.01) and dark but lighted conditions (OR = 0.690, p <.01). All conditions showed a significant decrease in relation to daylight except for dawn/dusk in which there was no difference for teen and middle aged drivers.

In order to examine weather in more detail, surface condition during time of accident was also assessed. Table 31 shows that in comparison to dry conditions on average passengers were not as useful at reducing driver factors during snowy or icy conditions. However, when older drivers were examined separately it was found that passengers were just as effective in snowy and icy conditions, and under wet conditions passengers were slightly more effective (OR = 0.868, p < .01).

The relationship between having an adult passenger present and one's likelihood to attempt an avoidant maneuver was assessed as well as one's risk of being involved in a crash at a junction. Table 32 and 33 illustrate whether the driver was able to attempt an

avoidant manoeuvre and whether a crash was present at a junction for each of the three age groups. Eighteen percent of drivers in general attempted an avoidant manoeuvre and 35.4% of drivers had crashes at junctions. It was found that 9.9% of elderly drivers attempted an avoidant manoeuvre and 50.7% were involved in crashes at a junction. Teen drivers showed an opposite pattern with 23.5% of drivers attempting an avoidant manoeuvre and involved 30.5% in a crash at a junction.

Finally as shown in table 34 drivers in general, had greater odds of making an avoidant maneuver when a passenger was present (OR = 1.050, $p < .01$). This was especially salient for older drivers. Results also show that middle aged and older drivers have a higher risk of being involved in a junction crash in the presence of a passenger (OR = 1.120 and 1.247, $p < .01$ respectively).

Discussion

Initial descriptive statistics appeared to be consistent with previous literature. Even after eliminating crashes in which the driver had been drinking (a condition more likely to be found in males) males regardless of age were at greater odds of being involved in a fatal crash (i.e. Stutts & Martell, 1992; Doherty, Andrey, & MacGregor, 1998; Laapotti & Keskinen, 1998; Bédard, Guyatt, Stones and Hirdes, 2002). This finding may be due to males driving more than females and therefore having a higher crash exposure rate. An alternative explanation is that males are overrepresented in fatal crashes due to their propensity to over-commit certain dangerous traffic manoeuvres, a finding which will be discussed later.

Results were consistent with previous literature in that teen and elderly drivers differed in which driver factors were most frequently reported. Younger drivers were

more at risk for having driver related factors related to a negative driving style such as speeding, reckless driving or failing to keep in the proper lane. On the other hand, older drivers tended to be involved in crashes which were based on driver ability and occurred under more complex conditions such as failing to yield, obeying traffic control devices, or making an improper entry from a trafficway. Perhaps older drivers are more at risk for these factors due to failures in information processing, inattention, and distraction (Stutts, Stewart, & Martell, 1998). Again, the above findings are consistent with previous studies (Ulleberg & Torbjorn, 2003; Ryan, Legge, & Rosman, 1998; Hakamies-Blomqvist, 1993).

Another interesting finding was that both older and younger drivers were at greater risk of having a reported driver related factor than middle aged drivers. This is an important note as for the purposes of the current study having a driver factor present may imply some form of responsibility for the crash. Given that both older and younger drivers tend to be both over represented in fatal car crashes, it seems plausible that they may be more at fault for causing crashes. This interpretation should be made with caution as the nature of some crashes for young and old drivers differs (Clark, & Jones, 1998). Younger drivers are more likely to kill other vehicle occupants whereas older drivers are more likely to fatally injure themselves. Based on such findings Dellinger, Kresno, White, and Sehgal (2004) concluded that "findings suggest that older drivers make relatively small contributions to crash-related morbidity and mortality; moreover, their contributions are generally a result of injuries to self rather than to others". It is also possible that an exposure bias may be present as older and younger drivers may drive more often within city limits where exposure to crashes may be greater than middle age

drivers who often drive on safer highways. However another recent study by Williams and Shabanova (2003) concluded that both young and old drivers are more likely to be responsible for a death in a fatal crash than a middle age driver. It appears that this responsibility issue needs to be further addressed in the future.

General effects of an adult passenger

In regards to the first question of whether a single passenger 18 years and above in the front seat would reduce the risk for having a driver factor, overall young drivers experienced an increase risk whereas middle age and older drivers had a lower risk of experiencing a driver factor. In line with the original hypothesis young passengers did not provide any benefit and increased the risk for young drivers to experience a driver factor. Again this finding is in line with previous research (Preusser, Ferguson, & Williams, 1998; Aldridge, Himmler, Aultman-Hall, & Stamatiadis, 1999; Vollrath, Meilinger, & Krüger, 2002).

For the most part having a child passenger present was associated with slightly lower benefits than an adult passenger. In particular, child passengers did not have much of an effect for driving on the wrong side of the road, a factor for which adult passengers were very beneficial. A similar finding was that a driver with a child passenger was less likely to overcorrect than an adult passenger. It is possible that younger passengers may provide less feedback than an adult passenger. It is also conceivable that middle age drivers with young passengers may naturally differ from those with no young passengers. For instance, the majority of individuals with young children are likely parents. Parents may drive in a different manner in general or while driving with their children than an adult with no children.

Younger drivers did not experience much benefit from the presence of a passenger except for reducing the risk of driving on the wrong side of the road, a factor which was greatly reduced in all three age groups. Passengers may have been useful under such a condition because of two main factors. First driving on the wrong side of the road often occurs without the driver's knowledge, therefore a passenger is able to bring the mistake to the driver's attention. Secondly it is unlikely that once a driver begins to drive on the wrong side of the road a crash will occur immediately, this allows the passenger sufficient time to warn the driver of his/her mistake. It is possible that the time component is especially important. Younger drivers experienced a large increase in a variety of driving factors when a single passenger was present such as improper turns and erratic lane changing suggesting both the ability to exert a negative driving style and ability. It may also be that certain passengers are serving to increase young drivers' negative driving style, a finding that will be discussed later.

Another possible explanation is that younger drivers are more easily distracted by passengers. Research has show that drivers under 20 years of age are generally 50% more likely to be distracted at the time of a crash (Stutts, Reinfurt, Staplin, & Rodgman, 2001). The authors also note that younger drivers appeared to be more likely to be distracted by factors inside the car whereas older drivers suffered from distractions outside of the car (i.e. other vehicles, signs or animals). These findings are consistent with the results on passenger presence in middle age and older drivers.

The analyses on middle age drivers found that driver factors typical occurring at intersections were increased by the presence of a passenger. These findings support the theory that passengers may become a distraction under difficult situations or when there

is little time for the driver to react. Older drivers benefited from passengers from a variety of situations such as speeding, erratic operating, or following and passing problems. Passengers appeared to slightly increase behaviours associated with crashes at intersections, such as improper turning or failing to yield, suggesting that drivers may become distracted from passengers at intersections. These findings are similar to those of Bédard and Meyers (2004) in which passengers were not as effective for complex driver factors such as those outlined above. It appears that perhaps the defining feature of whether a passenger is beneficial for a driver may hinge upon the complexity of the task. A task that is fairly simple and can be easily corrected such as driving the wrong way is easily noticed by the passenger and remedied by the driver. A more complex task such as yielding may not be so readily noticed by a passenger and even if the driver is alerted they may not have sufficient time or the ability to properly rectify the driving error.

All drivers experienced an increased risk for overcorrecting when a passenger was present. While this may appear worrisome it may be that in fact this overcorrecting behaviour may be viewed positively rather than as an unsafe driving behaviour. It is possible that the passenger is alerting the driver of a danger or driver error. Nevertheless, the driver attempts to overcorrect for their mistake but the crash still occurs. In such a case the passenger may be simply changing the driver factor responsible for the crash. Overcorrecting may be one driver factor for which an increased risk is not necessarily a problem.

Relationship between passenger and drivers characteristics

In regards to the relationship between gender of driver and age/gender of passenger some interesting results emerged. As expected it was found that male

passengers were not as useful in reducing driving factors as female passengers (Ulleberg, 2004; Schlag and Schupp, 1998). This was particularly salient for young drivers. Driving too fast and reckless driving were severely elevated for young males driving with other young males. This is especially worrisome given that only sober drivers were included. Additionally, female passengers appeared to reduce the risk of such behaviours more than male passengers, this gender difference was apparent in both young and old passengers. Surprisingly this finding occurred not only for young drivers but middle age drivers as well. While studies have found that young males are less likely then young females to speak up in dangerous situations it is possible that the same is true for older passengers as well. McKnight and McKnight (2003) and Elander, West, and French (1993) have suggested that the need to recognize unsafe driving behaviours as well as considering the impact of one's decisions are both important criteria for safe driving. An alternative hypothesis is that young and middle age drivers may be naturally more aware of their driving when in the presence of females or older passengers. This finding deserves more attention in the future to help understand the nature of this effect.

The current study's hypothesis was correct in that gender and age of passengers seemed to play less of a role for older/elderly drivers. Older drivers have generally been viewed as exhibiting a cautious driving style which may in part explain why type of passenger did not have an effect, as speeding in older drivers is likely attributed to driver ability whereas speeding in younger and middle age drivers may reflect driving style. It is also possible that passenger/driver relationship may be based upon more complicated aspects such as familiarity with driver. Regan and Mitsopoulos (2001) recently found that young passengers (16-24) who were friends of a driver were most likely to provide a

negative influence upon the driver. This study parallels that of Williams (2003) who found that parental passengers were more likely to reduce negative driving behaviour. Future research examining specific passenger feedback through experimental designs may help to further understand such results.

An unexpected finding regarding driver/passenger relationships concerns situations in which the driver failed to yield. Results often showed that young males reduced the risked for failing to yield while older females increased the risk (a pattern fairly opposite to result findings). These results should be interpreted with caution. In regards to driver factor coding a driver can only be coded with 3-4 driver factors for a fatal crash. The plausible that in certain cases a driver may have made failed to yield as well as committed three to four other driver factors which were coded ahead of the failure to yield. For instance a young male driving with a young male passenger may be speeding, driving recklessly, failing to keep in the proper lane, and finally failing to yield, but it is possible that only the first three were coded leaving out the failure to yield from the report. If this is the case it could explain why younger drivers with male passengers experienced less of a risk for failing to yield than with female passengers.

Situational effects for passengers

Finally the ability of passengers to reduce driver factors across a variety of driving conditions was examined. Results appeared to indicate that passengers are more effective for a variety of difficult conditions, although there does appear to be some limits as to how difficult a condition can be. It was found that passengers were slightly more effective in rainy conditions, during the nighttime, and in dark conditions. However, in snow and icy conditions passengers were less effective. This suggests that there may

exist an optimum driving difficulty for passengers to become beneficial. It is possible that under difficult conditions a passenger may be able to pick up on dangers the driver may have misperceived. It is also possible that passengers may be more alert under difficult situations. These findings expand upon those of Hing, Stamatiadis, and Aultman-Hall (2003) in which it was found that during night time conditions older drivers benefited more from passengers. The authors suggested that while passengers may be more useful in difficult circumstances there is a point where a situation becomes so difficult that having a passenger present will increase one's risk of being involved in a crash. Interestingly, in the current study, passengers were just as effective for older drivers in snowy and icy conditions in reference to clear conditions suggesting that passengers may be more beneficial to older drivers across a variety of situations, whereas older and younger drivers did experience an increase risk as hypothesized by of Hing, Stamatiadis, and Aultman-Hall (2003). This falls in line with the current study's findings which found that older drivers experienced more reductions in common driver factors when a passenger was present than any other age group.

There is also an alternative interpretation to these findings on passenger effectiveness by situation. Studies on older drivers have shown that older drivers may attempt to limit their driving to certain conditions such as during the day or during bad weather (Ball, Owsley, Stalvey, Roenker, Sloane, & Graves, 1998; Kington, Reuben, Rogowski, & Lillard, 1994, Hakamies-Blomqvist, 1993). As such it is possible that those who drive at night and during poor weather conditions are more skilled on average than drivers who limit their driving to daylight and good weather. Future studies will need to account for such a possible selection bias.

Lastly, it was found that older drivers were the most likely benefit from passengers in regards to attempting to avoid a crash. It appeared that whether a driver attempted to avoid an accident was inversely related to driver age. Younger drivers were twice as likely as older drivers to have attempted to avoid a crash when a passenger was present. This finding may result from a difference in driving styles between older and younger drivers. For instance younger drivers were more at risk for committing driving errors which were related to a negative driving style such as speeding, reckless driving or failing to keep in the proper lane. On the other hand, older drivers tended to be involved in crashes which are based more on driver ability tied to such factors as cognitive decline (Zhang, Fraser, Lindsay, & Clarke and Mao, 1998) or inattention (Ball, Owsley, Stalvey, Roenker, Sloane, & Graves, 1998) which may have resulted in a disproportionate amount of crashes at intersections such as failing to yield, obeying traffic control devices, or making an improper entry from a trafficway. Stutts, Reinfurt, Staplin, and Rodgman, (2001) found a disproportionate number of drivers were being distracted on multilane roadways or other junctions. It may be that certain crashes involving speeding or reckless behaviour as opposed to failing to yield may be easier to correct (or notice) as opposed to more complex accidents which may occur at intersections or across multilane roadways. It also might be expected that drivers with slower reaction times (older drivers) would be more at risk to be involved in a fatal crash, as reaction time allows for more time to initiate a manoeuvre to avoid a crash. Results do appear to lend credibility to this theory. However, Elander, West, and French (1993) concluded that the literature does not support this assumption.

Limitations

While the current results are promising there are several limitations regarding study methodology and generalizability that should be discussed. Though the study examined the relationship between various age groups, passenger characteristics, and situational variables, it did not employ any statistical techniques to assess interaction. As such, it is difficult to state how these variables interact. Although the discussion has attempted to make some assumptions based on initial statistics future studies would benefit from devising methods to assess such interactions. In addition, the current study had a very large sample size and statistical power. As a result several findings were statistically significant but perhaps not clinically significant. Confidence intervals were included to help the reader judge the practical significance of results. One needs to exercise some discretion when deciding how important an effect is. It is difficult to state exactly how large an odds ratio must be to represent significant practical increases for risk assessment in the study conducted here. Nevertheless, the findings on passenger presence for driving on the wrong side of the road, overcorrecting, under dark conditions, and the relationship between young males and driver factors approached or excluded 2, suggesting effect sizes worthy of consideration.

Generalizing from these results may be somewhat difficult. First, only fatal crashes were used in the analysis. Fatal crashes are a rare occurrence and not representative of an everyday driving situation. It is possible that passengers may play a different role under more ordinary conditions. Additionally, the analysis used vehicles in both single and multiple crashes. Previous studies have employed single vehicle crashes to eliminate possible confounding variables and ensuring that each vehicle is

independent. The current study was unable to use such a method as to do so would eliminate various crashes such as sideswipes. While the majority of vehicles in the current study came from crashes involving 1 or 2 vehicles there were some crashes involving over 10 vehicles (although very rarely). Finally there have been a number of assumptions made regarding how a passenger interacts with a driver. One can only hypothesize such relationships as the FARS database includes only basic crash statistics. How an actual passenger behaves inside a vehicle will need to be studied in further detail. Unfortunately the FARS database can only provide information regarding crashes. One can argue that such a relationship needs to be viewed within a context where crashes did not occur or were effectively prevented through passenger feedback. Furthermore, it remains to be seen exactly how a passenger interacts with a driver. A passenger driving with a young male as opposed to elderly female will most likely interact in a different manner. Actions which benefit an older driver may not necessarily benefit a younger driver and vice versa.

One needs to keep in mind that this research is observational in nature and thus suffers from typical limitations inherent in such studies regarding causality. Future studies employing such methods as experimental controls will aid in determining the specific factors which may influence passenger effectiveness and how the possible pitfalls of passengers (primarily with regards to young drivers) may be adverted.

Conclusions

Results suggest that passengers are beneficial across a variety of situations both inside (driving errors) and outside (driving conditions) of the vehicle. Conversely, passengers may be detrimental under certain circumstances. Results suggesting the

negative impact of young males driving with other young males are especially concerning.

Transportation authorities have suggested numerous ways to reduce crashes involving older drivers. Traffic calming measures and larger road sings/letters may aid older drivers. Reducing the amount of driving in the dark may serve to decrease crashes due to vision problems. It is also suggested that younger relatives aid elderly drivers in education efforts. Ball, Owsley, Stalvey, Roenker, Sloane, and Graves (1998) suggest that self regulation (avoiding difficult situations through one's own free will) may lead to a reduction of crashes. Researchers have espoused the benefits of intelligent driving technology where certain information is presented to the driver only when it is required (Chira-Chavala & Yoo, 1994). For instance, a driver approaching a stop sign may receive a warning to slow down if he or she is proceeding at a speed which is faster than usual. However, such technological aids may be too expensive or restrictive on personal autonomy. In many respects the presence of passengers may provide the same benefits as intelligent driving or various traffic calming measures. In such situations passengers may serve to alert the driver of any objects he/she may have not noticed.

Crash prevention for young drivers has largely taken place in a formal classroom setting. While various educational programs exist few have addressed the issue of the driving with passengers, or for that matter being a responsible/effective passenger. However before such matters may be properly address it is important that researchers understand what factors specifically allow for a passenger to be helpful as opposed to a hindrance. Future studies will need to examine the relationship between passengers in detail in order to decide how this problem may be ameliorated.

While this study has shed some important light on how passengers may affect drivers under various conditions a variety of questions remain. Future research needs to be done in order to address how multiple passengers affect a driver as opposed to a single passenger as well as how important familiarity is in the relationship between driver and passenger. With the emergence of computer simulations there exist new methods by which such situations may be manipulated and tested. These new methods will also allow for situations which are more representative of everyday driving circumstances. Studies will need to find a balance in order to control for passenger variables and feedback but still maintain adequate experimental realism. Future controlled studies will aid in determining what factors are most important between the driver and passenger dyad.

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Table 1

Gender of Drivers.

Gender	All Drivers	Teen Drivers	Middle Aged Drivers	Older Drivers
Male	63.8% N = 450481	68.3% N = 78049	61.1% N = 155376	63.8% N = 65481
Female	34.9% N = 246624	31.7% N = 36292	38.9% N = 99043	36.2% N = 37094

* Due to missing data percentages do not add up to 100% for all drivers.

Table 2

Driver factor reported/coded per vehicle

Driver Factor Reported?	All Drivers	Teen Drivers	Middle Aged Drivers	Older Drivers
YES	50.5% N = 356646	64.2% N = 73376	40.2% N = 102219	63.7% N = 65310
NO	48.9% N = 345275	35.8% N = 40968	59.8% N = 152213	36.3% N = 37264

* Due to missing data percentages do not add up to 100% for all drivers.

Table 3

Type of weather during crash by vehicle

Weather Condition	All Drivers	Teen Drivers	Middle Aged Drivers	Older Drivers
Clear	83.8% N = 591395	85.3% N = 97584	83.0% N = 211148	86.5% N = 88678
Rain	10.9% N = 76853	10.5% N = 12003	11.6% N = 29502	9.8% N = 10022
Snow	2.2% N = 15379	1.6% N = 1858	2.6% N = 6667	1.9% N = 1949

* Due to missing data or other weather conditions percentages do not add up to 100% for drivers.

Table 4

Time of day of crash by vehicle

Time of Day	All Drivers	Teen Drivers	Middle Aged Drivers	Older Drivers
Midnight-6am	14.4% N = 101604	18.2% N = 20815	12.5% N = 31786	2.6% N = 2665
6am-noon	20.7% N = 145825	14.9% N = 17025	22.2% N = 56366	30.4% N = 31148
Noon-6pm	34.4% N = 242799	29.8% N = 34039	35.1% N = 89206	50.8% N = 52123
6pm-Midnight	29.7% N = 209627	36.8% N = 42128	30.0% N = 76364	16.0% N = 16392

Table 5

Lighting conditions during crash by vehicle

Lighting Conditions	All Drivers	Teen Drivers	Middle Aged Drivers	Older Drivers
Daylight	54.9% N = 387970	46.5% N = 53205	56.2% N = 143094	80.7% N = 82826
Dark	24.6% N = 173614	32.4% N = 37012	23.8% N = 60670	9.4% N = 9607
Dark but lighted	15.4% N =108754	16.8% N = 19169	15.0% N = 38179	6.8% N = 6932
Dawn/Dust	4.1% N = 29062	4.0% N = 4525	4.6% N = 11588	2.9% N = 3019

* Due to missing data or other lighting conditions percentages do not add up to 100% for drivers.

Table 6

Surface conditions during crash by vehicle

Surface Conditions	All Drivers	Teen Drivers	Middle Aged Drivers	Older Drivers
Dry	78.6% N = 554951	79.8% N = 91222	77.7% N = 197575	81.7% N = 83793
Wet	16.1% N = 113895	16.1% N = 18384	16.9% N = 43078	14.7% N = 15082
Snow	2.1% N = 14528	1.7% N = 1921	2.4% N = 6191	1.7% N = 1721
Ice	2.1% N = 14899	1.9% N = 2123	2.5% N = 6376	1.5% N = 1542

* Due to missing data or other surface conditions percentages do not add up to 100% for drivers.

Table 7

Driver factors present for teen drivers (16-19).

Driver Factor	Percentage from total crashes Teens	Percentage from total crashes General population
Driving too Fast... (44)	31.22% n = 35700	17.51% n = 122924
Failure to keep in proper lane (28)	24.87% n = 28441	17.73% n = 124482
Operating the Vehicle in an Erratic manner... (36)	9.95% n = 11378	6.51% n = 45707
Failure to Yield Right of Way (38)	9.32% n = 10662	11.45% n = 80402
Failure to obey traffic control devices or laws... (39)	5.86% n = 6705	5.79% n = 40369
Driving on Wrong Side of Road (51)	4.53% n = 5185	3.39% n = 23768
Over Correcting (58)	1.76% n = 2015	1.05% n = 7361
Operator Inexperience (52)	1.61% n = 1840	0.45% n = 3183
Making Improper Turn (48)	1.68% n = 1886	1.81% n = 12728
Passing with insufficient Distance... (35)	1.61% n = 1842	0.94% n = 6571
Passing where Prohibited (33)	0.81% n = 924	0.40% n = 2815
Improper or Erratic Lane Changing (27)	0.70% n = 797	0.64% n = 4511
Operating without Required Equipment (24)	0.60% n = 683	0.45% n = 3129
Following Improperly (26)	0.59% n = 680	0.65% n = 4538

Table 8

Driver factors present for middle age drivers (30-60).

Driver Factor	Percentage from total crashes Middle Age	Percentage from total crashes General population
Failure to keep in proper lane (28)	14.64% n = 37255	17.73% n = 124482
Driving too fast... (44)	12.44% n = 31661	17.51% n = 122924
Failure to Yield Right of Way (38)	8.59% n = 21846	11.45% n = 80402
Operating the Vehicle in an Erratic manner... (36)	4.82% n = 12266	6.51% n = 45707
Failure to obey traffic control devices or laws... (39)	4.46% n = 11357	5.79% n = 40369
Driving on Wrong Side of Road (51)	2.82% n = 7174	3.39% n = 23768
Making Improper Turn (48)	1.50% n = 3806	1.81% n = 12728
Over Correcting (58)	0.83% n = 2115	1.05% n = 7361
Passing with insufficient Distance... (35)	0.68% n = 1735	0.94% n = 6571
Following Improperly (26)	0.60% n = 1532	0.65% n = 4538
Improper or Erratic Lane Changing (27)	0.59% n = 1504	0.64% n = 4511

Table 9

Driver Factors present for older drivers (65-98).

Driver Factor	Percentage from total crashes Elderly	Percentage from total crashes General population
Failure to Yield Right of Way (38)	28.36% n = 29093	11.45% n = 80402
Failure to keep in proper lane (28)	16.68% n = 17107	17.73% n = 124482
Failure to obey traffic control devices or laws... (39)	10.78% n = 11057	5.79% n = 40369
Driving too Fast... (44)	6.22% n = 6376	17.51% n = 122924
Operating the Vehicle in an Erratic manner... (36)	5.12% n = 5251	6.51% n = 45707
Making Improper Turn (48)	3.34% n = 3423	1.81% n = 12728
Driving on Wrong Side of Road (51)	2.74% n = 2809	3.39% n = 23768
Over Correcting (58)	0.85% n = 867	1.05% n = 7361
Following Improperly (26)	0.79% n = 813	0.65% n = 4538
Improper or Erratic Lane Changing (27)	0.59% n = 605	0.64% n = 4511
Passing with insufficient Distance... (35)	0.58% n = 597	0.94% n = 6571
Making Improper Entry to or Exit from Trafficway (30)	0.58% n = 590	0.21% n = 1485

Table 10

Odds of experiencing a driver factor in relation to passenger present for teen drivers (16-19).

Driver Factor	Adult Passenger (18 and above in front seat) Odds Ratio	99% CI Low	High	Child/Children Passenger (13 and below) Odds Ratio	99% CI Low	High
All Driver Factors (20-60)	**1.170****	1.103	1.241	**1.489****	1.366	1.660
Driving too Fast... (44)	**1.124****	1.053	1.200	**1.042**	0.921	1.179
Failure to keep in proper lane (28)	**1.233****	1.154	1.317	**1.234****	1.097	1.388
Operating the Vehicle in an Erratic manner... (36)	**1.161****	1.045	1.290	**1.111**	0.910	1.358
Failure to Yield Right of Way (38)	**1.042**	0.944	1.149	**1.361****	1.174	1.579
Failure to obey traffic control devices or laws... (39)	**1.154****	1.018	1.308	**1.427****	1.167	1.744
Driving on Wrong Side of Road (51)	**0.541****	0.465	0.642	**1.074**	0.848	1.361
Over Correcting (58)	**1.796****	1.493	2.161	**1.259**	0.902	1.758
Making Improper Turn (48)	**1.856****	1.527	2.255	**0.650***	0.386	1.093
Operator Inexperience (52)	**1.728****	1.365	2.187	**1.876****	1.307	2.694
Passing with insufficient Distance... (35)	**0.922**	0.725	1.174	**0.964**	0.631	1.474
Passing where Prohibited (33)	**1.015**	0.720	1.433	**0.911**	0.477	1.739
Improper or Erratic Lane Changing (27)	**1.788****	1.312	2.436	**0.830**	0.397	1.736
Operating without Required Equipment (24)	**2.006****	1.449	2.778	**2.358****	1.403	3.963
Following Improperly (26)	**0.977**	0.674	1.418	**1.491**	0.864	2.573

* p <.05 & ** p <.01

Table 11

Odds of experiencing a driver factor in relation to passenger present middle age drivers (30-60)

	Adult Passenger (18 and older in front seat)			Child/Children Passenger (13 and below)		
Driver Factor	Odds Ratio	99% CI Low	99% CI High	Odds Ratio	99% CI Low	99% CI High
All Driver Factors (20-60)	**0.869****	0.840	0.899	**0.999**	0.953	1.047
Failure to keep in proper lane (28)	**0.858****	0.818	0.900	**0.981****	0.860	0.981
Driving too Fast... (44)	**0.787****	0.746	0.831	**0.874****	0.809	0.945
Failure to Yield Right of Way (38)	**1.263****	1.194	1.336	**1.235****	1.147	1.329
Operating the Vehicle in an Erratic manner... (36)	**0.850****	0.782	0.922	**0.920**	0.818	1.033
Failure to obey traffic control devices or laws... (39)	**1.176****	1.088	1.271	**1.194****	1.077	1.323
Driving on Wrong Side of Road (51)	**0.456****	0.400	0.519	**0.873***	0.757	1.006
Making Improper Turn (48)	**1.349****	1.187	1.533	**1.166***	0.972	1.398
Over Correcting (58)	**1.984****	1.705	2.308	**1.195***	0.950	1.501
Passing with insufficient Distance... (35)	**0.945**	0.772	1.157	**0.928**	0.691	1.247
Following Improperly (26)	**0.721****	0.573	0.907	**0.868**	0.634	1.190
Improper or Erratic Lane Changing (27)	**1.009**	0.817	1.248	**0.667****	0.476	0.962

* $p < .05$
** $p < .01$

Table 12

Odds of experiencing a driver factor in relation to passenger present older drivers (65 plus)

	Adult Passenger (18 and older in front seat)			Child/Children Passenger (13 and below)		
Driver Factor	Odds Ratio	99% CI Low	High	Odds Ratio	99% CI Low	High
All Driver Factors (20-60)	**0.894****	0.858	0.931	**0.957**	0.799	1.145
Failure to Yield Right of Way (38)	**1.286****	1.233	1.342	**1.120**	0.930	1.348
Failure to keep in proper lane (28)	**0.742****	0.704	0.783	**0.873**	0.696	1.095
Failure to obey traffic control devices or laws... (39)	**1.031**	0.969	1.097	**0.916**	0.692	1.213
Driving too Fast... (44)	**0.789****	0.726	0.859	**0.556****	0.360	0.890
Operating the Vehicle in an Erratic manner... (36)	**0.872****	0.796	0.955	**1.031**	0.704	1.509
Making Improper Turn (48)	**1.150****	1.033	1.279	**1.314**	0.853	2.023
Driving on Wrong Side of Road (51)	**0.433****	0.374	0.501	**0.783**	0.458	1.339
Over Correcting (58)	**2.035****	1.680	2.464	**1.581**	0.715	3.495
Following Improperly (26)	**0.774****	0.618	0.969	-	-	-
Improper or Erratic Lane Changing (27)	**1.187**	0.922	1.527	-	-	-
Passing with insufficient Distance... (35)	**0.687****	0.522	0.906	-	-	-
Making Improper Entry to or Exit from Trafficway (30)	**0.809***	0.623	1.052	-	-	-

* p <.05 & ** *p* <.01

Table 13

Odds of experiencing any driver factor based on passenger type for teens 16-19

Group	Odds Ratio	sig.	99% CI Low	99% CI High
Female driver Old female passenger	0.642	.001	0.527	0.782
Female driver Old male passenger	0.882	.303	0.644	1.208
Female driver Young female passenger	1.114	.001	1.038	1.197
Female driver Young male passenger	1.105	.006	1.006	1.212
Male driver Old female passenger	0.965	.667	0.782	1.192
Male driver Old male passenger	1.257	.005	1.019	1.552
Male driver Young female passenger	1.173	.000	1.094	1.258
Male driver Young male passenger	2.066	.000	1.960	2.179

Reference Category male/female driver no passenger

Table 14

Odds of experiencing Driving too Fast (44) based on passenger type for teens 16-19

Group	Odds Ratio	sig.	99% CI Low	99% CI High
Female driver Old female passenger	0.310	.001	0.222	0.434
Female driver Old male passenger	0.785	.105	0.534	1.153
Female driver Young female passenger	0.888	.001	0.818	0.965
Female driver Young male passenger	0.887	.004	0.796	0.988
Male driver Old female passenger	0.502	.001	0.373	0.675
Male driver Old male passenger	1.061	.507	0.843	1.335
Male driver Young female passenger	1.271	.001	1.180	1.370
Male driver Young male passenger	2.342	.001	2.228	2.461

Reference Category male/female driver no passenger

Table 15

Odds of experiencing failure to keep in proper lane (28) based on passenger type for teens 16-19

Group	Odds Ratio	sig.	99% CI Low	99% CI High
Female driver Old female passenger	0.584	.001	0.443	0.769
Female driver Old male passenger	1.031	.832	0.714	1.488
Female driver Young female passenger	1.069	.036	0.985	1.159
Female driver Young male passenger	1.168	.001	1.053	1.296
Male driver Old female passenger	0.788	.020	0.605	1.027
Male driver Old male passenger	1.051	.588	0.830	1.331
Male driver Young female passenger	0.998	.947	0.921	1.082
Male driver Young male passenger	1.330	.001	1.261	1.403

Reference Category male/female driver no passenger

Table 16

Odds of experiencing Operating the Vehicle in an Erratic manner (36) based on passenger type for teens 16 to 19

Group	Odds Ratio	sig.	99% CI Low	99% CI High
Female driver Old female passenger	0.788	.147	0.517	1.202
Female driver Old male passenger	1.126	.595	0.634	2.000
Female driver Young female passenger	1.109	.040	0.974	1.262
Female driver Young male passenger	0.970	.655	0.812	1.158
Male driver Old female passenger	0.962	.809	0.639	1.450
Male driver Old male passenger	1.289	.063	0.906	1.832
Male driver Young female passenger	1.346	.001	1.196	1.515
Male driver Young male passenger	2.125	.001	1.972	2.290

Reference Category male/female driver no passenger

Table 17

Odds of experiencing Failure to Yield Right of Way (38) based on passenger type for teens 16 to 19

Group	Odds Ratio	sig.	99% CI Low	99% CI High
Female driver Old female passenger	1.618	.001	1.218	2.149
Female driver Old male passenger	1.165	.437	0.701	1.936
Female driver Young female passenger	1.469	.001	1.322	1.633
Female driver Young male passenger	1.320	.001	1.145	1.520
Male driver Old female passenger	1.965	.001	1.483	2.602
Male driver Old male passenger	1.357	.011	0.995	1.850
Male driver Young female passenger	1.022	.631	0.909	1.148
Male driver Young male passenger	0.772	.001	0.706	0.844

Reference Category male/female driver no passenger

Table 18

Odds of experiencing any driver factor based on passenger type for drivers 30-60

Group	Odds Ratio	sig.	99% CI Low	99% CI High
Female driver Old female passenger	0.999	.980	0.935	1.068
Female driver Old male passenger	1.036	.203	0.964	1.113
Female driver Young female passenger	0.913	.001	0.849	0.983
Female driver Young male passenger	0.984	.617	0.906	1.069
Male driver Old female passenger	0.694	.001	0.664	0.726
Male driver Old male passenger	1.328	.001	1.245	1.416
Male driver Young female passenger	0.974	.489	0.885	1.073
Male driver Young male passenger	1.286	0.001	1.188	1.392

Reference Category male/female driver no passenger

Table 19

Odds of experiencing failure to keep in proper lane (28) based on passenger type for drivers 30-60.

Group	Odds Ratio	sig.	99% CI Low	99% CI High
Female driver Old female passenger	0.712	.001	0.644	0.787
Female driver Old male passenger	0.936	.086	0.848	1.033
Female driver Young female passenger	0.788	.001	0.709	0.876
Female driver Young male passenger	0.907	.028	0.809	1.017
Male driver Old female passenger	0.632	.001	0.591	0.675
Male driver Old male passenger	1.043	.206	0.957	1.137
Male driver Young female passenger	0.862	.005	0.752	0.987
Male driver Young male passenger	1.076	.074	0.968	1.196

Reference Category male/female driver no passenger

Table 20

Odds of experiencing driving too fast... (44) based on passenger type for drivers 30-60

Group	Odds Ratio	sig.	99% CI Low	99% CI High
Female driver Old female passenger	0.536	.001	0.473	0.606
Female driver Old male passenger	0.858	.001	0.767	0.959
Female driver Young female passenger	0.682	.001	0.602	0.771
Female driver Young male passenger	0.694	.001	0.604	0.797
Male driver Old female passenger	0.736	.001	0.687	0.790
Male driver Old male passenger	1.778	.001	1.642	1.926
Male driver Young female passenger	1.259	.001	1.106	1.434
Male driver Young male passenger	1.769	.001	1.603	1.952

Reference Category male/female driver no passenger

Table 21

Odds of experiencing failure to yield right of way (38) based on passenger type for drivers 30-60.

Group	Odds Ratio	sig.	99% CI Low	99% CI High
Female driver Old female passenger	1.950	.001	1.775	2.141
Female driver Old male passenger	1.256	.001	1.115	1.415
Female driver Young female passenger	1.519	.001	1.357	1.699
Female driver Young male passenger	1.511	.001	1.331	1.715
Male driver Old female passenger	1.110	.748	0.935	1.091
Male driver Old male passenger	0.990	.829	0.879	1.115
Male driver Young female passenger	1.034	.618	0.871	1.228
Male driver Young male passenger	0.955	.430	0.823	1.109

Reference Category male/female driver no passenger

Table 22

Odds of experiencing operating the vehicle in an erratic manner... (36) based on passenger type for drivers 30-60.

Group	Odds Ratio	sig.	99% CI Low	99% CI High
Female driver Old female passenger	0.879	.039	0.748	1.032
Female driver Old male passenger	1.022	.734	0.867	1.204
Female driver Young female passenger	0.782	.001	0.648	0.942
Female driver Young male passenger	0.760	.001	0.614	0.941
Male driver Old female passenger	0.903	.010	0.815	1.000
Male driver Old male passenger	1.744	.001	1.548	1.965
Male driver Young female passenger	1.328	.001	1.092	1.615
Male driver Young male passenger	1.649	.001	1.420	1.916

Reference Category male/female driver no passenger

Table 23

Odds of experiencing any driver factor based on passenger type for elderly 65 plus.

Group	Odds Ratio	sig.	99% CI Low	99% CI High
Female driver Old female passenger	1.234	.001	1.135	1.342
Female driver Old male passenger	1.037	.248	0.956	1.126
Female driver Young female passenger	0.900	.328	0.682	1.187
Female driver Young male passenger	1.115	.389	0.806	1.543
Male driver Old female passenger	0.788	.001	0.755	0.822
Male driver Old male passenger	0.912	.059	0.804	1.034
Male driver Young female passenger	0.787	.068	0.561	1.104
Male driver Young male passenger	0.588	.001	0.445	0.778

Reference Category male/female driver no passenger

Table 24

Odds of experiencing failure to keep in proper lane (28) based on passenger type for elderly 65 plus

Group	Odds Ratio	sig.	99% CI Low	99% CI High
Female driver Old female passenger	0.650	.001	0.581	0.727
Female driver Old male passenger	0.912	.019	0.824	1.009
Female driver Young female passenger	0.614	.002	0.410	0.918
Female driver Young male passenger	1.091	.552	0.748	1.590
Male driver Old female passenger	0.664	.001	0.626	0.704
Male driver Old male passenger	0.684	.001	0.574	0.815
Male driver Young female passenger	0.674	.036	0.416	1.093
Male driver Young male passenger	0.661	.009	0.439	0.996

Reference Category male/female driver no passenger

Table 25

Odds of experiencing driving too fast (44) based on passenger type for elderly 65 plus

Group	Odds Ratio	sig.	99% CI Low	99% CI High
Female driver Old female passenger	0.790	.001	0.666	0.936
Female driver Old male passenger	0.829	.004	0.701	0.980
Female driver Young female passenger	0.428	.006	0.194	0.943
Female driver Young male passenger	1.160	.505	0.654	2.057
Male driver Old female passenger	0.849	.001	0.777	0.927
Male driver Old male passenger	1.198	.040	0.955	1.503
Male driver Young female passenger	0.934	.798	0.496	1.858
Male driver Young male passenger	0.968	.885	0.548	1.711

Reference Category male/female driver no passenger

Table 26

Odds of experiencing failure to yield right of way (38) based on passenger type for elderly 65 plus

Group	Odds Ratio	sig.	99% CI Low	99% CI High
Female driver Old female passenger	1.624	.001	1.499	1.759
Female driver Old male passenger	1.244	.001	1.144	1.352
Female driver Young female passenger	1.281	.026	0.962	1.706
Female driver Young male passenger	1.069	.608	0.764	1.497
Male driver Old female passenger	1.145	.001	1.094	1.198
Male driver Old male passenger	1.085	.119	0.948	1.241
Male driver Young female passenger	1.195	.203	0.833	1.713
Male driver Young male passenger	0.785	.062	0.562	1.097

Reference Category male/female driver no passenger

Table 27

Odds of experiencing failure to obey traffic control devices or laws (39) based on passenger type for elderly 65 plus

Group	Odds Ratio	sig.	99% CI Low	99% CI High
Female driver Old female passenger	1.385	.001	1.240	1.547
Female driver Old male passenger	0.920	.092	0.809	1.045
Female driver Young female passenger	1.158	.345	0.771	1.739
Female driver Young male passenger	0.917	.660	0.553	1.520
Male driver Old female passenger	0.957	.096	0.895	1.024
Male driver Old male passenger	1.014	.850	0.835	1.232
Male driver Young female passenger	0.703	.142	0.380	1.303
Male driver Young male passenger	0.649	.038	0.380	1.110

Reference Category male/female driver no passenger

Table 28

Odds of experiencing a driver factor with a passenger in relation to weather condition

Situational Variables?	All Drivers	Teen Drivers	Middle Aged Drivers	Older Drivers
Rain	0.888	0.989	0.989	0.816
	(0.841, 0.938)	(0.830, 1.177)	(.898, 1.089)	(0.731, .910)
Snow	1.203	1.519	1.513	1.030
	(1.081, 1.340)	(0.995, 2.321)	(1.276, 1.794)	(0.821, 1.291)

99% CI in brackets
Reference condition clear weather

Table 29

Odds of experiencing a driver factor with a passenger in relation to time of day.

Situational Variables?	All Drivers	Teen Drivers	Middle Aged Drivers	Older Drivers
6am – noon	1.392	1.660	1.207	1.983
	(1.308, 1.482)	(1.364, 2.022)	(1.077, 1.354)	(1.541, 2.551)
Noon – 6pm	1.261	1.264	1.020	1.992
	(1.192, 1.335)	(1.079, 1.480)	(0.918, 1.134)	(1.554, 2.553)
6 pm – midnight	0.712	0.797	0.644	1.116
	(0.671, 0.756)	(0.685, 0.927)	(0.579, 0.720)	(0.863, 1.443)

99% CI in brackets
Reference condition midnight till 6am

Table 30

Odds of experiencing a driver factor with a passenger in relation to lighting condition

Situational Variables?	All Drivers	Teen Drivers	Middle Aged Drivers	Older Drivers
Dark	0.753	0.727	0.782	0.619
	(0.703, 0.807)	(0.590, 0.894)	(0.692, 0.883)	(0.529, 0.724)
Dark but	0.690	0.585	0.765	0.799
lighted	(0.640, 0.743)	(0.468, 0.731)	(0.669, 0.874)	(0.672, 0.950)
Dawn/dusk	0.935	1.141	1.026	0.829
	(0.851, 1.027)	(0.833, 1.563)	(0.871, 1.208)	(0.675, 1.017)

99% CI in brackets
Reference condition daylight

Table 31

Odds of experiencing a Driver factor with a passenger in relation to road surface

Situational Variables?	All Drivers	Teen Drivers	Middle Aged Drivers	Older Drivers
Wet	0.927	1.035	0.973	0.868
	(0.885, 0.971)	(0.893, 1.200)	(0.894, 1.058)	(0.791, 0.953)
Snow	1.191	1.394	1.451	1.047
	(1.064, 1.334)	(0.912, 2.131)	(1.212, 1.737)	(0.822, 1.334)
Ice	1.357	1.518	1.747	0.926
	(1.211, 1.520)	(1.025, 2.248)	(1.455, 2.097)	(0.723, 1.185)

99% CI in brackets
Reference condition dry surface

Table 32

Vehicle attempt at avoidant manoeuvre (data from 1991 to 2003)

Avoidant Manoeuvre	All Drivers	Teen Drivers	Middle Aged Drivers	Older Drivers
YES	18.0% N = 48076	23.5% N = 9357	18.6% N = 18573	9.9% N = 4987
NO	39.2% N = 104641	34.7% N = 13779	39.6% N = 39460	45.6% N = 23010
Missing/Unknown*	42.8% N = 114122	41.8% N = 16601	41.8% N = 41704	44.5% N = 22462

*Often police are unable to determine whether an avoidant manoeuvre is made

Table 33

Vehicle involved in accident at junction

Accident at Junction	All Drivers	Teen Drivers	Middle Aged Drivers	Older Drivers
YES	35.4% N = 250157	30.5% N = 34889	34.7% N = 88311	50.7% N = 52011
NO	60.4% N = 451691	69.5% N = 79448	65.3% N = 166084	49.3% N = 50552

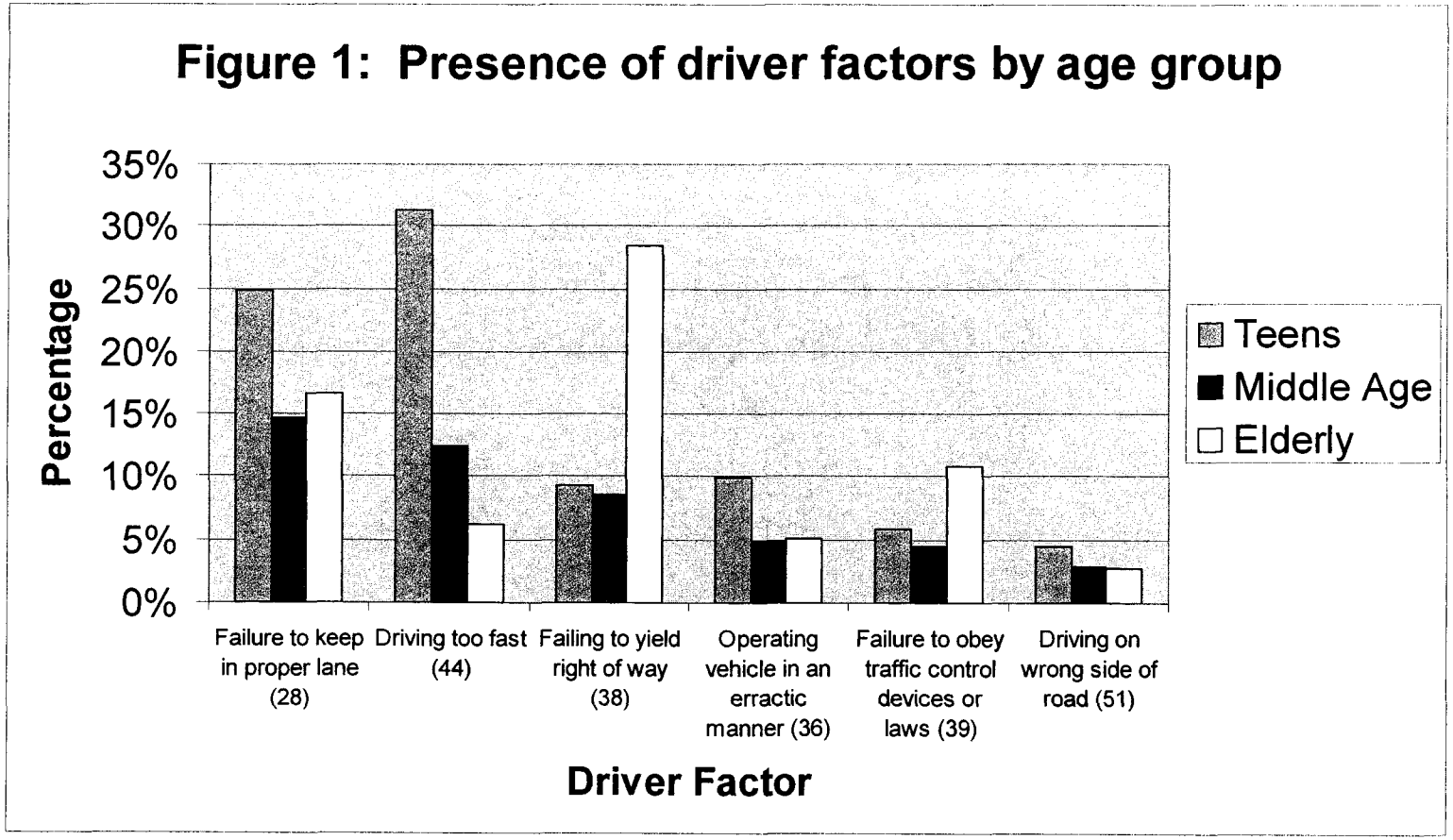
* Due to missing data percentages do not add up to 100% for all drivers.

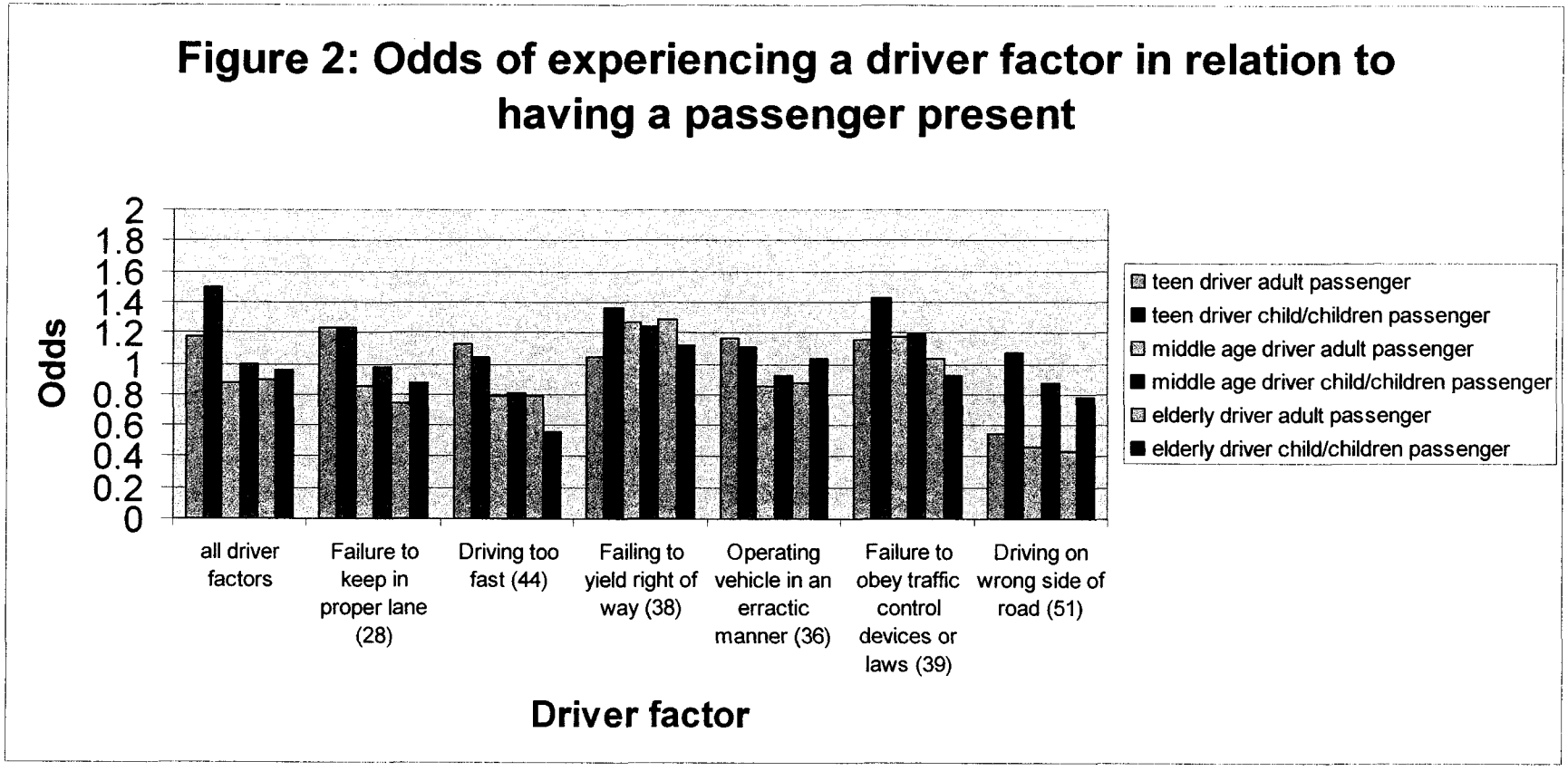
Table 34

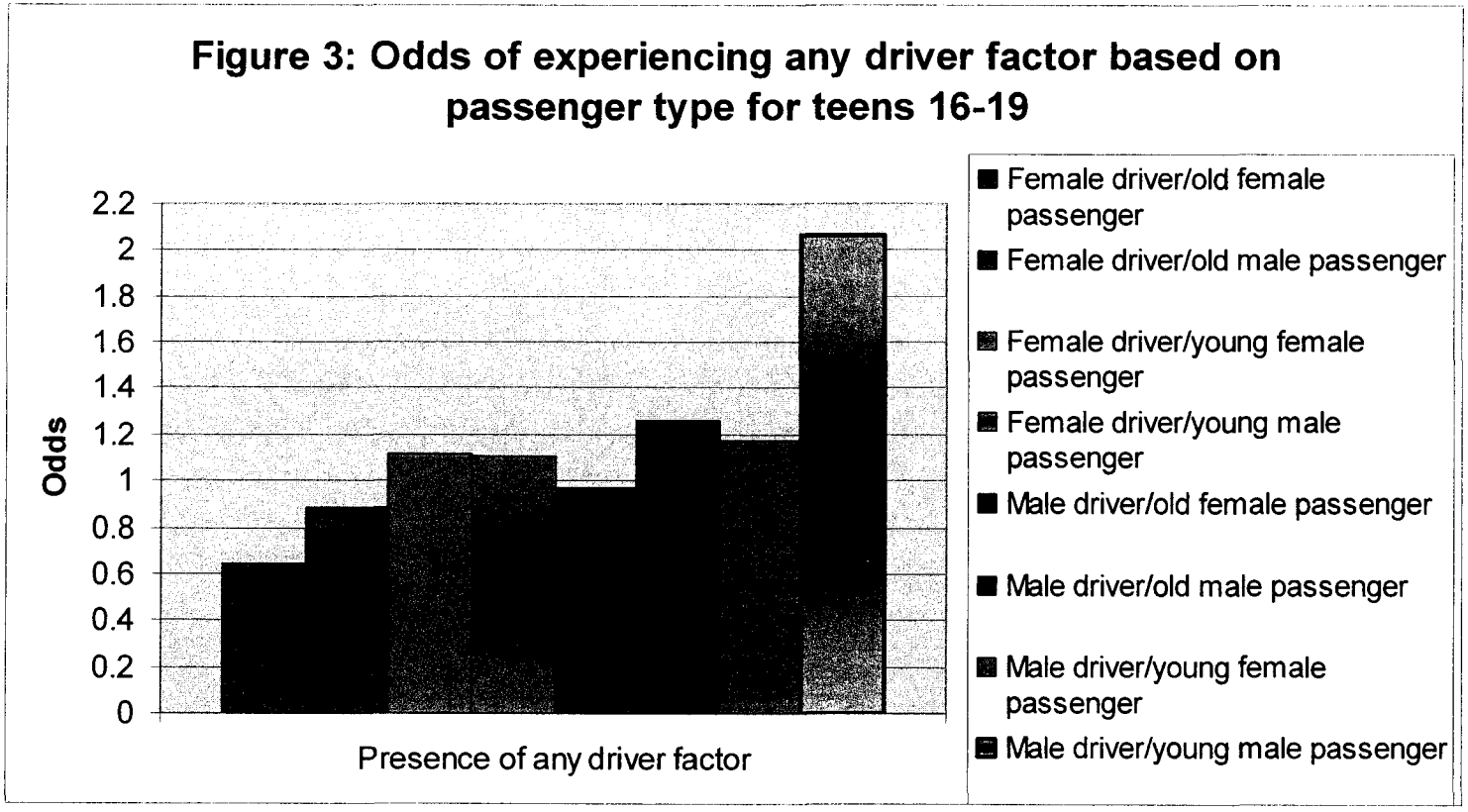
Odds of driver committing an avoidant manoeuvre or being involved in a crash at a junction with an adult passenger.

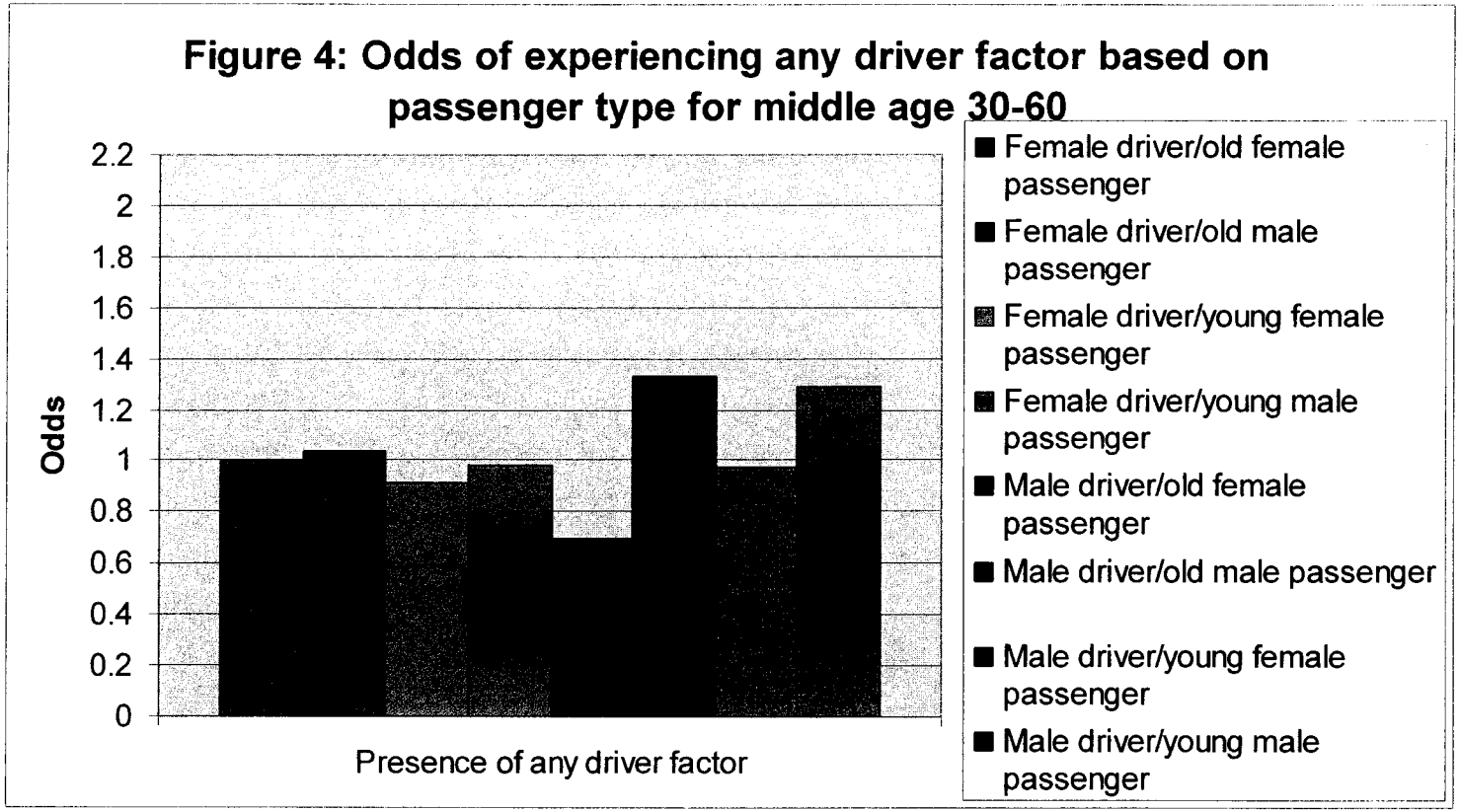
Situational Variables?	All Drivers	Teen Drivers	Middle Aged Drivers	Older Drivers
Odds of Avoidant manoeuvre	1.050 (1.010, 1.090)	1.117 (1.003, 1.245)	1.113 (1.044, 1.186)	1.229 (1.123, 1.344)
Odds of accident at junction	1.206 (1.182, 1.230)	0.981 (0.922, 1.044)	1.120 (1.082, 1.160)	1.247 (1.200, 1.297)

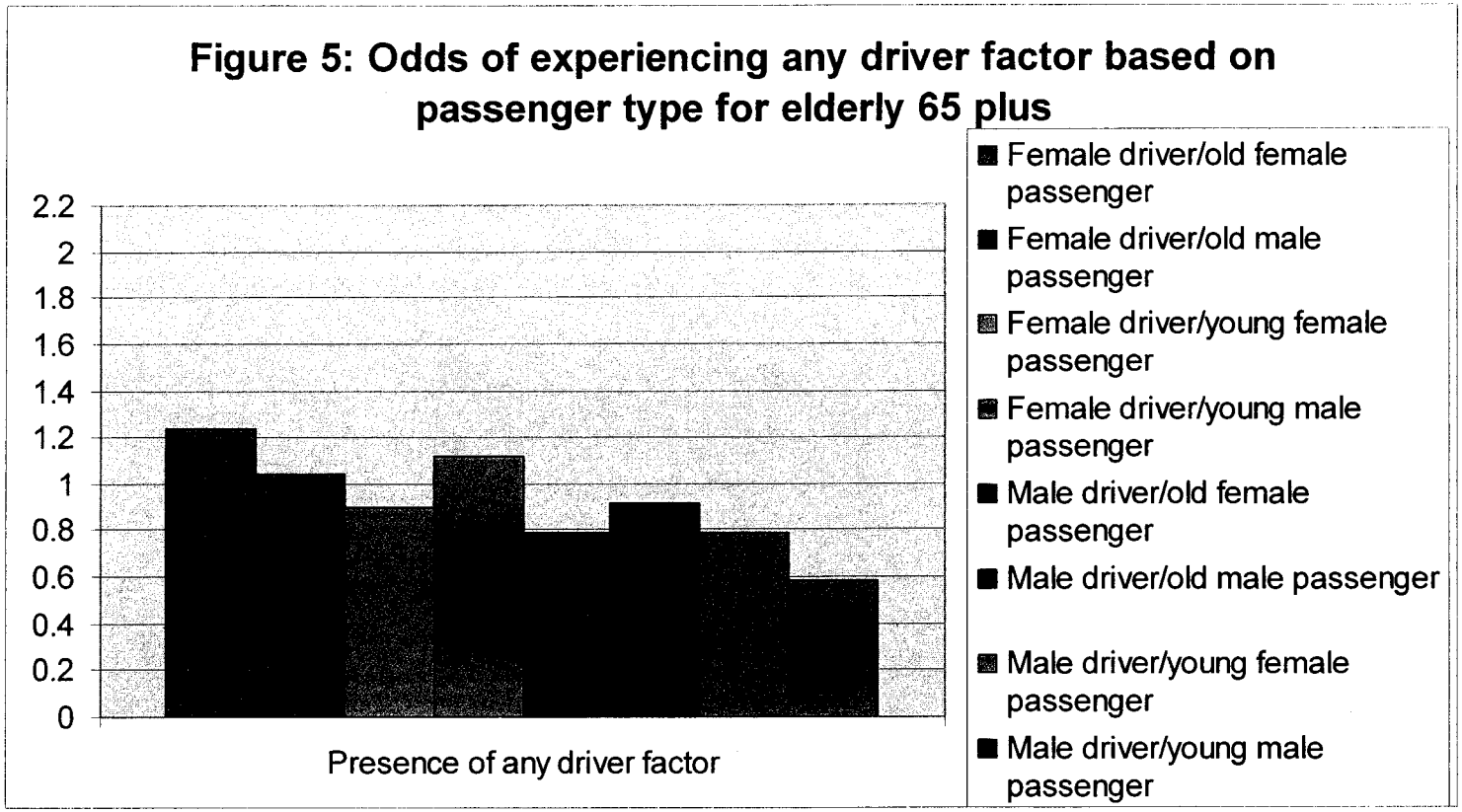
99% CI in brackets
Reference Condition no passengers











Appendix A

Variable = BODY_TYP

01 Convertible
02 2 door Sedan/HT/Coupe
03 3 door/2 door Hatchback
04 4 door Sedan/HT
05 5 door/4 door Hatchback
06 Station Wagon
07 Hatchback/unknown doors
08 Other auto (1991 - 1993 only)
08 Sedan/Hardtop# doors unknown (Since 1994)
09 Unknown auto type (1991 - 1993 only)
09 Other or Unknown auto type (Since 1994)
10 Auto Pickup
11 Auto Panel
12 Large Limousine
13 3-Wheel Auto
14 Compact Utility
15 Large Utility
16 Utility Station Wagon
19 Utility Unknown Body
20 Minivan
21 Large Van
22 Step Van
23 Van Motorhome
24 Van-Based School Bus (Since 1993)
25 Van-Based Transit Bus (Since 1993)
28 Other Van type
29 Unknown Van type
30 Compact Pickup (Gross Vehicle Weight, GVWR, < 4500 lbs)
31 Standard Pickup (4500 lbs #GVWR < 10,000 lbs)
32 Pickup w/Camper
33 Convertible Pickup
39 Unknown Pickup
40 Cab Chassis Based
41 Truck Based Panel
42 Light Truck Motorhome
45 Other Light Conventional
48 Unknown Light Conventional
49 Unknown Light Vehicle
50 School Bus
51 X-country/Intercity
52 Transit Bus
58 Other Bus

59 Unknown Bus
60 Step Van
61 Single Unit Straight Truck low GVWR
62 Single Unit Straight Truck med GVWR
63 Single Unit Straight Truck high GVWR
64 Single Unit Straight Truck unknown GVWR
65 Med/Hvy Motorhome
66 Truck/Tractor (Cab only, or with any number of
trailing units:any weight)
67 Medium/Heavy Pickup (GVWR > 10,000 lbs.) {Since 2001}
71 Med Single Unit Straight Truck or Combination
10,000 lbs < GVWR < 26,000 lbs
72 Hvy Single Unit Straight Truck or Combination
26,000 lbs < GVWR
73 Camper or Motorhome, Unknown Truck Type
78 Unknown Medium/Heavy Truck
79 Unknown Truck
80 Motorcycle
81 Moped
82 3-wheel MC/Moped - not All-Terrain Vehicle
83 Off Road Motorcycle (2-wheel) (Since 1993)
88 Other Motorcycle
89 Unknown Motorcycle
90 ATV (All-Terrain Vehicle; includes 3 or 4 wheels)
91 Snowmobile
92 Farm Equipment
93 Construction Equipment
94 Motorized Wheel Chair (Since 1997)
97 Other Vehicle (includes go-cart, fork-lift,
city street sweeper, dune/swamp buggy)
99 Unknown Body Type

Variable = BODY_TYP BY NHTSA vehicle category

NHTSA has precise definitions for several vehicle categories, such as passenger cars, pickups, buses etc. LE is less than or equal EQ is equal

The analysis used only passenger cars as defined by the NHTSA. All other behicles were excluded from the analysis.

Passenger Cars => 01 LE BODY_TYP LE 11

Light Trucks* => 14 LE BODY_TYP LE 19 OR 30 LE BODY_TYP LE 41 OR 45 LE BODY_TYP LE 49 OR (BODY_TYP EQ 79 AND [TOW_VEH EQ 0 OR TOW_VEH EQ 9])

Utility Vehicles => 14 LE BODY_TYP LE 19
Note that utility vehicles are also part of the light truck category.

Pickups => 30 LE BODY_TYP LE 39 {See BODY_TYP value 67 from 2001}

Vans => 20 LE BODY_TYP LE 22 OR 28 LE BODY_TYP LE 29 {OR 24 LE BODY_TYP LE 25 Since 1993}

Light Trucks & Vans* => 14 LE BODY_TYP LE 22 OR 28 LE BODY_TYP LE 41 OR 45 LE BODY_TYP LE 49 OR (BODY_TYP EQ 79 AND [TOW_VEH EQ 0 OR TOW_VEH EQ 9]) {OR 24 LE BODY_TYP LE 25 Since 1993}

Passenger Vehicles => 01 LE BODY_TYP LE 11 OR 14 LE BODY_TYP LE 22 OR 28 LE BODY_TYP LE 41 OR 45 LE BODY_TYP LE 49 OR (BODY_TYP EQ 79 AND [TOW_VEH EQ 0 OR TOW_VEH EQ 9]) {OR 24 LE BODY_TYP LE 25 Since 1993}

Medium Trucks => 60 LE BODY_TYP LE 62 OR BODY_TYP EQ 64 OR BODY_TYP EQ 71

Heavy Trucks => BODY_TYP EQ 63 OR BODY_TYP EQ 66 OR BODY_TYP EQ 72 OR BODY_TYP EQ 78 OR (BODY_TYP EQ 79 AND [1 LE TOW_VEH LE 4])

Large Trucks => 60 LE BODY_TYP LE 64 OR BODY_TYP EQ 66 OR 71 LE BODY_TYP LE 72 OR BODY_TYP EQ 78 OR (BODY_TYP EQ 79 AND [1 LE TOW_VEH LE 4])

Combination Trucks => (60 LE BODY_TYP LE 64 AND [1 LE TOW_VEH LE 4]) OR (71 LE BODY_TYP LE 72 AND [1 LE TOW_VEH LE 4]) OR (78 LE BODY_TYP LE 79 AND [1 LE TOW_VEH LE 4]) OR See V_CONFIG BODY_TYP EQ 66

Single Unit Trucks => [60 LE BODY_TYP LE 64 OR 71 LE BODY_TYP LE 72 OR

BODY_TYP EQ 78] See V_CONFIG AND [TOW_VEH EQ 0 OR TOW_VEH EQ 9]

Motorcycles => 80 LE BODY_TYP LE 89

Buses => 50 LE BODY_TYP LE 59 See V_CONFIG

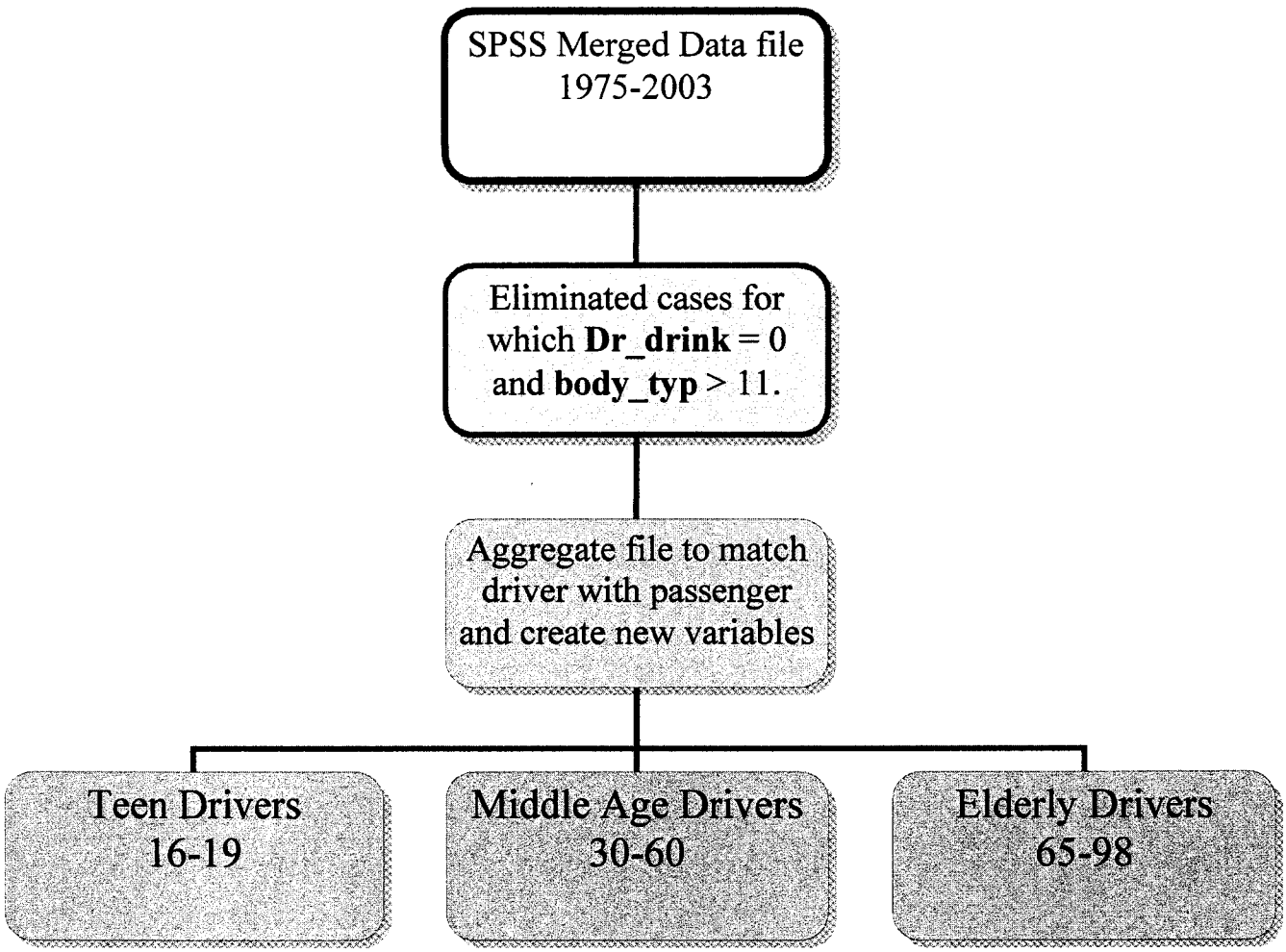
Appendix B

DR_CF as coded in FARS

20 Leaving Vehicle Unattended with Engine Running Leaving Vehicle Unattended in Roadway
21 Overloading or Improper Loading of Vehicle with Passengers or Cargo
22 Towing or Pushing Vehicle Improperly
23 Failing to Dim Lights or to Have Lights on when Required
24 Operating without Required Equipment
25 Creating Unlawful Noise or using Equipment Prohibited by Law
26 Following Improperly
27 Improper or Erratic Lane Changing
28 Failure to keep in Proper Lane or Running off Road (1982-1999)
28 Failure to keep in Proper Lane (Since 2000)
29 Illegal Driving on Road Shoulder, in Ditch or Sidewalk or on Median
30 Making Improper Entry to or Exit from Trafficway
31 Starting or Backing Improperly
32 Opening Vehicle Closure into Moving Traffic or Vehicle is in Motion
33 Passing where Prohibited by Posted Signs, Pavement Markings, Hill or Curve, or School Bus Displaying Warning not to Pass
34 Passing on Wrong Side
35 Passing with insufficient Distance or Inadequate Visibility or Failing to Yield to Overtaking Vehicle
36 Operating the Vehicle in an Erratic, Reckless, Careless or Negligent Manner or Operating at erratic or Suddenly Changing Speeds
37 High Speed Chase with Police in Pursuit (See Note)
38 Failure to Yield Right of Way
39 Failure to Obey Traffic Actual Signs, Traffic Control Devices or traffic Officers, Failure to Observe Safety Zone Traffic Laws
40 Passing Through or Around Barrier
41 Failure to Observe Warnings or Instructions on Vehicle Displaying Them
42 Failure to Signal Intentions
43 Giving Wrong Signal
44 Driving too Fast for Conditions or in Excess of Posted Speed Limit
45 Driving Less than Posted Maximum
46 Operating at Erratic or Suddenly Changing Speeds (1982 - 1994)
46 Not Used (1995-1997)
46 Racing (Since 1998)
47 Making Right Turn from Left Turn Lane or Making Left Turn from Right Turn Lane
48 Making Improper Turn
49 Failure to Comply with Physical Restrictions of License
50 Driving Wrong Way on One-Way Trafficway
51 Driving on Wrong Side of Road (Intentionally or Unintentionally)

52 Operator Inexperience
53 Unfamiliar with Roadway
54 Stopping in Roadway (Vehicle not Abandoned)
55 Underriding a Parked Truck
56 Improper Tire Pressure
57 Locked Wheel
58 Over Correcting
59 Getting Off/Out of or On/In to Moving Vehicle
60 Getting Off/Out of or On/In to Non-Moving Vehicle

Appendix C



Appendix D

For the analysis any value from 1-6 was coded as an avoidant maneuver

Variable = AVOID
0 No Avoidance Maneuver Reported
1 Braking (skidmarks evident)
2 Braking (no skidmarks, driver stated)
3 Braking (other reported evidence)
4 Steering (evidence or stated)
5 Steering and Braking (evidence or stated)
6 Other Avoidance Maneuver
8 Not Reported [/Inconclusive (Since 1999)] (by police)

For the analysis only values 1-4 were used regarding surface condition

Variable = SUR_COND
1 Dry
2 Wet
3 Snow or Slush
4 Ice
5 Sand, Dirt, Oil
8 Other
9 Unknown

For the analysis only 1,2, and 4 were used regarding weather condition

Variable = WEATHER
1 No Adverse Atmospheric Conditions
2 Rain
3 Sleet
4 Snow
5 Fog
6 Rain and Fog
7 Sleet and Fog
8 Other: Smog, Smoke, Blowing Sand or Dust
9 Unknown