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CRASH RISK OF OLDER FEMALE DRIVERS

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Crash Risk of Older Female Drivers

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Abstract:

The majority of the elderly in the population are women and future predictions suggest an increase in this proportion, an increase in the proportion of licensed older women, increased driving by older women drivers, and a subsequent estimated three-fold increase in crash rates amongst older women drivers in the coming decades without active intervention. It is therefore essential to understand the contributory factors to crash and injury risk in order to develop appropriate and effective countermeasures to reduce this risk.

Two studies are described in this report that aimed to address the crash risk of older female drivers and to determine the contributory factors. The first study used existing data from a recent survey of 673 current older female drivers in the ACT. The survey provided a rich data source in which to examine the relationships between health and driving factors and crash risk. Logistic regression analysis was used to model the 'at-risk' older female driver using crash involvement in the last five years as the dependent variable and taking correlations between other variables into account. The second case-control study of 48 crash-involved and 44 non crash-involved older female current drivers in the ACT examined in detail the effect of functional performance, health factors and driving factors on crash risk. Functional performance was examined using four validated tests of skills that are likely to be important in driving such as visual processing, memory and search, scanning strategies, attention span, divided and selective attention, problem-solving, and motor performance.

The survey data analyses revealed that the most 'at-risk' older female drivers were those who: i) were the principal driver, ii) were moderately or not at all confident that they were a safe driver; iii) shared driving on long-distance trips; iv) had problems with the driving style of older drivers; and, v) experienced problems driving on unfamiliar roads.

The case-control study confirmed the findings of the survey data analyses and identified a number of additional predictors of crash involvement. Poor attentional, cognitive, executive and motor skills as well presence of multiple medical conditions were associated with crash involvement. In particular, the results suggested that those with more pronounced functional changes and multiple medical conditions were most at risk of crashing possibly due to the effect of functional limitations on the skills necessary for driving performance but also due to the effects on adoption of compensatory strategies. Low confidence, difficulty in some driving situations and principal driver status were also related to increased risk of crash involvement. These findings suggest that older female drivers who become principal drivers, perhaps due to illness or death of a partner, may lack the up-to-date driving experience and associated confidence to drive safely. Further, the findings suggest that this group may be at risk of crash involvement as a result of 'low mileage' and a higher propensity to drive on the urban network. The finding that the majority of crash-involved participants were involved in crashes at intersections would support this view.

This information has enhanced our understanding of which drivers are at increased risk, particularly through identifying a small, more precisely defined target group for road safety countermeasures. Recommendations for countermeasures were made and include behaviour and educational resources, improvements to licensing procedures, and improvements to road design and system operation. Recommendations for further research were also made.

Key Words:
Older Driver, Safety, Gender, Crash Risk, Functional Performance, Travel Patterns, Countermeasure

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Preface

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EXECUTIVE SUMMARY

Introduction

The over-representation of older drivers in fatal and serious injury crashes compared with younger drivers may be due, in part, to age-related diminished ability to cope with challenging driving situations. Older female drivers may be at further risk due to additional health-related and driving-related factors.

Given that the majority of the elderly are women, predictions that this proportion will increase in the near future, and the likelihood that a greater proportion of older females will be licensed and drive substantial distances over the coming decades, it is of great importance to understand the contributing factors to crash and injury risk in order to develop appropriate and effective countermeasures to reduce this risk.

The literature addressing the issues of older female drivers is scarce, however, it seems that there are a number of gender-specific factors that may place older females at higher crash and injury risk compared with men in the same age group including lack of recent driving experience, avoidance of difficult and stressful driving situations, lack of confidence, poor health and functional status and greater physical frailty. A recent study (Oxley et al., 2004), highlighted some important transportation, driving and health factors amongst older female drivers. It provided valuable information on which effective countermeasure programs can be built, particularly educational resources targeting older female driver groups to raise their awareness of safety and promote the adoption of safe driving behaviours. In addition, this study highlighted the need for a comprehensive examination of the contributory factors to this group's crash risk.

This report presents the results of two follow-up studies aimed to determine the contributory factors to the crash risk of older female drivers. The first study used the existing data from the recent survey of 673 current older female drivers in the ACT (Oxley et al., 2004). The survey data provided a rich source of information in which to examine the relationships between health and driving factors and the impact on crash risk. These relationships were explored using logistic regression analysis. The second study was undertaken to establish a more complete understanding of the effect of health and functional performance as well as driving factors on crash risk using a case-control methodology. A total of 92 older female drivers in the ACT, who had already responded to the recent survey, took part in the study, consisting of two groups: 48 'cases' (those who reported having had a crash in the last five years) and 44 'controls' (those who reported having not had a crash in the last five years).

Survey data analyses

Logistic regression analysis was used to model the 'at risk' older female driver, using crash involvement in the last five years as the dependent variable and taking correlations between other variables into account. Potential contributing factors were included in the model, based on a priori knowledge and preliminary bi-variate analyses identifying factors related to crash involvement. Factors identified as potential contributors to crash involvement included principal driver status, distance driven per week, confidence of being a safe driver, sharing driving on long-distance trips, reported problems in difficult driving situations, description of feelings about driving, age group, and presence of vision problems.

The analysis revealed the following:

- Those who considered themselves to be the principal driver in the household were 5.97 times more likely than those who were not the principal driver in the household to have been crash-involved;

- Those who were moderately or not at all confident of being a safe driver were 1.94 times more likely than those who were highly confident of being a safe driver to have been crash-involved;

- Those who reported problems with the driving style of others and shared long-distance travel were 3.18 times more likely than those who did not share long distance driving to have been crash-involved; and,

- Those who shared long distance driving, reported difficulty driving on unfamiliar roads, and reported having problems with the driving style of other drivers were 7.93 times more likely to have been crash-involved than those who did not report having problems with driving style of others.

In sum, the most 'at-risk' older female drivers who responded to the survey were those who:

- Were the principal driver;

- Were moderately or not at all confident that they were a safe driver;

- Shared driving on long-distance trips;

- Had problems with driving style of other drivers; and,

- Experienced problems driving on unfamiliar roads.

Case-control study

The case-control study was undertaken to compare the functional performance of a sample of crash-involved older female drivers with a sample of matched non crash-involved older female drivers (matched on age group, marital status, health status and weekly distance driven), to examine the impact of impairments on crash risk.

Participants undertook four assessments of functional performance, three of which have been shown to correlate well with driving and road-crossing performance and crash risk amongst older drivers, and one has been shown to be a strong predictor of subtle cognitive impairment. These were:

- **Gr**oss **Imp**airments **S**creening Battery of General Physical and Mental Abilities (GRIMPS);

- **M**attis **O**rganic **M**ental **S**yndrome **S**creening **E**xamination (MOMSSE);

- **U**seful **F**ield **o**f **V**iew test (UFOV); and,

- **S**ubtle **C**ognitive **I**mpairment **T**est (SCIT).

In addition, participants completed a questionnaire providing details on their health status, current medical conditions, driving habits, experiences, travel patterns, confidence in and avoidance of driving situations, and, for crash-involved participants, details of recent crashes.

Presence of a higher number of medical conditions was associated with increased crash risk. While more research is needed to better understand the links between crash risk, medical conditions, associated functional impairments, and the impact of compensatory strategies in moderating risk, the current findings lend support to the contention that presence of multiple medical conditions is related to crash risk, possibly because of the effect on functional performance but it is also possible that the presence of comorbid conditions may make adoption of compensatory behaviours more difficult, i.e., may overwhelm the normal attempts at compensation.

Crash-involved participants generally performed more poorly on assessments of functional performance. This finding suggests that limitations in attentional, cognitive, executive and motor functions increase crash risk status. The MOMSSE examines skills such as visual memory, attention span and problem-solving, the GRIMPS examines skills such as visual search, memory, division of attention, scanning strategies and motor performance, and the UFOV examines visual processing speed, selective and divided attention. In the driving context, these kinds of skills are likely to be important in tasks such as understanding and remembering traffic rules and signs, following directions, utilising executive functions, allocating attention, processing information quickly and accurately, and minimizing the effects of distraction.

The crash details of the crash-involved group provide further support of this assertion. While the majority of crashes occurred in normal driving conditions (not in busy traffic, on familiar roads and in dry weather), most crashes occurred at intersections, while driving straight or turning. Moreover, the additional circumstances described by some participants suggested some attentional, cognitive and executive function limitations. Negotiating an intersection demands a host of age-sensitive functions, such as processing and integration of multiple sources of visual information and quick interpretation of the most important stimuli in fast-moving and busy traffic. These are difficult tasks for many older adults and a decline in cognitive and executive functional performance means that at least some older drivers will experience difficulty coping with the demands of complex intersections and may result in inaccurate perception of the approach of vehicles or even disregard of important perceptual cues altogether.

There were no group differences in performance in subtle cognitive impairment on the SCIT. The lack of group differences lends support to the contention that it is the more pronounced changes associated with cognitive and executive function decline and impairment (particularly dementia) that may lead to driving difficulties and increase crash risk. Performance on the SCIT, a test of very early stages of cognitive impairment, did not predict crash involvement in this sample (although it did correlate significantly with performance on both components of the UFOV, and GRIMPS overall score, both of which were associated with crash-involvement, suggesting some association with crash-involvement). In contrast, performance on the MOMSSE, a screening test for mild, moderate and severe dementia of the Alzheimer's type, strongly predicted crash involvement. It is also interesting to note that, 26 percent of crash-involved participants showed early signs of cognitive impairment, and so did 24 percent of the non crash-involved participants. This is an important point, as it is likely that those in the early stages of cognitive impairment are those who continue to drive, but who may be at increased risk of future crash involvement. Early detection of mild cognitive impairment may help to raise awareness of the progress of cognitive decline and the impact on driving (and therefore crash risk) and assist drivers and their families to appropriately plan for driving reduction and cessation.

In addition to health and functional performance factors, a number of driving factors were associated with crash involvement. Principal driver status was associated with crash involvement, as was moderate to low confidence and difficulty in some driving situations. It was unexpected that principal drivers were more likely to have been involved in a crash, and could be interpreted by the 'increased exposure' hypothesis (those who drive more are exposed for longer periods of time to the risks of crashes). However, principal driver status may not be a good indicator of distance travelled (particularly as participants were matched on weekly distance driven). Moreover, it is well recognised that, independent of age, drivers travelling more kilometres will typically demonstrate reduced crash rates per kilometre travelled, compared with those driving fewer kilometres. Therefore, this hypothesis cannot fully explain crash risk. There are two possible explanations. First, it is possible that current principal drivers are those women who may have taken on the role of principal driver when their male partner became unfit to drive or who passed away, and possibly when they lacked up-to-date driving experience. The correlations between marital status and principal driver status and descriptions of the circumstances participants became principal drivers lend support to this argument. Second, given that low confidence and difficulty in some driving situations were also associated with crash risk, we may consider the 'low-mileage' hypothesis. 'Low-mileage' drivers may be those who restrict their driving in response to a perceived or real decline in functional performance, may have more medical conditions, greater functional difficulties, avoid travel under conditions which are perceived to be threatening or causing discomfort, lack quantitative and qualitative driving experience and lack confidence and, intuitively, have a higher risk of crashing. In addition, these drivers are most likely to be those who do their driving on the urban road network which would increase their crash risk further.

While the group differences in driving behaviour may indicate that crash-involved drivers adopt behaviours to compensate for (real or perceived) changes in performance, these behaviours may also be counter-productive from the viewpoint of crash risk. Reduction of travel, particularly on highways and freeways (roads with relatively high safety records) leads to greater travel on local urban roads which generally have many more conflict points including intersections and relatively low safety records. In addition, reduced travel means that important driving experience and confidence levels are reduced, thereby increasing crash risk.

Summary and Recommendations

The results of this study confirmed some previous findings and identified a number of predictors of crash involvement amongst older female drivers. The findings that poor attentional, cognitive, executive and motor skills as well as principal driver status and low confidence in difficult driving situations were related to increased risk of crash involvement have enhanced our understanding of which drivers are at increased risk, particularly through identifying a small, more precisely defined target group for road safety countermeasures.

Potential countermeasures

Recommendations for countermeasures are as follows and include behavioural and educational resources, improvements to licensing procedures, and improvements to road design and system operation:

- Development of educational and awareness materials for older female drivers, with a particular focus on how they can reduce risk and maintain mobility by awareness of the effect of declining health and functional abilities and adoption of safe driving practices;

- Adoption of appropriate identification of 'at-risk' drivers by licensing authorities, particularly a more strategically targeted licensing re-assessment procedure that uses screening tests to identify drivers who have an increased risk of crashing due to health conditions or functional deficits; and

- Implementation of engineering countermeasures that modify the physical environment of the transport system, particularly design measures at intersections such as provision of roundabouts, speed reduction, provision of adequate sight distance and introduction of full-control turn signals.

Recommendations for further research

The current study provided some evidence of an effect of functional performance declines, health factors and some driving characteristics on crash risk, and highlighted some gaps in our knowledge on the contributing factors to crash risk. Further research opportunities include the following:

- A more detailed investigation to explore further the effects of functional performance declines, onset of medical conditions, driving experience, low mileage and confidence on driving performance and crash risk (particularly information on crash type and crash responsibility) using a larger sample of older female drivers and a comparison group of older male drivers;

- A detailed analysis of travel patterns amongst older drivers using a travel diary and survey methodology to determine gender differences in driving conditions and locations, driving frequency and amount of driving;

- An in-depth examination of the issues surrounding the onset of dementia and driving, and particularly to examine gender differences including i) prevalence of dementia amongst older drivers, ii) crash types, iii) relationship between functional performance declines associated with advancing levels of dementia and crash risk, and iv) the relative risk of cognitive impairment amongst crash-involved and non crash-involved older drivers;

- An examination of gender effects on changes in self-regulatory practices in a cohort study of drivers using a longitudinal study method; and

- An examination of gender differences on the decision to stop driving and consequent mobility restrictions to quantify the costs and other health outcomes associated with driving cessation.

Conclusion

Older female drivers are the fastest growing segment of the driver population due to a proportional increase of women in the population, increased licensing rates and increased driving and it is predicted that crash and injury rates amongst older females drivers will exceed that of older male drivers in the coming decades. Older females also have a higher prevalence of illness, disability and long-term medical conditions and utilise health services more than older men. Given these factors, the safety and mobility of older females has become an important community and road safety concern.

There are obvious mobility benefits of continuing to drive, particularly for older females, who, in the event of their partner being unable to drive, may be forced into principal driver status after years of reduced driving and therefore little up-to-date driving experience. This study has enhanced our understanding of ‘at-risk’ older female drivers by identifying the predictors of crash involvement including declines in functional performance, onset of medical conditions, and driving-related factors such as lack of confidence, low mileage, and lack of up-to-date driving experience. This information has led to a number of recommendations for countermeasures aimed at maintaining their safe mobility and identified a number of areas worthy of further research.

CRASH RISK OF OLDER FEMALE DRIVERS

1 INTRODUCTION

Driving is a fundamentally important part of today's society and is an essential determinant of the quality of life of older individuals. Many older adults rely on driving to fulfil most of their transportation needs, and to maintain mobility and independence. While there is a strong emphasis around the world for older people to maintain their mobility for as long as possible, it is also important to ensure that they remain safe drivers.

Older drivers have attracted considerable attention amongst road safety researchers in recent years, not least because in most industrialised countries, they represent the fastest growing proportion of the population. Moreover, increased frailty means that they are more likely to sustain a serious injury once involved in a crash and take longer to recover (Evans, 2001; Mitchell, 2000; OECD, 2001; Ulfarsson & Mannering, 2004).

The majority of older drivers are generally considered safe and cautious drivers, and in terms of absolute numbers of crashes, they are currently not a large road safety issue in most Western societies, compared with other age groups such as young drivers aged 18 to 25 years. However, there are relatively fewer older people in the population, fewer are licensed and they tend to drive less. Current crash rates suggest that older drivers are over-represented in serious injury and fatal crashes per head of population and distance travelled. Moreover, as the population ages and drives further, fatality rates are expected to increase up to three-fold over the following decades (Fildes, Fitzharris, Charlton & Pronk, 2001).

In the past, little attention has been given to elderly women in traffic and consequently, little consideration is given to gender, resulting in an underestimation of differences between groups and the understanding of these (Sirén, Heikkinen & Hakamies-Blomqvist, 2001). However, given that the proportion of elderly people in the population is increasing and that the majority of the elderly are women, it is essential to understand their transportation needs, their behaviour in traffic and their risks to gain a complete understanding of the needs of older drivers in general. The safe mobility of older female drivers has therefore attracted some attention over the last few years, essentially because of the recognition that they will constitute a larger part of the older driver population in the future and recent evidence suggesting that their involvement in fatal and serious injury crashes will exceed that of older male drivers (Fildes et al., 2001). Moreover, a recent study by Oxley, Charlton Fildes, Koppel and Scully (2004) highlighted many issues of concern regarding older female drivers, particularly the need to investigate the contributing factors to crash risk in more detail. In light of these findings, it is essential for the safe mobility of older female drivers that a complete understanding of the impact of driving experience and practices, health factors and functional status on crash risk is realised in order to develop the most effective countermeasures aimed to reduce their crash and injury risk.

This report documents research undertaken by the Monash University Accident Research Centre (MUARC), funded by NRMA-ACT Road Safety Trust, to follow up on some issues raised in previous work (Oxley et al., 2004) and to establish a more complete understanding of the contributing factors to crash and injury risk amongst older female drivers. Specific aims of the study were to:

- Examine the impact of personal and driving characteristics on crash and injury risk by examining the association between crash-involvement and key predictor variables,

- Compare the characteristics, driving experiences and travel patterns of a sample of crash-involved older female drivers with a sample of matched non crash-involved older female drivers,

- Examine the impact of functional performance limitations on crash risk by comparing the performance of a sample of crash-involved older female drivers with a sample of matched non crash-involved older female drivers, and

- Provide recommendations for appropriate countermeasures aimed to reduce the crash and injury risk of older female drivers in the ACT.

This study was conducted in two parts, incorporating an in-depth analysis of existing data from the self-administered survey of older female drivers (Oxley et al,. 2004) and undertaking follow-up assessments of selected crash-involved and matched non crash-involved women who had responded to the initial survey.

This report briefly outlines the issues surrounding the mobility and safety of older female drivers. In this section the previous literature on gender effects and crash rates is presented and a discussion of some of the contributing factors to crash and injury risk is provided. Section 2 presents the follow-up statistical analysis of existing survey data (Oxley et al., 2004). Section 3 presents the second phase of the project, a case-control study comparing functional performance and driving patterns of crash-involved and non-crash-involved female drivers. Section 4 brings together the findings of the two studies, providing practical recommendations and areas for further research and development.

1.1 THE IMPORTANCE OF DRIVING

Prior to a discussion of crash risk amongst older drivers, it is important to note that driving is one of the most important activities of daily living for many older adults. Driving affords easy access to activities and services and to fulfil social needs and is a good indicator of mobility, independence, good health, quality of life and well-being. This is particularly so in the US and in Australasia where the increase in urbanisation, isolation of rural towns and the present transportation system have resulted in a high dependency on car travel. Not surprisingly, most research shows that many older adults rely on driving for most of their transportation needs and that older drivers are strongly interested in keeping their cars and licences for as long as possible after retirement (OECD, 2001; Gelau, Metker & Trankle, 1992; Rosenbloom, 1988).

In providing transportation, the car meets psychological needs, that is, maintaining independence, autonomy and self-esteem. To most older people, driving is both a symbol of and a means of achieving freedom, independence and self-reliance, and allows them maximum control of their life and mobility. In contrast, forfeiture of driving privileges is considered a major loss for many older adults in terms of social identification, control and independence. Even curtailment of driving usually means relying on others for transportation, incurring potential inconveniences of public transportation, or reducing the number of trips. Furthermore, older people are sometimes reluctant to use public transport because it is not responsive to their travel needs (it often does not go where and when older people want to go), it is often unreliable and is often perceived as providing inadequate personal security. Clearly, any changes in the mode of mobility of older adults are likely to have a significant impact on their capacity for participation in various activities and overall quality of life.

For many older drivers, the thought of stopping driving evokes a level of fear of loss of independence and consequences among the elderly that seems to have a negative effect on their psychological outlook regarding their future quality of life (Harper & Schatz, 1998), and loss of driving privileges may be associated with increased depressive symptoms and a range of other social and health disadvantages (Marottoli, Mendes de Leon, Glass, Williams, Cooney, Berkman & Tinetti, 1997). Eisenhandler (1990) reported that older drivers were reluctant to address safety concerns directly, associated public transportation use with dependency and reduced convenience, derived a sense of control and independence from driving and experienced isolation as a result of the inability to drive. Others studies, too, have found that older drivers report strong feelings about the importance of driving and extremely negative views about the loss of driving (Carp, 1971, 1988; Rothe, 1990; Persson, 1993; Yassuda, Wilson & von Mering, 1997; Kostyniuk & Shope, 1998; Harris, 2000).

1.2 CRASH RISK

Absolute numbers of older driver crashes are relatively small compared with other age groups such as young drivers aged 18 to 25 years, constituting approximately 13 percent of fatal crashes and around 10 percent of serious injury crashes (younger drivers account for around 29% of fatal and 32% of serious injury crashes) (ATSB, 2001). However, the overall number of older driver crashes may under-estimate the magnitude of the older driver problem. There are relatively few older drivers, their total distance travelled tends to be less and they are more frail than younger drivers. When these factors are taken into account, the safety of older drivers is of concern. Older drivers in Australia and internationally are shown to be involved in significantly more serious injury and fatal crashes per distance travelled than younger drivers (Evans, 1991; Fildes, Corben, Kent, Oxley, Le & Ryan, 1994; NHTSA, 1999; OECD, 2001). Figure 1 shows that, even when these rates are adjusted for differences in physical vulnerability (frailty), older drivers have a higher serious injury and fatality risk than younger drivers (with the exception of the youngest driver age group (under 25 years) (Mitchell, 2000; OECD, 2001).

Over the last two decades or so, some gender differences in crash statistics have been noted. In general, females (in both older and younger age groups) are at greater risk of being seriously injured in a crash compared with male drivers, while male drivers are at increased risk of fatal crash involvement (ATSB, 1996; Massie, Campbell & Williams, 1995). However, there is some suggestion that these trends are changing and that female drivers may constitute a growing proportion of serious injury and fatal crashes amongst the driving population. An Australian study reported that 55 years ago, virtually all drivers killed were male, however, the proportion of female driver fatalities rose to 13 percent in 1970 and in the early nineties, females accounted for between 22 and 27 percent of all deaths on Australia’s roads (Ginpil & Attewell, 1994). More recent studies report an increase in the number of female drivers killed and hospitalised in the mid- to late-nineties and a decrease for men. These findings are despite the fact that there was an overall decrease in the national road toll and that females tend to drive fewer kilometres than males (Anderson, Adena & Montesin, 1993; Attewell, 1998). This increase was evident for the youngest females (under 30 years) and the oldest females (over 70 years). In New

Zealand, too, there is evidence that the rate of fatal and serious injury crashes involving female drivers aged over 75 years per kilometre driven, was substantially greater than for male drivers in the same age group (LTSA, 2000). Recent US data shows a similar over-representation. In their comparison of crashes involving older drivers in Maine, Finison and Dubrow (2002) found that the risk of hospitalisation or death for a crash-involved older driver was 1.7 times that of middle-aged drivers. Of this group, older female drivers were 1.6 times more likely to be hospitalised or die following a crash than were older male drivers. Similarly, Li, Baker, Langlois and Kelen (1996) found that, when crash rates are adjusted for kilometres driven, older female drivers exhibited nearly twice the crash involvement rate of older male drivers.

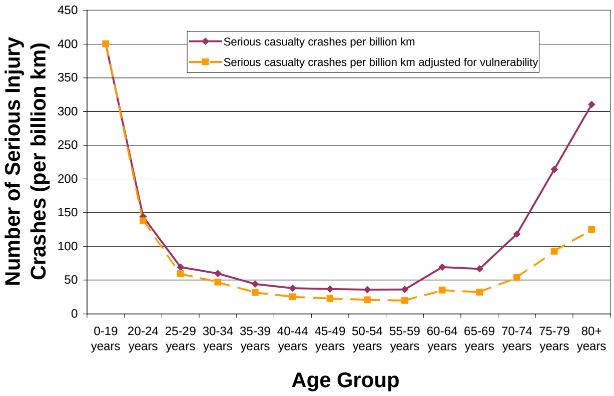

Figure 1: Involvement in serious injury crashes by age adjusting for exposure and vulnerability, Australia, 1996.

These trends may be due, in part, to an increasing proportion of older women in the population compared to older men, increased travel amongst older females, increasing licensure rates, changes in women's roles in driving, greater independence, higher education and greater affluence (Mayhew, Ferguson, Desmond & Simpson, 2003; Rosenbloom, 1996; Spain, 1997; Wallace & Franc, 2001). Moreover, these factors are likely to continue to affect the crash risk of older female drivers in the near future. Projections of the crash involvement for future generations of older drivers in Australia suggest a greater increase in fatalities for older female drivers compared to older male drivers (an increase of 336% for females and 261% for males between 1995 and 2025) (Fildes et al., 2001) (Figure 2). These projections take into account driving behaviour, population migration, personal wealth and health, infrastructure and technological impacts. Similar projections are forecast in the United States (Hu, Jones, Reuscher, Schmoyer & Truett, 2000).

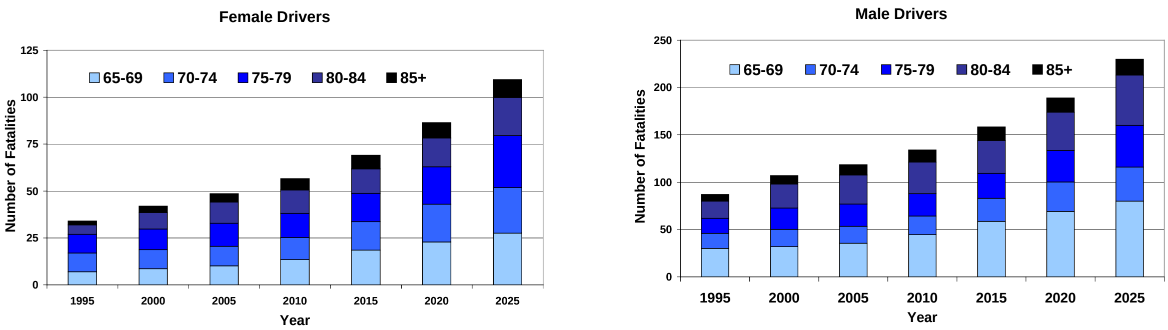

Figure 2: Projected older driver fatalities in Australia, 1995-2005

1.3 RISK FACTORS

The causes of older road user crashes are undoubtedly complex and poorly understood, however, it is necessary to attempt an understanding of the potential risk factors in order to develop appropriate measures to decrease risk. Several explanations have been offered to account for the over-representation of older drivers in fatal and serious injury crashes including age-related changes in functional performance and health status as well as changes in driving factors. There are also a number of gender-specific issues such as functional and health status, physical frailty, travel patterns and driving behaviour that may render older female drivers at increased crash and injury risk compared to older male drivers. Many researchers now contend that the older driver 'problem' is mainly restricted to certain sub-groups of older people, rather than encompassing all older people and much of the recent research, therefore, has shifted from a general approach of ***why*** older drivers have high crash risk to focussing on identifying ***which*** older drivers are most at risk (OECD, 2001). What remains to be established are clear relationships between these factors. These issues are discussed below.

There are also some gender-specific factors that may place older females at higher crash and injury risk compared to men in the same age group, including lack of recent driving experience, avoidance of difficult or stressful driving situations, lack of confidence, health and functional status and greater physical frailty (Charlton, Oxley, Fildes, Newstead & Oxley, 2003; Hakamies-Blomqvist & Sirén, 2003; Parker, MacDonald, Sutcliffe & Rabbitt, 2001; Rosenbloom, 1996; Stutts, Wilkins, Reinfurt, Rodgman & van Heusey-Causey, 2001).

1.3.1 Vulnerability

Frailty, susceptibility to injury and poorer capacity to recover from an injury can also explain at least part of the elevated trauma of older road users. With increasing age, biological processes result in a reduction of resilience to trauma and biomechanical tolerance to injury becomes progressively lower, primarily due to reductions in bone and neuromuscular strength and fracture tolerance.

Women of all ages are more likely to suffer more serious injury than men, given the same physical insult (Evans, 2001; Abdel-Aty & Abdelwahab, 2001; Ulfarsson & Mannering, 2004). There are average physiological differences between males and females that can affect crash injury severity. Physiological differences can arise from average differences in male/female size and weight and their interaction with vehicle safety design (typically designed for the 50^{th} percentile young male driver, location and operation of airbag, crash zones, safety-belt design and seating position), as well as differences in the body to withstand impacts (Ulfarsson & Mannering, 2004).

1.3.2 Health, disability and task performance

Most people experience some level of functional decline as the age, particularly associated with changes in sensation, perception, cognition and physical functioning which may be the result of many factors including 'normal' ageing, onset of medical conditions, lifestyle changes and psychosocial factors, acting together over a long period of time (Morris, 1997; OECD, 2001; Wang, van Belle, Kukull & Larson, 2002). Functional limitations (in one or more activities of daily living) have been observed to be more prevalent with increasing age, with rates increasing from 7 percent for those aged 65 to 74 years to 24 percent in those aged 85 years and older (Manton, 1988). Poor health status can further limit functional performance. Vision Australia (2005) estimates that there are currently approximately 380,000 people living in Australia with legal blindness or low vision (of whom 80% are over the age of 55 years), and expects this number to double by 2030. Further, it has been estimated that at least 10 percent of people older than 65 years and 50 percent of those older than 85 years have some form of cognitive decline or impairment, ranging from mild deficits to dementia (Jorm & Jolley, 1998; Kukull & Ganguli, 2000).

Gender differences in older person's mortality and morbidity rates have been well-defined world-wide. Males have consistently higher mortality rates and shorter life expectancy than females, approximately six years less (Centers for Disease Control and Prevention, 1997). Despite longer survivorship, older females report both greater prevalence of illness and more utilisation of health services than older males (Verbrugge, 1983), and are reported to spend a larger proportion of their lifetime disabled, compared to older males (US Administration on Aging, 2002). In a US epidemiologic study of the elderly, women over 70 years of age reported themselves as 1.8 times more likely than men to be disabled in terms of seven activities of daily living (ADLs), 1.9 times more likely than men to have a gross mobility (walking) limitation, and 2.6 times more likely than men to have a limitation in the ability to move their joints (range of motion) (Cornoni-Huntley, Ostfield, Taylor, Wallace, Blazer, Berkman, Evans, Kohout, Lemke & Scherr, 1993). Smith and Baltes (1998) reported significant gender-related differences in 13 of 28 aspects of personality, social relationships, everyday activity patterns, and reported well-being. A cluster analysis identified 11 subgroups whose profiles of life conditions and health and psychological functioning could be categorised as more or less desirable. The relative risk of a less desirable profile was 1.6 times higher for women than for men.

Jylhä, Guralnik, Balfour and Fried (2001) found interesting associations between self-rated health, age and physical disabilities among older women in Baltimore, USA. Not surprisingly, they noted a strong association of fair or poor self-rated health with increasing severity of walking difficulty, but they also found that the likelihood of reporting fair or poor health decreased as age increased. Women aged 65-74 years were 3.7 times more likely and women aged 75-84 years were 3.1 times more likely to report poor or fair self-rated health than older women aged 85 years or older. They argued that there is a complex pattern of association between age and self-rated health and suggested that self-rated health is a global summary measure in which different health-related aspects are taken into account in relation to different contextual frames (e.g., in the context of one's own age and what is considered usual at that age).

It seems that women have illnesses that do not lead to death and, on the other hand, are more willing to report their illnesses than men are. The reasons for this paradox are complex and may include fundamental biological and physiological differences between men and women as well as psychological and sociological differences in the perception of illness and the threshold for reporting symptoms and disability (Arber & Cooper, 1999). Of most relevance here, is the fact that very little is known about how these differences affect driving performance and crash risk.

Safe and efficient driving requires the adequate functioning of a range of sensory, perceptual, cognitive, executive and physical abilities and loss of efficiency in any function may reduce performance and increase crash risk. Given these changes, then, it may be reasonable to predict that judgements and performance may be hampered when driving, at least in some traffic circumstances. Indeed, much of the recent research on older drivers has focussed on these issues and attempted to identify which older drivers are most at risk, particularly in terms of the relationships between functional performance, medical conditions, health status and crash risk. However, surprisingly few unequivocal relationships have been found between declines in single functions and poor driving performance and or crash risk. Indeed, it is now argued that moderate functional changes related to normal ageing do not appear to lead to a discernible increase in crash risk. Rather, it seems that simultaneous deterioration of multiple relevant functions and/or specific functional deficits linked to certain illness (especially those that lead to cognitive deterioration such as dementia) increase crash risk considerably (Janke, 1994; Marottoli et al., 1998; OECD, 2001).

There is some evidence to suggest that some health factors do influence crash risk of older female drivers. Hu, Trumble, Foley, Eberhard & Wallace (1998) found that women who live alone or who experience back pain had higher crash risk than similar aged men. According to Margolis, Kerani, McGovern, Songer, Cauley and Ensrud (2002), increased risk factors associated with older women drivers (after adjustment for age and miles driven) include exposure (each additional 50 miles driver per week increased crash risk by 14%), a history of falling (one or more falls within the previous year in those who did not walk for exercise increased crash risk by 50%), and physical decline (orthostatic systolic blood pressure drop, poor visual acuity an increased foot reaction time were associated with 10% higher crash risk).

1.3.3 Awareness of performance changes and risk perception

Functional impairments can be partly compensated for by changing driving habits and travel patterns, for example, travelling less frequently, avoiding complex situations, or by travelling slower and taking more time to observe traffic. Indeed, there is substantial national and international evidence to suggest that many older drivers do adjust their driving adequately to suit changing abilities, and do so successfully (Eberhard, 1996; Charlton et al., 2003; OECD, 2001; Rumar, 1986; Smiley, 1999).

It is also possible that some older drivers fail to ‘self-regulate’ appropriately and, as a consequence, may be at higher risk of crash involvement. Indeed, there are reports that some older drivers continue to drive, may into their eighth or ninth decade of life and are unwilling to forfeit their driving privileges. These drivers may be those who lack insight into the impact of ageing on driving skills (Cooper, 1990; Sabey, 1988), those who have inappropriate perception of risk (Holland & Rabbitt, 1992), those who lack the ability to compensate adequately (Yanik & Monforton, 1991), or those with onset of cognitive impairment such as dementia that can hamper good judgement of performance (Morris, 1997).

Support for this comes from a number of studies, suggesting that small but significant proportions of drivers, particularly those with cognitive impairment, do not limit their driving (Stutts, 1998), under-estimate the risk of being involved in a crash, fail to admit to driving errors, feel they have total control to avoid crashes, and believe that a crash would be much more likely to occur through some other cause than their own error (Brainin, 1980; Matthews, 1986).

Marottoli and Richardson (1998) addressed some of these issues, exploring the relationship between confidence, awareness of limitations, driving patterns, performance and crash history in a group of older drivers with a mean age of 81 years. They found that, despite the fact that 40 percent of participants reported a history of adverse events (crash involvement, receiving a violation notice or being stopped by police), and 27 percent displayed moderate to major difficulties in a driving test, all drivers rated themselves as being average or above-average drivers. Similarly, they found that drivers were confident irrespective of on-road performance and/or event history.

1.3.4 Driving experience and confidence

One of the key issues for older female drivers is a lack of up-to-date driving experience and associated lack of confidence in driving. Among today's older couples, the male partner is generally the principal driver when couples driver together. Noble (undated) reported that, in the UK, women were less likely to be main drivers and more likely to be passengers, and the proportion of drivers decline with age. In the age group 50 to 54 years, 47 percent of women were main drivers and a further 20 percent were 'other drivers' in a household with a car. Three-quarters of women aged 80 years and over were non-drivers, living in a household without a car. However, if and when the male partner is unable to drive, it is often left to the female partner to take on the principal driving role. This may be a stressful experience for many older women who do not have the up-to-date experience and the confidence to get behind the wheel.

This is of great concern for the current cohort of older female drivers, since women have a longer average life expectancy than men and also tend to marry older than themselves. It is predicted that seven out of ten baby-boom women will outlive their husbands and many can expect to be widows for 15 to 20 years (US Administration on Aging, 2002). By the year 2020 older women will account for 85 percent of persons aged 65 years and older who live alone.

In addition, it is well documented that older female drivers have less driving experience, both quantitatively and qualitatively, compared to males of similar age. Older female drivers tend to drive fewer kilometres and drive shorter distances than younger females and older males (Rosenbloom, 2004; Charlton et al., 2003). Amongst a sample of Victorian drivers, Charlton et al. (2003) reported that 46 percent of older female drivers drove 100 kms or less per week, compared with 25 percent of older male drivers. The majority of older male drivers (56%) reported driving 200 km or over per week, compared with only 29 percent of female drivers. Moreover, the largest gaps are at the oldest ages. For example, Rosenbloom (2004) reported that, in the USA, men aged 75 to 79 years old made 3.5 trips per day or almost 21 percent more than comparable women and they travelled 25.2 miles per day or 42 percent more than comparable women. But men aged 85 years or older made almost 52 percent more trips and travelled 84 percent more miles than women of that age did.

It has long been recognised that the relationship between travel distance and crash rate is not linear. That is, independent of age, drivers travelling more kilometres will typically demonstrate reduced crash rates per kilometre travelled, compared to those driving fewer kilometres (Janke, 1991). This, it is suggested, is because more experienced drivers may be more proficient in the driving task and so are able to avoid crashes more successfully. There are many reports of the benefits of experience and continued practice for skill development and maintenance and problems for inexperienced drivers in perceiving hazards and possessing the skills needed to avoid risks (e.g., Macdonald, 1994; McKnight, 1997).

While crash rates (per distance travelled) show an over-representation of older drivers compared to younger drivers, it is argued that these comparisons (termed the 'low-mileage bias') may be too simplistic and may inflate older driver risk per km estimates, as they are typically compared with other age groups having larger yearly driving exposure

(Hakamies-Blomqvist, Johansson & Lundberg, 1996; Hakamies-Blomqvist, Raitanen & O'Neill, 2002). 'Low-mileage' drivers may also be those who restrict their driving in response to a perceived decline in driving performance, may have more medical conditions, greater functional difficulties, lack quantitative and qualitative driving experience and lack confidence and intuitively a higher probability of crashing (Eberhard, 1996; Smiley, 1999; Parker et al., 2001; Charlton et al., 2003; Hakamies-Blomqvist & Sirén, 2003; Stutts et al., 2001). In addition, 'low-mileage' drivers may also be those drivers who do their driving on the urban road network. Particularly for older drivers, urban travel is more likely to result in crashes, due to greater numbers of complex traffic environments and possible traffic conflict points, such as at intersections (Keall & Frith, 2004).

Given that older female drivers display many of these characteristics, it may be that they are at increased risk, however, the explanation is certainly complex and warrants further research. For instance, a recent report on the associations between crash involvement and gender derived from a telephone survey of 2,000 older Victorian drivers aged 65 years and over (Langford, Charlton, Fildes, Oxley & Koppel, 2005) revealed that crash rates varied across three different crash denominators. When crash rates per 10,000 drivers were considered, older males had a 1.2 additional crash involvement, compared with older females. However males were more than twice as likely to be driving 100 kilometres or more per week, relative to females. Once different driving exposure was controlled by using crash rates per 10 million driver–kilometres, there was a reversal of the previous finding, i.e., females had a crash rate roughly 1.5 times higher than that of males. More females than males were found in the shortest distance groups, therefore, gender comparisons of crash rates per 10 million driver–kilometres were made separately for males and females in different distance groups, revealing that females had lower crash rates than males for three of the four distance groups. While the numbers of crash-involved drivers were relatively small and the authors acknowledge that the findings should be treated with some caution, they also concluded that, depending upon which of the denominators were used, females were variously safer, less safe or (mainly) safer than males.

Moreover, there are reports that, compared to older male drivers, older female drivers report more difficulties in traffic situations (Bishu, Foster & McCoy, 1991; Rimmö & Hakamies-Blomqvist, 2002), experience several traffic situations as more stressful than males do (Hakamies-Blomqvist & Wahlström, 1998) and have higher overall stress levels while driving (Simon & Corbett, 1996). These experiences of stress might well be associated with higher risk perception and lower risk-taking, compared to male drivers. Older female drivers report more difficulties making left-turns (equivalent of a right-turn in Australia), at signalised and unsignalised intersections, and report more problems with vision and driving postures (Bishu et al., 1991), compared to older male drivers.

Parker et al. (2001) examined confidence in a range of driving situations, self-ratings of driving ability, self-reported driving behaviour and personality and argued that confidence seems to be an important factor in driving performance. They found that surprisingly few older drivers experienced nervousness (less than 5% of the sample), even though the majority were aware of their strengths and weaknesses and recognised changes in abilities with age. They also found that low confidence and high nervousness was associated with being female, relatively low mileage, and a high level of self-reported violations.

Goggin and Keller (1996) found gender differences in driving behaviour and abilities during driver simulation despite no differences in age, educational level, visual acuity or years driving. They argued that these differences may have been the result of strength differences, gender role expectations and marital status as well as greater driving experience of males – males drove more often, under more challenging conditions and for more years than older women.

1.3.5 Reduction and cessation of driving

As discussed previously, various studies both internationally and nationally have shown gender differences in the process of driving reduction and cessation, generally pointing to higher likelihood of driving reduction (in terms of mileage reduction and avoidance of stressful traffic conditions) and voluntary cessation at a younger age and in better health by older women compared with older men (Charlton et al., 2003; Gallo, Rebok & Lesikar, 1999; West, Gildengorin, Haegerstrom-Portnoy, Lott, Schneck & Brabyn, 2003; Hakamies-Blomqvist & Sirén, 2003; Hakamies-Blomqvist & Wahlström, 1998; Stutts, Wilkins, Reinfurt, Rodgman & Van Heusen-Causey, 2001).

Women are more likely to give up driving than men are, and do so for less pressing reasons (Hakamies-Blomqvist & Wahsltröm, 1998). Their decisions to give up driving seem not to be influenced as much by health factors as men's are, however, it also appears that an increasing number of medical conditions are related to driving reduction among both men and women. For example, in their examination of driving patterns and medical conditions amongst older women, Forrest, Bunker, Songer, Coben and Cauley (1997) found that fractures, angina, diabetes and self-reported poor vision were related to driving cessation amongst this group. Notwithstanding, women's driving cessation seems more related to social factors, such as limited driving experience and poor financial status (Eberhard, 1996; Sirén, Heikkenen & Hakamies-Blomqvist., 2001; Sirén, Hakamies-Blomqvist & Lindeman, 2004). The most common reason for driving cessation among older Finnish women was that they had no need to drive anymore, while for men it was poor health. Women also mentioned financial constraints and fear of traffic more often than men did (Hakamies-Blomqvist & Wahsltröm, 1998). A US study showed that women were more likely than men to have personal reasons for driving cessation while men were more likely to blame external reasons (Burkhardt, Berger & McGavrock, 1998). (It is pertinent to add here that older females are more likely to live alone and in poverty or in inadequate housing, to have lower educational attainment and less formal labour force experience than older males: Rosenbloom, 2004). Further, personal driving history seems to be related to driving cessation among women. In a UK study, those women who started their driving career later were more likely to give up (Rabbitt, Carmichael, Jones & Holland, 1996). In contrast, an active driving career predicts driving continuation in old age among women (Sirén et al., 2001).

In their study of driving reduction and cessation, Stutts, Wilkins and Schatz (1999) found gender differences in this process. Men were especially reluctant to stop driving, often denying deterioration in driving skills, feeling a responsibility to provide transport and were less willing to accept transportation help from others. Women, in contrast, were more willing to stop driving particularly if another driver was available, and more likely to develop a network of friends and family to help with transportation. They also noted, however, that there was a sub-set of seniors that may prematurely give up driving even though they may still be capable of driving safely. These are typically women who never really enjoyed driving, had a general lack of driving confidence, who were uncomfortable in the driving environment, and were fearful of crash involvement and had a spouse who enjoyed driving and was readily available to drive. In a related study, Wilkins, Stutts and Schatz (1999) noted that, as women drive less, they may find it difficult to resume driving even when their life circumstances change.

It is interesting to note that, in Queensland, Australia, the number of licences surrendered show an impact of age-based mandatory licence re-assessment, particularly for older women (Figure 3). Women aged 75 years were more likely than men of the same age to voluntarily surrender their licence, evidence of the stress associated with licence re-assessment. Further, peaks for voluntary surrender were generally at younger ages for female drivers than male drivers.

While driving reduction is mostly discussed in a positive way, implying that appropriate reduction and cessation reduces crash and injury risk, there are potential negative implications, particularly if cessation occurs prematurely (and unnecessarily) in terms of personal mobility loss and the trade-off for different travel modes. Studies focussing on the consequences of driving cessation point to negative aspects including increased dependency on other people, decrease in out-of-home activities (Marottoli, Ostfield, Merrill, Perlman, Foley & Cooney, 1993), along with increased depressive symptoms and general well-being (Marottoli, Mendes de Leon, Glass, Williams, Cooney, Berkman & Tinetti, 1997; Burkhardt, 1999), and increased exposure and risk as users of other forms of unprotected transport (pedestrians, public transport, etc.) (OECD, 2001). Therefore, voluntary driving cessation at a relatively early old age, particularly for women who give up driving at a younger age while still physically fit to drive, may indeed be problematic because it may restrict mobility without increasing safety, possibly even decreasing safety (Hakamies-Blomqvist & Sirén, 2003).

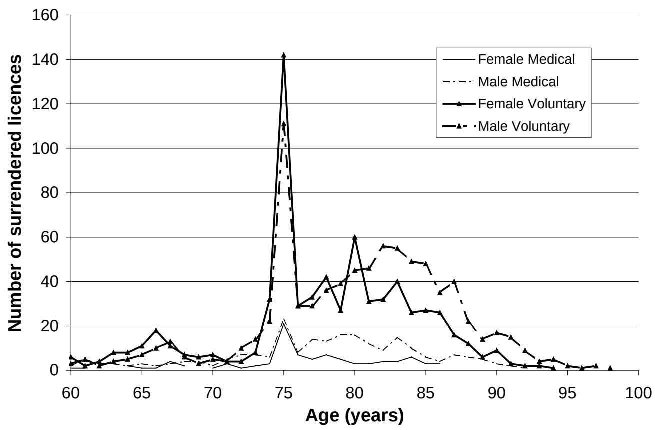

Figure 3: Number of medical and voluntary surrenders of licence, Queensland, 1998.

1.3.6 Summary of risk factors

The safety of older female drivers is an emerging concern, given the predominance of women amongst the oldest old, the growth in dependency on the car, and changes in driving patterns. A number of gender-related factors may render older female drivers at increased crash and injury risk including vulnerability, health and functional status, driving patterns and experience. Clearly, a complete understanding of the relationships between these factors is required in order to develop appropriate measures to reduce crash and injury risk whilst maintaining mobility.

2 STATISTICAL ANALYSIS OF SURVEY DATA

The first stage of this research sought to identify and examine risk factors for crash involvement for older female drivers, using existing data from our recent survey of older female drivers in the ACT (Oxley et al., 2004). First, a brief overview of method and the findings of the initial survey is presented. Following this, the follow-up regression analysis of the risk factors for crash involvement is presented and implications of findings are discussed.

2.1 OVERVIEW OF INITIAL SURVEY

Information on driving experiences, driving and travel patterns and transportation needs, driving decisions, crash history, demographic characteristics, health status and medical conditions, and current mobility was sought from older female drivers and former drivers in the ACT using a self-administered questionnaire.

2.1.1 Method

Briefly, a total of 2,000 questionnaires were mailed to a random sample of older females aged 60 years and over (stratified according to age group) who had ACT Senior Card membership. In total, 839 (42%) of surveys were returned, however, only 726 of these were complete, of which 673 indicated they were current drivers. The analyses of current drivers only are presented here. For detailed information relating to the development of the questionnaire, and recruitment or participants, the reader is referred to Oxley et al., (2004).

2.1.2 Results

General demographic information of current drivers is summarised in Table 1. The majority of drivers were married, aged 65 to 74 years old, retired, living independently and close to local shops and services. They generally drove frequently and travelled substantial distances each week, with most travelling between 21 and 100 kilometres per week. Younger drivers tended to drive longer distances than older drivers, $\chi^2_{(18)}=29.65$, $p<0.05$. Seventy percent of drivers indicated that they were the principal driver in their household. Marital status was significantly related to principal driver status, $\chi^2_{(5)}=300.06$, $p<0.001$, with married women less likely to be principal drivers than those who were widowed and/or divorced.

In addition, drivers were asked to rate their overall health status and indicate whether they suffered from any medical conditions, including vision problems, difficulty with daily living tasks and whether they were on long-term medications for any medical condition. Overall, the majority of drivers rated their health as either excellent or very good (60%), 32 percent rated their health as good and only a small proportion (7%) rated their health as fair or poor. Most drivers indicated that they had ongoing medical conditions (40%) such as arthritis, osteo-arthritis, high blood pressure, diabetes, heart condition, hypertension and osteoporosis, and 29 percent reported vision problems. Sixty-six percent were taking long-term prescribed medication. Only 11 percent indicated they experienced difficulties with activities of daily living and these included climbing stairs, lifting heavy objects, kneeling and bending, and walking long distances.

Table 1: Summary of demographic and driver characteristics of survey participants

Variable	Proportion of Drivers (n=673)
<u>Age Group</u>	
60-64 years	26.9
65-74 years	56.2
75+ years	16.9
<u>Marital Status</u>	
Married/Defacto	44.1
Widowed	32.7
Divorced/Separated	16.7
Never Married	6.5
<u>Principal Driver Status</u>	
Principal driver	68.6
<u>Kilometres Driven Per Week</u>	
under 20kms	8.7
21 to 50 kms	28.6
51 to 100 kms	28.8
101 to 200 kms	19.8
over 200kms	8.6
Not sure	5.5

Drivers were asked a series of questions about their driving to examine their confidence of being a safe driver, and difficulty with specific driving situations. In general, the majority of drivers (70%) were very confident that they were safe drivers. These were generally principal drivers, $\chi^2_{(3)}=9.17$, $p<0.05$, drivers who did not prefer to have a passenger, $\chi^2_{(15)}=25.65$, $p<0.05$, and younger drivers (although this failed to reach statistical significance, $p=0.55$).

Interestingly, the majority of drivers indicated that the amount they drove had not changed over the past five years, however, age group, reported health status, principal driver status and confidence of being a safe driver were associated with this. Those who were aged under 75 years, who reported excellent or very good health status, were the principal driver in the household and were confident that they were a safe driver were more likely to drive about the same or more, compared with five years ago (age group, $\chi^2_{(9)}=19.95$, $p<0.01$; health status, $\chi^2_{(12)}=33.86$, $p<0.01$; principal driver status, $\chi^2_{(3)}=12.58$, $p<0.01$; confidence of being a safe driver, $\chi^2_{(9)}=26.96$, $p<0.01$).

Drivers were asked to identify whether particular driving situations were a problem for them. Overall, drivers were more likely to indicate that they did not have problems with any of the listed driving situations, however, substantial proportions of drivers reported experiencing problems with driving at night or in poor weather conditions, driving on unfamiliar roads or in unfamiliar areas, the driving style of other drivers, and driving on busy roads (Figure 4). Other reported problems included reversing into parking bays, getting lost, car breaking down and being tail-gated by other drivers.

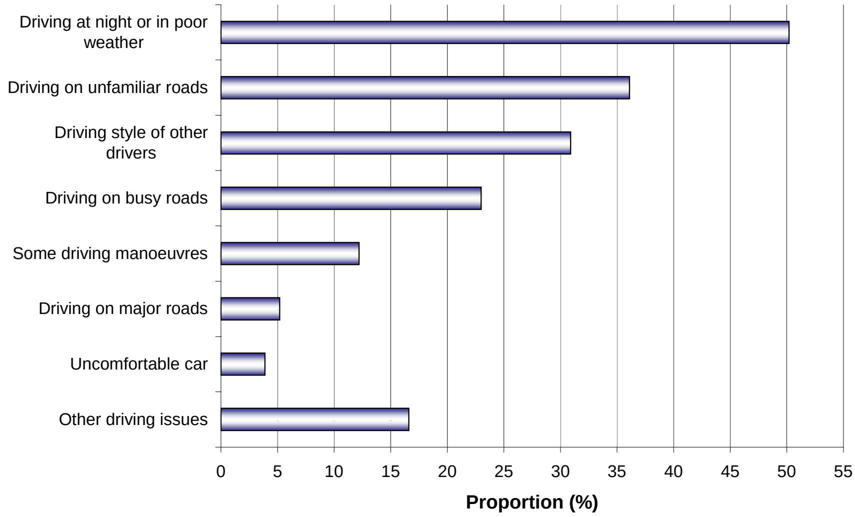

Figure 4: Summary of driving situations that were reported as being a problem by current drivers.

Reported problems with driving situations were associated with other variables and the outcomes of analyses are shown in Table 2. In general, older drivers with vision problems and self-reported poor health status were more likely than younger drivers without vision problems and self-reported good health status to report problems driving on unfamiliar roads and driving at night or in poor weather conditions.

Table 2: Summary of comparisons between problems with driving situations and other variables for current drivers.

	Problem Driving Situations					
	Major roads	**Other drivers**	**Busy roads**	**Difficult manoeu-vres**	**Unfamiliar roads**	**Night, poor weather**
Age Group	n/s	$p < 0.05$	n/s	n/s	$p < 0.001$	$p < 0.01$
Health Status	n/s	n/s	n/s	n/s	$p < 0.05$	$p < 0.05$
Vision Problems	$p < 0.05$	$p < 0.01$	n/s	n/s	$p < 0.01$	$p < 0.001$
Medical Condition	n/s	n/s	n/s	n/s	n/s	n/s
ADL Problems	n/s	$p < 0.01$	n/s	$p < 0.01$	n/s	n/s
Confidence	$p < 0.001$	$p < 0.01$	$p < 0.001$	$p < 0.001$	$p < 0.001$	$p < 0.001$
Principal Driver	$p < 0.05$	n/s	$p < 0.001$	n/s	n/s	n/s
Crash-involved	n/s	$p < 0.01$	n/s	n/s	n/s	n/s

Those who reported vision problems were also more likely than those without vision problems to report having problems on major roads and older drivers were more likely than younger drivers to have problems with the driving style of other drivers. Drivers who reported difficulties with daily living tasks were more likely than those without these difficulties to indicate they experienced problems with some driving manoeuvres and the driving style of other drivers. Confidence of being a safe driver was highly associated with the likelihood of reporting problems with driving situations: Those who were moderately or not at all confident that they were a safe driver were more likely to report problems in all driving situations than those who reported that they were very confident of being a safe driver.

In addition, drivers were asked a series of questions addressing the issues of driving reduction and cessation, their experiences, and thoughts about stopping driving. Of the 20 percent of drivers who indicated that they had reduced the amount of driving in the last five years, the majority (77%) indicated this was a gradual process. The most common reason for driving reduction was simply because there was no need to drive as often (93%). Other responses related to discomfort in driving: 39 percent indicated that they didn't enjoy driving or just preferred not to drive as much, while 30 percent indicated that they didn't feel as safe a driver as they used to.

In general, drivers had not thought much about the possibility of not driving one day, nor had they made many plans for this event. It appeared that health-related issues were associated with this. Those who reported problems with vision and presence of a long-term medical condition were more likely to think about not driving in the future a little or a lot. In contrast, those with no problems with vision or no ongoing medical conditions were more likely to report not thinking of driving cessation, $\chi^2_{(3)}=13.40$, $p<0.01$ and $\chi^2_{(3)}=10.53$, $p<0.05$ respectively.

In terms of future driving amongst current drivers, responses indicated that drivers felt very strongly about keeping driving, with 59 percent indicating that keeping driving for as long as possible was very important. This view was particularly evident amongst principal drivers, those who did not have another available driver in the household, drove frequently and longer distances, enjoyed driving and were confident of being a safe driver. Further, the majority of drivers voiced strong concerns about not being able to drive including loss of independence, inconvenience (to self and to others), problems reaching services and social limitations

Drivers were asked to indicate whether they had been in a crash or incurred any traffic infringements (other than parking fines) over the last five years. Only 12 percent (n=75) of the sample reported that they had been involved in a crash and 13 percent (n=86) had incurred infringements. Given that the numbers of reported crashes and infringements were low, there were few associations with other factors, such as age group, health-related factors, problem driving situations, and confidence of being a safe driver. There were, however, some associations between crash involvement and other variables, particularly exposure factors. For instance, those who drove more kilometres per week were more likely to have been involved in a crash than those who drove fewer kilometres per week, $\chi^2_{(6)}=14.31$, $p=0.026$. Similarly, those who drove more frequently (at least three to four times per week) reported being involved in more crashes than those who drove less frequently (once or twice a week or less), $\chi^2_{(4)}=10.79$, $p=0.029$. Principal driver status was also associated with crash involvement, $\chi^2_{(1)}=19.26$, $p<0.001$. Those who considered themselves to be the principal driver in the household were more likely than those who did not do most of the driving in the household to have been in a crash in the last five years. In addition, there was some suggestion that crash involvement was associated with lack of confidence of being a safe driver, p=0.78. Those who had been involved in a crash were more likely to report that they were not at all confident of being a safe driver. In contrast, those who had not been involved in a crash were more likely to indicate that they were very confident that they were a safe driver.

These results demonstrated that there are a number of travel, driving and health factors that contributed to crash risk of this sample of older female drivers. Women who drove more often and longer distances were more likely to have been involved in a crash than women who drove less. These findings may purely be an artefact of increased exposure – those who drive more are exposed for longer periods of time to the risks of crashes. However, as noted previously, this is in contrast to the view that it is those who drive fewer kilometres who are at increased crash risk. Notwithstanding the question about the influence of exposure, it is clear that other factors may play some role here, for example, driving style, and when and where older women drive. Indeed, the finding that lack of confidence of being a safe driver among this sample of women was also associated with crash involvement suggests that it is not solely an exposure issue and requires more robust analyses of the data.

2.2 FOLLOW-UP ANALYSES

The survey data provided a rich source of information to understand the relationship between health and driving factors and the impact on crash risk. These relationships were explored further in the following analyses.

2.2.1 Method

To understand the relationships between independent variables better, logistic regression was used to model the 'at risk' older female driver, using crash involvement in the last five years as the dependent variable and taking correlations between other variables into account. Because the format of most variables in the survey meant that most of the data collected was categorical, it was decided that logistic regression was the best statistical method for determining how different factors contribute to the risk of older female drivers being involved in a crash.

2.2.1.1 Selection of potential contributing factors

Potential contributing factors that were considered for inclusion in the model were chosen using two methods. First, items from the survey of current drivers were included if preliminary bivariate analyses identified these items as being significantly related to whether respondents had been in a crash during the last five years. Second, a priori knowledge of previous literature was used to identify potential relationships between independent and dependent variables. Thirteen independent variables were identified as being potential confounding factors and these are listed in Table 3.

Variables were selected for inclusion in the model based on i) examination of the Wald statistics of each factor, ii) examination of the Likelihood-Ratio (LR) test which compared differences between models, and iii) researcher's decision based on a priori knowledge. This flexibility allowed the most accurate and useful model to be built by using the knowledge of both the data set and the evidence-based relationships between variables.

Table 3: Factors identified as potential contributors of crash involvement in the last five years (with possible responses and p-value for the Log Likelihood function univariate logistic regression model in which the effect of only one variable is controlled).

Independent Variable	Possible Responses	p-value of Log Likelihood
Principal driver status	No Yes	 p<0.001
Kilometres driven per week *	≤ 100 km > 100 km not sure	 p=0.61 p=0.28
Confidence of being a safe driver	Very confident Moderately confident Not at all confident	 p<0.02 p=0.29
Sharing driving on long-distance trips	No Yes	 p=0.34
Problems driving on major roads	No Yes	 p=0.66
Problems with driving style of other drivers	No Yes	 p=0.01
Problems driving on busy roads	No Yes	 p=0.51
Problems with some driving manoeuvres	No Yes	 p=0.62
Problems driving on unfamiliar roads or unfamiliar areas	No Yes	 p=0.31
Problems driving at night or in poor weather conditions	No Yes	 p=0.82
Description of feelings about driving	Always enjoyed driving Used to enjoy more than now Never liked driving much Driving is something you have to do	 p=0.38 p=0.31 p=0.44
Age group *	60-64 years 65-69 years 70-74 years 75+ years	 p=0.43 p=0.18 p=0.13
Experienced problems with vision	No Yes	 p=0.64

** Note: For survey items related to the variables kilometres driven per week and age group, drivers were given slightly different options to possible responses shown in Table 3. Due to small numbers of responses in some cells, response categories were merged and reclassified. For kilometres driven per week, responses of 'less than 20km', '21-50km' and 50-100km' were reclassified as belonging to the group who usually drove less than or equal to 100km per week. Wile those who responded that they usually drove '101-200km' or 'more than 200km' were reclassified as members of the group who drive more than 100km per week. Similarly, for the survey item related to age group, respondent who indicated their age as being in the 75-79 years, 80-84 years, 85-89 years, 90-94 years or 95+ years groups were reclassified as part of a 75+ years age group.*

2.2.2 Results

The sample of 673 survey respondents who considered themselves to be current drivers provided the data to build the regression model to predict the factors associated with crash involvement. Some of the respondents did not provide answers to some survey questions. Due to this missing data, data from 583 respondents were used to calculate the odds ratios of the final regression model.

2.2.2.1 Building the main effects model

The goal of logistic regression modelling was to find the best fitting and simplest model that describes the relationships between being involved in a crash in the last five years and the independent variables identified above.

Each of the variables listed in Table 3 were of equal interest, therefore a ‘prediction model’ was selected because of its capacity to predict an outcome using data from a series of equally important confounding factors. The end result of the model building process was a model that estimates the odds ratios for each independent variable included in the model while adjusting each odds ratio for the confounding effects of the other independent variables. Generally, independent variables were included in the model if their inclusion significantly improved the model’s ability to predict correct outcomes. However, if an independent variable affected the confidence intervals of the odds ratios of other confounding factors already in the model, then it was also considered an important variable.

Not all factors or independent variables that were thought to have a relationship to the outcome variable were included in the final model. This was because the goal of a logistic regression analysis is to build a simple and accurate model that provides strong predictive power of the outcome variable (crashes), not necessarily one that adjusts for all contributing variables. In addition, data constraints such as small sample sizes and thinly populated covariate groups prevented all independent variables from being included in the final model.

The first step in building the model was to build separate univariate models for each independent variable. The Log Likelihood function was used to determine whether any of these were significantly better than a model that does not adjust for any independent variables. The univariate models relating to principal driver status, confidence of being a safe driver, problems with the driving style of other drivers, and age group were all significantly better than the model that doesn’t adjust for any of these independent variables (Table 3). However, the Wald statistics for the age-related variables were far from significant ($p>0.78$) and the LR test showed their removal did not alter the model, $\chi^2_{(3)}=0.18$, $p=0.98$. Therefore, the model was simplified by removing the age-related variables.

In addition, the confidence intervals of the odds ratio for confidence of being a safe driver were very large. This was due to a small number of ‘not at all confident’ responses. This variable was subsequently reclassified using two categories, ‘very confident’ and ‘moderately or not at all confident’. All variables were then added back to the model one at a time. The Wald value for the new confidence variable was significant ($z=2.07$, $p<0.04$). Similarly, the Wald statistic for the variable sharing long-distance driving was also significant, $z=-2.09$, $p<0.04$). Therefore these two variables were added to the main effects model which served as the foundation of the final model (Table 4).

Table 4: The main effects model that controls for predictive variables

Crash involvement	Odds Ratio	SE	Wald statistic	p-value	95% Conf. Interval	
Principal driver status	5.84	2.59	3.99	0.001	2.45	13.92
Confidence	2.03	0.56	2.55	0.01	1.18	3.49
Problems with other drivers	1.90	0.55	2.23	0.03	1.08	3.34
Shared long-distance driving	1.60	0.45	1.66	0.10	0.92	2.79
Problems on unfamiliar roads	0.59	0.18	-1.72	0.09	0.32	1.09
Log. Likelihood = -193.71						

2.2.2.2 Addition of interaction terms

All possible interactions between the variables included in the main effects model were tested. Inclusion of only three interactions resulted in a model that was significantly different than the main effects model. These interactions were between the variables principal driver status and problems driving on unfamiliar roads, p=0.003, between kilometres driven and problems with the driving style of other drivers, p=0.08, and between problems with the driving style of other drivers and problems driving on unfamiliar roads, p=0.04. Table 5 shows the final model.

Table 5: The final model that controls for predictive variables and interactions

Crash involvement	Odds Ratio	SE	Wald statistic	p-value	95% Conf. Interval	
Principal driver status	5.97	2.66	4.01	0.001	2.49	14.29
Confidence	1.94	0.55	2.36	0.02	1.12	3.37
Sharing long-distance driving	0.98	0.36	-0.06	0.95	0.48	1.99
Problems with other drivers	0.54	0.31	-1.09	0.28	0.18	1.64
Problems driving on unfamiliar roads	0.25	0.14	-2.47	0.01	0.09	0.75
Problems with other drivers and problems driving on unfamiliar roads	4.54	3.18	2.16	0.03	1.15	17.92
Problems with other drivers and shared long-distance driving	3.25	1.90	2.01	0.05	1.03	10.24
Log. Likelihood = -189.58						

Due to prohibitively large standard errors, the interaction between principal driver status and problems driving on unfamiliar roads was not added to the main effects model. The other two interactions were added to the main effects model, as the LR comparisons revealed significant differences between models. The final model therefore was made up of the main effects model plus the two interactions between kilometres driven and problems with the driving style of other drivers and between problems with the driving style of other drivers and problems driving on unfamiliar roads.

2.2.2.3 Odds ratios of crash involvement for each independent variable

This section presents the calculated odds ratios of having had a crash in the last five years for independent variables separately. In cases in which an interaction was found, results are presented for each level of the other independent variable. In order to do this, it was necessary to take the exponential of the difference of the logit transformation of the model for different values of the independent variable being examined. The logit transformation of the final model is represented by the following equation:

$$\begin{aligned} g(x) &= -3.650847 + 1.785895 * b2\_most - 0.664463 * b11\_new \\ &- 0.021858 * b13\_dist - 0.619408 * b17\_drvr - 1.371305 * b17\_unfm \\ &+ 1.513037 * b17\_drvr * b17\_unfm + 1.177409 * b17\_drvr * b13\_dist. \end{aligned}$$

where: b2_most = principal driver status
b11_new = confidence
b13_dist = sharing long-distance driving
b17_drvr = problems with driving style of other drivers
b17_unfm = problems driving on unfamiliar roads

2.2.2.3.1 Principal driver status

As the model does not contain any interactions involving principal driver status, the following conclusions can be drawn:

- The odds of having a crash in the last five years for a driver who did most of the driving in the household was 5.97 times greater than that of a similar driver who did not do most of the driving in the household. This difference was significant.

2.2.2.3.2 Confidence of being a safe driver

As the model does not contain any interactions involving confidence of being a safe driver, the following conclusion can be drawn:

- The odds of having a crash in the last five years for a driver who was moderately or not at all confident of being a safe driver was 1.94 times greater than that of a similar driver who was very confident of being a safe driver. This difference was significant.

2.2.2.3.3 Sharing the driving on long distance trips

The model contained an interaction involving sharing the driving on long distance trips and having problems with the driving style of other drivers. Therefore, odds ratios are presented regarding sharing the driving on long distance trips separately for when a respondent indicated that they had problems with the driving style of other drivers and when the indicated that they did not have problems with other drivers. Figure 5 shows odds ratios and confidence intervals by responses indicating having problems with the driving style or others or not.

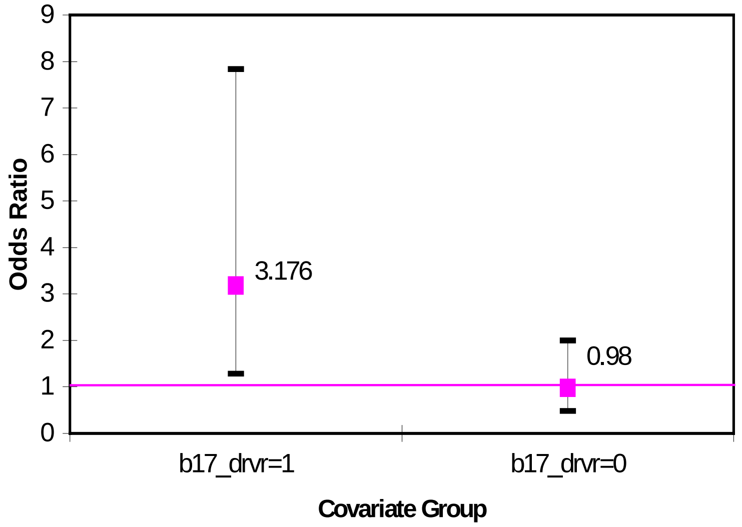

Figure 5: Odds ratios of crash involvement for positive and negative response with regard to shared long distance driving for those who had problems with the driving style of other drivers (b17_drvr=1) and those who did not have problems with other drivers (b17_drvr=0).

The following conclusions can be drawn:

- For drivers who had problems with the driving style of other drivers, the odds of having a crash in the last five years for a driver who shared long distance driving was 3.18 times greater than that of a similar driver who did not share long distance driving. This difference was significant.

- For drivers who did not have problems with the driving style of other drivers, the odds of having a crash in the last five years for a driver who shared long distance driving was 0.98 times greater that that of a similar driver who non not share long distance driving. This difference was not significant.

2.2.2.3.4 Having problems with the driving style of other drivers

The two interactions in the final model both involve the variable of having problems with the driving style of other drivers. Therefore, odds ratios are presented regarding having problems with the driving style of other drivers separately for four different covariate groups:

i) respondents who shared driving on long distance trips and had problems on unfamiliar roads,

ii) respondents who shared driving on long distance trips and did not have problems on unfamiliar roads,

iii) respondents who did not share driving on long distance trips and had problems on unfamiliar roads, and

iv) respondents who did not share the driving on long distance trips and did not have problems on unfamiliar roads.

Figure 6 shows odds ratios and confidence intervals by responses indicating having problems with the driving style or others or not.

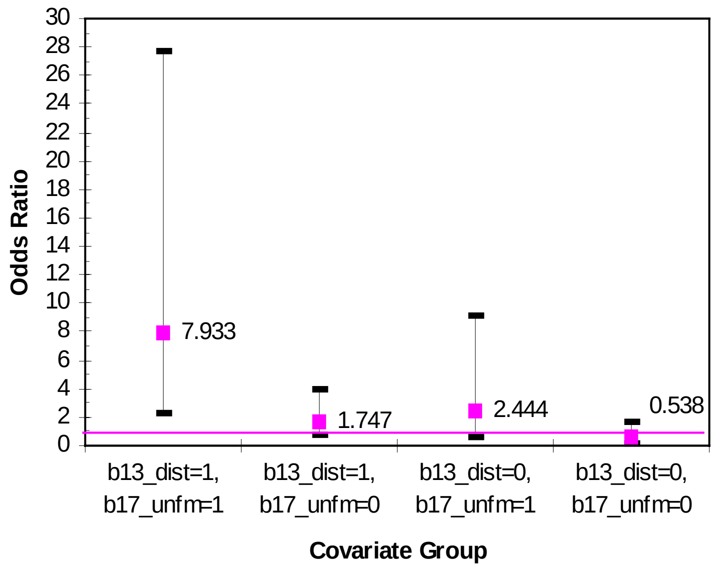

Figure 6: Odds ratios of crash involvement for positive and negative response with regard to having difficulty with the driving style of other drivers for those who shared driving and had problems on unfamiliar roads (b13_dist=1, b17_unfm=1), those who shared driving and did not have problems on unfamiliar roads (b13_dist=1,b17_unfm=0), those who did not share driving and had problems on unfamiliar roads (b13_dist=0, b17_unfm=1) and those who did not share driving and did not have problems on unfamiliar roads (b13_dist=0,b_17_unfm=0).

The following conclusions can be drawn:

- For drivers who shared driving on long distance trips and had difficulty driving on unfamiliar roads, the odds of having a crash in the last five years for a driver who had problems with the driving style of other drivers was 7.93 times greater than that of a similar driver who did not have problems with other drivers. This difference was significant.

- For drivers who shared driving on long distance trips and did not have difficulty driving on unfamiliar roads, the odds of having a crash in the last five years for a driver who had problems with the driving style of other drivers was 1.75 times greater than that of a similar driver who did not have problems with other drivers. This difference was not significant.

- For drivers who did not share driving on long distance trips and had difficulty driving on unfamiliar roads, the odds of having a crash in the last five years for a driver who had problems with the driving style of other drivers was 2.44 times greater than that of a similar driver who did not have problems with other drivers. This difference was not significant.

- For drivers who did not share driving on long distance trips and did not have difficulty driving on unfamiliar roads, the odds of having a crash in the last five years for a driver who did not have problems with the driving style of other drivers was 1.86 (1/0.54) times greater than that of a similar driver who did nave problems with other drivers. This difference was not significant.

2.2.2.3.5 <u>Having problems driving on unfamiliar roads or in unfamiliar areas</u>

The model contained an interaction involving having problems driving on unfamiliar roads and having problems with the driving style of other drivers. Therefore, odds ratios are presented regarding driving on unfamiliar roads separately for when a respondent indicated that they had problems with the driving style of other drivers and when the indicated that they did not have problems with other drivers. Figure 7 shows odds ratios and confidence intervals by responses indicating having problems driving on unfamiliar roads or not.

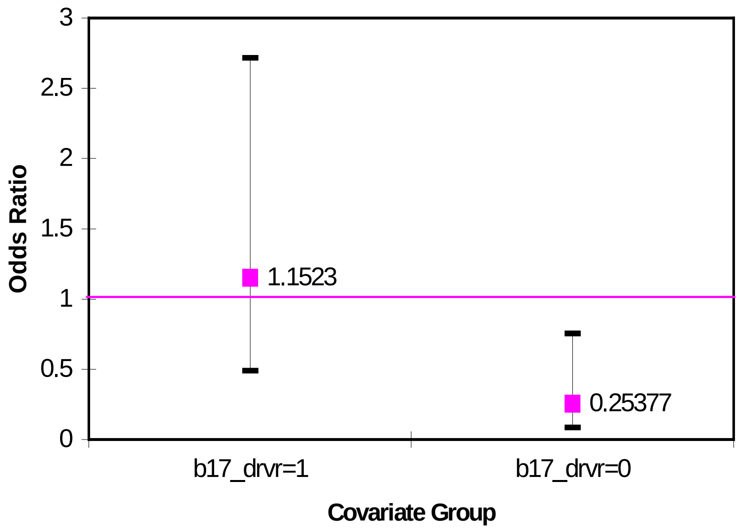

Figure 7: Odds ratios of crash involvement for positive and negative response with regard to having problems driving on unfamiliar roads or in unfamiliar areas for those who had problems with the driving style of other drivers (b17_drvr=1) and those who did not have problems with other drivers (b17_drvr=0).

The following conclusions can be drawn:

- For drivers who had problems with the driving style of other drivers, the odds of having a crash in the last five years for a driver who had problems driving on unfamiliar roads was 1.15 times greater than that of a similar driver who did not have problems driving on unfamiliar roads. This difference was not significant.

- For drivers who did not have problems with the driving style of other drivers, the odds of having a crash in the last five years for a driver who did not have problems driving on unfamiliar roads was 3.94 (1/0.254) times greater than that of a similar driver who did have problems driving on unfamiliar roads. This difference was not significant.

2.2.2.4 Conditional probabilities of covariate groups

In order to identify more clearly the 'at-risk' older female driver, conditional probabilities for each of the co-variate variables included in the above logistic regression model were calculated and ranked. There were 32 different co-variate groups in the data set and these were ordered in the ranking assigned to them (Figure 8). For example, the co-variate group ranked number 1 was being the principal driver, moderately confident or not confident at all regarding their safety as a driver, shared long-distance driving, had problems with the driving style of others and had problems driving on unfamiliar roads. Women in this group were the most likely to have been involved in a crash in the last five years (probability of crash involvement: 0.372). The covariate group least likely to have been involved in a crash (ranked number 32) was not the principal driver, highly confident of being a safe driver, shared long distance driving, did not have problems with the driving style of other drivers and had difficulty driving on unfamiliar roads (probability of crash involvement: 0.006).

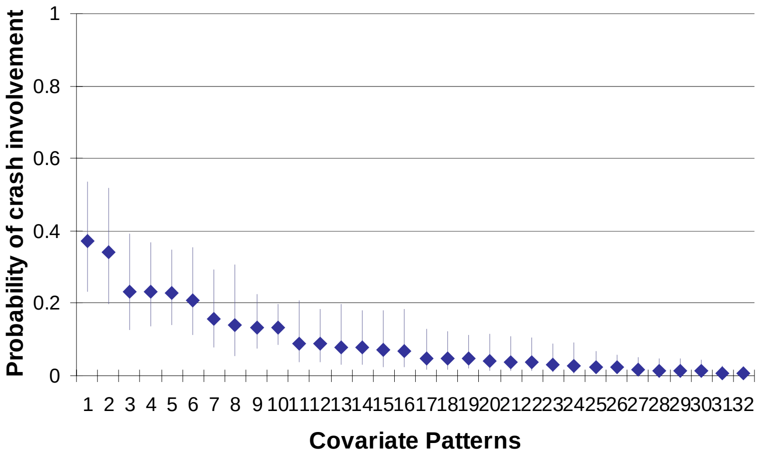

Figure 8: Conditional probabilities of crash involvement for each of the co-variate patterns.

2.2.3 Summary of regression analyses

Logistic regression modelling was used to enable a clearer understanding of the effects of factors on the odds of being involved in a crash. The final model estimated the odds ratios of being involved in a crash in the previous five years while adjusting for the following five potential contributing factors:

- Principal driver status

- Confidence of being a safe driver

- Sharing driving on long distance trips
- Experiencing problems with the driving style of other drivers, and
- Experiencing problems driving on unfamiliar roads or in unfamiliar areas.

Other potential contributing factors were also tested. However, they were not included in the final model either because they showed no significant relationship with crash involvement or their inclusion weakened the predictive power of the model. The factors not included in the model were:

- Kilometres driven per week,
- Experiencing problems driving on major roads,
- Experiencing problems driving on busy roads,
- Experiencing problems with some driving manoeuvres,
- Experiencing problems driving in poor weather conditions,
- Drivers' level of enjoyment of driving,
- Drivers' age, and
- Whether drivers reported any vision problems.

In summary, the analysis revealed that the most 'at-risk' covariate pattern for current drivers in this study were those who:

- Were the principal driver,
- Were moderately or not at all confident that they were a safe driver,
- Shared the driving on long-distance trips,
- Had problems with the driving style of other drivers, and
- Experienced problems driving on unfamiliar roads.

3 CASE-CONTROL STUDY

The second phase of this project was undertaken to establish a more complete understanding of the contributing factors to crash and injury risk amongst older female drivers in the ACT, particularly the effect of functional performance limitations on crash risk. A case-control study was undertaken to achieve the following aims:

- To compare the characteristics, driving experiences and travel patterns of a sample of crash-involved older female drivers with a sample of non-crash-involved older female drivers,

- To examine the impact of functional performance limitations on crash and injury risk by comparing the functional performance of a sample of crash-involved older female drivers with a sample of matched non-crash-involved older female drivers, and

- To provide recommendations for appropriate countermeasures aimed to reduce the crash and injury risk of older female drivers in the ACT.

This section describes the methods used to undertake the research including participant details, administration of tests of functional performance and questionnaire development. It also presents the findings of the study, comparing the performance and driving characteristics of crash-involved drivers with that of non-crash-involved drivers. The impacts of these characteristics on crash and injury risk are discussed.

3.1 METHOD

Information on functional performance, health status and driving characteristics that may impact on crash risk was collected using a case-control study of two groups of older female drivers aged 60 years and older in the ACT. Following ethical clearance from the Monash University Standing Committee on Ethics in Research Involving Humans (SCERH), recruitment and testing of participants was undertaken by researchers in the Older Road User Research team.

3.1.1 Participants

A total of 92 older female drivers aged 60 years and older took part in this study, consisting of two groups: 48 'cases', those who reported having had a crash in the last five years and 44 'controls', those who reported having not had a crash in the last five years. Two participants initially identified as controls were subsequently re-classified as cases on the basis of self-reported crash involvement provided in the follow-up questionnaire.

3.1.1.1 Recruitment

Participants responding to the initial survey (Oxley et al., 2004) were given the opportunity to indicate their interest in participating in a follow-up study by providing their contact details (name phone number). Of the total sample of current drivers, 325 women (43%) agreed to be contacted for future research, and they formed the potential sample pool for follow-up studies. Of these, 36 women had indicated that they had been involved in a crash in the last five years, forming the potential pool of 'case' participants. Therefore, 289 drivers formed the potential pool of 'control' participants. Extra 'case' participants were recruited from a separate survey on self-regulatory practices amongst older drivers in the ACT and NSW who also provided their contact details for any additional studies (study also funded by NRMA-ACT Road Safety Trust).

Potential participants were telephoned, the aims and methods of the study were explained and they were invited to participate. If they agreed, a convenient appointment time was arranged. All participants were sent an explanatory letter outlining briefly the nature of the research, the aims of the study and confirming the time and place of their appointment (see Appendix A). Contact details of the researchers were also provided, should they require a re-scheduling of their appointment. Taxis were offered for those who preferred not to drive. On the day prior to testing, participants were contacted by telephone to remind them of their appointment time and the venue location.

3.1.1.2 Matching criteria

Case and control participants were matched as closely as possible on four characteristics. These were marital status, age group, kilometres driven per week and self-reported health status. These characteristics were listed and potential control participants were selected by matching the characteristics as closely as possible with the case group.

All potential case participants were invited to participate in the study first and then potential control participants were invited. Potential control participants were ranked in priority of number of matching criteria with case participants. Those who matched the highest number of cases on all four criteria were invited first, those who matched the highest number of cases on three criteria were subsequently invited. This prioritising continued until a similar number of control participants to case participants agreed to take part in the study.

3.1.2 Procedure

Testing was undertaken during a two-week period in February, 2005 at the ACT-Council of the Ageing offices. On arrival, the nature and aims of the research, confidentiality of results and the procedure was explained to each participant. They were then asked to sign a consent form which indicated their understanding of the study aims and willingness to take part in the study. They were also asked to indicate whether or not they would like to be informed of their assessment performance. All participants were given a revocation of consent form should they wish to withdraw from the study in accordance with the Monash University Standing Committee on Ethics in Research on Humans (see Appendix B).

Following this, participants undertook the assessments of functional performance. A battery of assessments designed to assess visual, perceptual, attentional, cognitive and motor functioning was administered and order of testing was counterbalanced. Assessments are described in detail in the following section. Testing took approximately 1 hour. On completion of the assessments, participants were given a follow-up questionnaire that gathered recent and detailed information on health status, medical conditions, driving experiences and crash involvement. Participants were given the choice to complete the questionnaire immediately or at a later date at home and post it to the researchers.

3.1.3 Functional performance assessments

Four assessments of functional performance were selected on the basis of previous findings linking functional performance measures and driving competence and crash experience

(Janke, 1994; Fildes et al., 2004; Scientex, 1999; Owsley, McGwin & Ball, 1998). They are described below and include:

- **Gr**oss **Imp**airments **S**creening Battery of General Physical and Mental Abilities (GRIMPS) (Scientex, 1999);

- **M**attis **O**rganic **M**ental **S**yndrome **S**creening **E**xamination (MOMSSE) (Mattis, 1976);

- **U**seful **F**ield **o**f **V**iew test (UFOV) (Ball & Owsley, 1991); and,

- **S**ubtle **C**ognitive **I**mpairment **T**est (SCIT) (Yelland, Robinson, Friedman & Hutchison, 2004).

3.1.3.1 GRIMPS (Scientex, 1999).

The GRIMPS test is a paper and pencil test that measures a number of skills and abilities that are believed to be important for the driving task including tests of cognitive and gross motor functioning such as lower limb strength, endurance and co-ordination, upper body flexibility, memory, visual search and scanning, and sign recognition. These skills are believed to be at risk of decline in older age and it is believed that such a decline may place a driver at increased risk of crashing.

The GRIMPS is comprised of eleven sub-tests. Performance for each task was scored (timed, number of errors, etc.) as either 'average or above' or 'below average', using criteria established by the test developers. A point was given for an 'average or above' score on each sub-test and an overall total score (maximum 11) was obtained. A description of each sub-test and the criteria required to score 'average or above' is listed below.

1. Rapid-Pace Walk – Participants are required to walk along a line (approximately 10ft long) on the ground as quickly as possible. This task is timed. Participants who complete the task in 7s or less score an 'average or above' rating.

2. Foot-tap Test – Participants are required to sit in a chair and tap their foot from side to side (five times on each side of a folder). This task is timed. Participants who complete the task in 8s or less score an 'average or above' rating.

3. Cued Recall – The assessor reads three short words (e.g., bed, apple, shoe) to the participant and asks them to repeat the three words. Following this the assessor asks the participant to remember the words for later. Participants score an 'average or above' rating if they can recall all three words.

4. Arm Reach – Participants are asked to raise both arms (one at a time) as high over their head as they can. Participants who can lift each arm so that their elbow is shoulder height score an 'average or above' rating.

5. Head/Neck and Upper Body Rotation – Participants are required to sit in a chair with a lap sash seat belt on and look over each shoulder and read a time on a clock face held up behind them. Participants who can turn and correctly read the presented time scored an 'average or above' rating.

6. Motor-Free Visual Perception – Participants are shown 11 incomplete objects and are required to identify what each object would look like if the object was completed from a selection of choices. Participants who make 2 or less errors score an ‘average or above’ rating.

7. Delayed Recall – Participants are asked to remember the three words presented to them earlier in the cued recall task. Participants score an ‘average or above’ rating if they can correctly recall 2 or 3 of the words.

8. Scan Test – Participants are required to stand at arms length in front of the assessor and, without moving their head, scan a chart held in front of them and name all of the shapes presented. Scan patterns are scored in the following categories: normal = clockwise, by rows, etc.; erratic = identified in haphazard way; neglect = 2 or more shapes not identified. Participants who demonstrate ‘normal’ scanning method score an ‘average or above’ rating.

9. Trails A – Participants are required to connect a series of numbers in ascending order from 1 to 12 on a sheet of paper as quickly as possible. This task is timed. Participants who complete the task in 30s or less score an ‘average or above’ rating.

10. Trails B – Participants are required to connect a series of numbers and letters in ascending order (e.g., 1-A-2-B-3-C…..) on a sheet of paper. This task is timed. Participants who complete the task in 210s or less score an ‘average or above’ rating.

11. Visual acuity – Participants are required to read a series of letters (high and low contrast) on an eye chart. Participants with an acuity score of 20/40 (i.e., able to read line 5 without errors) and who have a high/low contrast difference score of 0, 1 or 2 score an ‘average or above’ rating.

The test developers have indicated that in a recent study, a below average score on any single item triggers a consultation regarding potentially needed changes in driving habits and/or follow-up with a specialist for a more comprehensive examination.

3.1.3.2 MOMSSE (Mattis, 1976)

The MOMSSE is a shortened version of the Dementia Rating Scale (DRS), was specifically designed for use with older adults, and is a screening test for dementia. It is reputedly quite effective in discrimination of adults with dementia from adults with depression with and without cognitive impairment. It evaluates cognitive functions including knowledge, abstraction ability, digit span, orientation, verbal and visual memory, speed, naming ability, comprehension, sentence repetition, writing and reading, drawing and problem solving.

The MOMSSE is comprised of 8 sub-tasks. Performances for each task are scored (timed, number of errors, etc.) on a scale of ‘premorbid intelligence’ including ‘defective’ ‘below average’, ‘average’, and ‘above average’. Assessors are instructed to begin with items in each sub-test at estimated level of ‘premorbid intelligence’. If that item is correctly solved, credit is given for all easier items. If item is failed, easier items should be presented until a correct response is made. A score is derived for each sub-test and an overall total score (maximum 59) is obtained. A description of each sub-test and the scoring criteria is listed below.

1. General Fund of Information – Participants are required to answer a series of six questions to assess their general knowledge (e.g., how many weeks are there in a year?, name the last two Prime Ministers of Australia, what is the capital of Italy?). One point is added if participant is aged 70+ years. Participants who correctly answer 4 or more (or 3 if aged 70+ years) score an 'average or above' rating (maximum score=6, regardless if aged 70+ years).

2. Verbal Abstraction – Participants are required to describe how two objects are alike (e.g., How are a table and chair alike? Abstract answer example: furniture; Concrete answer example: four legs). A score of 2 requires an abstract answer compared to a concrete answer (score=1). Participants who score a total of 7 or above (if aged <65 years) or a total of 5 or above (if aged 65+ years) score an 'average or above' rating (maximum score=12).

3. Attention: Digit Span – Participants are presented with a series of digits with increasing numbers up to seven (e.g., 5-8-2, 4-2-7-3-1, 6-1-9-4-7-3), and required to repeat them. The maximum series number of digits correctly repeated is recorded. Participants are also presented with a series of digits with increasing numbers and required to repeat them backwards. The maximum series number of digits correctly repeated backwards is recorded. One point is added if participant is aged 65+ to the sum of forward and backward digit span. Participants who score a total of 9 or above score an 'average or above' rating (maximum score=14).

4. Memory I – Participants are required to answer questions to assess general orientation, verbal memory and visual non-verbal memory. For orientation, participants are asked seven questions of orientation (e.g., what year is it?, what is the date today, what building are we in?). For verbal memory, participants are required to repeat a sentence presented by the assessor and remember it for later, write a sentence using two words presented by the assessor (e.g., write a sentence using the words boy and dog), and remember the sentence for later. For visual non-verbal memory, participants are shown three designs for 10s each and required to reproduce three designs immediately. Participants who correctly answer 7 or more score an 'average or above' rating (maximum score=12).

5. Language – Participants are required to demonstrate their language skills by following spoken and written commands (e.g., repeat a sentence, read aloud, and follow triple commands). Participants who correctly answer 5 or more score an 'average or above' rating (maximum score=7).

6. Memory II – Participants are required to recall the sentence presented to them and the sentence they were asked to write earlier in Memory I. Participant who correctly recall both sentences score an 'average or above' rating (maximum score=2).

7. Construction – Participants are required to draw two objects, one from memory (a clock) and one copied (a cube). Participants who correctly construct both objects score an 'average or above' rating (maximum score=2).

8. Block Design – Participants are required to solve three block design problems (from pictured WAIS designs) by arranging blocks showing different colour combinations on their faces in 60s. The task is timed. One point is added if participant is 70+ years. Participants who correctly solve all three problems score an ‘average or above’ rating (maximum score=4).

The MOMSSE has been shown to correlate highly with crash involvement amongst drivers in the USA, predicting 47 percent of intersections crashes (Owsley, Ball, Sloane, Roeneker & Bruni, 1991). In addition, they found that participants showing poor mental status on the MOMSSE were involved in about three times more crashes than were those with good mental status. Amongst older pedestrians, too, the MOMSSE was found to be a good predictor of poor road crossing decisions (Oxley, Ihsen, Fildes & Charlton, 2000). Participants who performed poorly on tests of functional performance including mental status (measured by MOMSSE) were more likely than those with good mental status to ‘cross’ roads in an unsafe manner in a simulated road-crossing environment.

3.1.3.3 UFOV (Owsley et al., 1991)

The UFOV is a touch-screen computer-based test that measures the visual field extent available to a person focussing on a task in the central part of the visual field. Using the Visual Attention Analyzer, the UFOV is measured through three separate automated sub-tests of information processing speed, divided attention and selective attention (divided attention with clutter). Participants are given practice trials prior to testing and testing is self-paced (participants can take their time in responding – reaction time is not measured).

- Sub-test 1: Participants are required to respond to an image in the centre of the monitor screen. An image of either a car or a truck is flashed onto the centre of the screen followed by a distracter screen. Following this a screen will appear requiring participants to indicate which image was presented (car or truck) by touching the screen over the correct image. This will be repeated, adjusting the length of stimulus presentation in milliseconds as needed. After two correct responses stimulus presentation time for the next item will be shortened whereas stimulus presentation time for the next item will be lengthened if the response was incorrect. This period may be as short as 14 presentations or much longer, depending on the consistency of the participant’s responses. No feedback is given and participant’s perceptual threshold level of processing speed (ms) is recorded. Lower scores indicate better performance.

- Sub-test 2: Participants are required to respond to an image in the centre of the monitor screen as in sub-test 1. In addition, participants are required to locate a simultaneously presented car displayed in the periphery. An image of either a car or truck is flashed onto the centre of the screen and at the same time a car in the periphery is flashed. This is followed by a distracter screen. Following this two screen will appear requiring participants to, first, indicate which image was presented in the centre of the screen and, second, where the car in the periphery was located. This will be repeated, adjusting the length of stimulus presentation in milliseconds as needed and the test will continue until a stable measure of threshold is determined. Like for sub-test 1, the administration time will depend upon the consistency of the participant’s performance and no feedback is given. Participant’s perceptual threshold level of divided attention (ms) is recorded. Lower scores indicate better performance.

- Sub-test 3: This sub-test is the same as sub-test 2 except that the car displayed in the periphery is embedded in a field of 47 triangles or distracters. All other procedures and conditions remain the same. Participants are required to indicate which image was presented in the centre of the screen (either a car or truck) and where the car in the periphery is located. Presentations will be repeated, adjusting the length of stimulus presentation in milliseconds as needed and the test will continue until a stable measure of threshold is determined and will depend on the consistency of the participant's performance. No feedback is given. Participant's perceptual threshold level of selective attention (ms) is recorded. Lower scores indicate better performance.

This test has been used extensively and repeatedly shown to be related to driving performance and crash risk. Owsley and Ball (1991) found that older drivers who failed the UFOV test had approximately four times more crashes than had those who passed, and the difference was more pronounced with respect to intersection crashes, where those who failed were involved in fifteen times more crashes than those with a normal UFOV. Amongst a sample of older drivers in New Zealand, Fildes, Charlton, Langford, Frith, Pronk, Newstead, Oxley, Oxley & Koppel (2005) found significant associations between two measures of the UFOV (divided attention and selective attention) and driving performance during an on-road test.

3.1.3.4 SCIT (Yelland et al., 2004).

The SCIT has recently been developed by Yelland and his colleagues at the Department of Psychology, Monash University. This test is designed to detect and quantify subtle and mild cognitive impairment. Participants are required to make a perceptual decision on a briefly presented visual stimulus that is backward masked. It shows a high concordance with results from 'gold standard' neuropsychological tests, including the MMSE, HIV-dementia scale and the grooved pegboard test.

The SCIT is a computer-based, inspection time task where participants are required to respond to an image in the centre of the monitor screen. First a cue stimulus (a small cross in the centre of the screen) is presented for 500ms. Following this, the test stimulus is presented in the centre of the screen. This is a 'U' shaped image in which one of the two parallel vertical lines is longer than the other. The long stimulus line is 14mm long and the short stimulus line is 6mm long. The lines are separated by 10mm and are approximately 1mm wide. Following the stimulus presentation a backward mask is shown which prevents further processing of the visual stimulus. . Participants are given practice trials prior to testing and testing is self-paced (participants can take their time in responding – reaction time is not measured).

Participants are required to indicate which of the two stimulus lines is the shorter by pressing the left or right mouse button. In the current version of the task, there are 11 different presentation times for the test stimulus, ranging from 11ms to 55ms in 11ms steps, then ranging from 55ms to 187ms in 22ms steps. There are 12 trials at each stimulus time, this 6 of the trials having the shorter line on the left-hand side, while the other 6 trials will be on the right-had side. This gives a total of 132 trials which is presented in a randomised order.

3.1.4 Follow-up questionnaire

In addition to completing the assessments of functional performance, participants were asked to complete a questionnaire that was designed to collect recent and detailed information on health status, presence of medical conditions, driving patterns, confidence and avoidance of driving situations, and details of crash involvement (for those who had been involved in a crash in the last five years) (see Appendix C).

3.2 RESULTS

This section presents the results of the assessments and follow-up questionnaire. First, some overall information on the groups of participants is provided, comparing demographic characteristics, self-reported health status and presence of medical conditions. Second, group responses relating to driving experience, patterns and confidence are compared. Third, group performance of assessments of functional performance is compared. These data are analysed using bi-variate techniques. Last, regression modelling of the data is presented examining the impacts of demographic information, driving information and functional performance on crash involvement.

3.2.1 Overall sample characteristics

Analyses revealed no significant group differences between cases and controls on variables used in the matching criteria, suggesting that the two groups were matched well. Table 6 provides a summary of these variables.

Table 6: Summary of matched variables by group

Variable	Crash-Involved Group (%) (n=48)	Non Crash-Involved Group (%) (n=44)
Age Group		
60-64 years	29.2	20.5
65-74 years	68.7	72.7
75+ years	2.1	6.8
Marital Status		
Married/Defacto	31.3	45.5
Widowed	27.1	29.5
Never Married	12.5	6.8
Divorced/Separated	29.1	18.2
Distance travelled (per week)		
<20km	6.2	4.5
21-50km	29.2	29.5
51-100km	29.2	47.8
101-200km	29.2	13.6
200km	4.1	2.3
Unsure	2.1	2.3
Self-reported health status		
Excellent	14.6	13.6
Very Good	45.8	68.2
Good	37.5	18.2
Fair or Poor	2.1	0

With regard to age group, there were similar proportions of both groups in all age group categories, $\chi^2_{(2)}$=1.93, p=0.38. Similarly, groups did not differ significantly in marital status, $\chi^2_{(3)}$=3.19, p=0.36, or in distances travelled each week, $\chi^2_{(6)}$=7.01 p=0.32. The majority of participants were aged 65 to 74 years and were married or widowed. There was some suggestion, however, that the crash-involved group was more likely to report lower health status compared with the non crash-involved group, however, this difference was not significant, $\chi^2_{(3)}$=5.99, p=0.11.

3.2.2 Health, medical conditions and functional performance

Participants were asked to provide details on their health status and current medical conditions. First, they were asked if they experienced difficulty with any activities of daily living. While the majority of cases and controls indicated they had no difficulty with activities of daily living (79.2% vs. 88.4%), a greater proportion of crash-involved participants indicated some difficulty compared with the non crash-involved group (20.8% vs. 11.6%), although this failed to reach significance, $\chi^2_{(1)}$=1.40, p=0.24. Of those who indicated difficulty, reported difficult tasks included climbing stairs, lifting heavy objects, bending and getting up out of a chair.

Participants were also asked to complete a medical checklist indicating whether they experienced medical conditions including eye diseases, cardiovascular diseases, dementia, and physical conditions. Table 7 shows the proportion of 'yes' responses by group for each medical condition listed.

Table 7: Proportion of (self-reported) presence of medical conditions by group.

Medical condition	Crash-involved group (%)	Non crash-involved group (%)
Cataract	8.3	17.6
Glaucoma	0	5.6
Macular degeneration	7.9	2.6
Diabetic retinopathy	0	0
Other eye diseases	16.2	5.9
Coronary heart disease	2.6	2.8
Cardiac arrhythmia	5.3	11.1
High blood pressure	45.0	37.8
Stroke/TIA	5.0	0
Diabetes mellitus	7.9	0
Alzheimer's disease	0	0
Parkinson's disease	0	0
Arthritis	60.0	36.8
Other	36.1	18.2

The most commonly reported conditions were arthritis, high blood pressure and cataract. There were few differences between groups, most likely due to small numbers, however, crash-involved participants were significantly more likely to report suffering from arthritis, compared with non crash-involved participants, $\chi^2_{(1)}$=4.18 $p<0.05$. 'Other' conditions included conditions such as osteoporosis, high cholesterol and asthma.

Participants were asked if they thought that presence of the medical condition affected their driving. In the majority of cases, participants indicated that there was no effect on driving, however, a handful of participants indicated that presence of glaucoma and macular degeneration did affect their driving.

The crash-involved group reported significantly more medical conditions, (mean: 1.83, sd: 1.0) compared to the non crash-involved group (mean: 1.28, sd: 1.0), t(77.8)=2.45, $p<0.05$. Figure 9 shows the proportion of participants in each group reporting medical conditions. Non crash-involved participants were more likely than crash-involved participants to report having zero or one medical condition. In contrast, crash-involved participants were more likely to indicate two or more medical conditions.

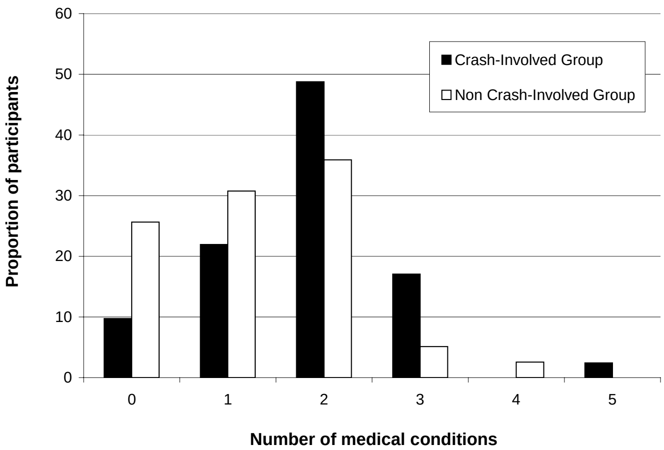

Figure 9: Number of self-reported medical conditions by group.

Table 8 shows the mean scores on functional performance assessments for both groups. Preliminary analyses comparing the performance of crash-involved participants with the performance of non crash-involved participants on assessments were conducted using t-test or chi-square tests. While there were few significant group differences (significant group differences are indicated by shaded cells), the overall trend indicates poorer performance by the crash-involved group compared with the non crash-involved group.

Eleven separate scores and an overall score (max. = 11) were derived from the GRIMPS test. Overall, the non-crash-involved group performed better compared with the crash-involved group, t(90)=2.59, $p<0.01$), one-tailed. An analysis of sub-test performance showed that the majority of the non crash-involved group scored 'average or above' in 9-11 sub-tests. In contrast, the majority of the crash-involved group scored 'average or above' on 8-10 sub-tests, and approximately 10 percent scored 'average or above' on only 6-7 sub-tests. Only five crash-involved participants scored the maximum possible 11 points, compared with ten non crash-involved participants (Figure 10).

Component scores for selected sub-tests of GRIMPS revealed small group differences on some tests. Crash-involved participants walked at a slower pace compared with the non crash-involved group, t(90)=-2.99, $p<0.01$, one-tailed. Other sub-test scores revealed small or no differences between groups: Foot tap: t(79.59)=-1.57, p=0.06, one-tailed; Trails B: t(90)=-1.49, p=0.07, one-tailed; Motor-free visual perception test: t(90)=-0.16, $p>0.05$, one-tailed; visual acuity (average of monocular scores for both eyes in high contrast condition): t(90)=-1.38, p=0.08, one-tailed; and visual acuity (average of monocular scores for both eyes in low contrast condition): t(90)=0.04, p>0.05, one-tailed. Figure 11 shows an example of the motor-free visual perception test where participants are required to identify a correct shape from a number of choices of incomplete shapes to create a complete shape.

Table 8: Mean scores on functional assessments by group

Assessment	Crash-involved group	Non crash-involved group	P-value
	Mean Score (sd)	*Mean Score (sd)*	
GRIMPS: Overall	9.06 (1.25)	9.68 (1.03)	< 0.01
GRIMPS sub-test: Rapid-paced walk	6.59s (1.61s)	5.74s (1.04s)	< 0.01
GRIMPS sub-test: Foot tap	5.59s (2.24s)	4.99s (2.24s)	= 0.06
GRIMPS sub-test: MVPT	9.50 (1.07)	9.45 (1.54)	= 0.87
GRIMPS sub-test: Visual acuity (high contrast)	0.87 (0.41)	0.76 (1.26)	= 0.08
GRIMPS sub-test: Visual acuity (low contrast)	0.45 (0.17)	0.46 (0.26)	= 0.97
UFOV: Divided attention	105.25ms (133.64ms)	65.34ms (53.32ms)	< 0.05
UFOV: Selective attention	208.52ms (117.06ms)	199.82ms (99.81ms)	= 0.70
MOMSSE: overall score	49.92 (4.16)	51.18 (2.76)	< 0.05
MOMSSE: Digit span	11.45 (1.64)	11.75 (1.46)	= 0.19
MOMSSE: Block design	2.00 (0.90)	1.98 (0.82)	= 0.45
MOMSSE: Construction	1.46 (0.65)	1.57 (0.66)	= 0.21
MOMSSE: Verbal abstraction	9.77 (2.39)	10.52 (1.68)	< 0.05
SCIT: % error interval *	35.58 (18.66)	34.66 (22.77)	= 0.84
SCIT: Response time interval *	740.81 (234.23)	708.51 (171.89)	= 0.48

** Note: Results of SCIT assessment is based on 46 crash-involved and 41 non crash-involved participants, as 5 participants could not/declined to complete the task. For all other assessments, all 48 crash-involved and 44 non crash-involved participants completed the tasks.*

Component scores for the two measures for the UFOV assessment showed a significant difference between groups for the divided attention task, t(62.67)=-1.91, p<0.05, one-tailed. The crash-involved group performed more poorly, that is, required longer inspection times than the non crash-involved group. No significant group difference was found for performance on the selective attention task, t(90)=-0.38, p>0.05, one-tailed. Figure 12 shows examples of the responses required to complete the UFOV assessment.

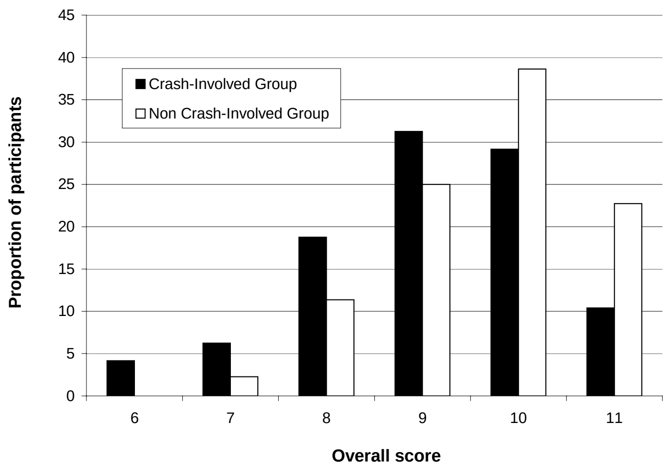

Figure 10: GRIMPS overall score by group

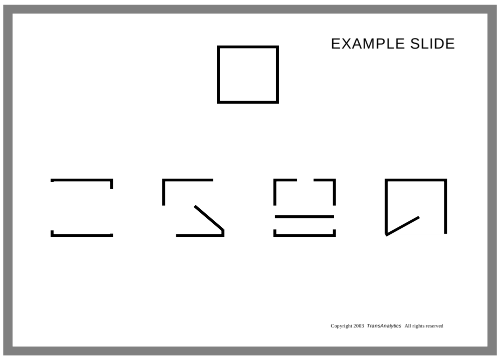

Figure 11: Example of motor-free visual perception GRIMPS sub-test stimuli

Figure 12: Examples of responses required to complete UFOV assessment

A significant difference between groups was found for the overall MOMSSE score, where the mean score of the crash-involved group was lower than that of the non crash-involved group, $t(82.35)=1.73$, $p<0.05$, one-tailed. Figure 13 shows overall MOMSSE score by group. The majority of non crash-involved participants (36%) scored between 48-55, and two scored 56 and 57 points each. None of the non crash-involved participants scored under 44 points. In contrast, five crash-involved participants scored under 44 points, the majority scored between 44 and 55 points, and five scored 56 points. No participant in either group scored the maximum possible points (59).

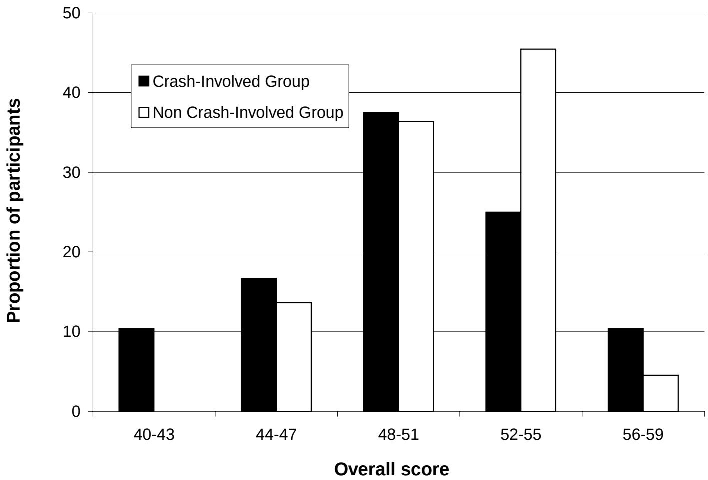

Figure 13: MOMSSE overall score by group

Component scores for selected MOMSSE sub-tests revealed few group differences: Digit span, $t(90)=-0.89$, $p=0.19$; Block design, $t(90)=0.13$, $p=0.45$; Construction, $t(90)=-0.98$, $p=0.16$. Despite these non significant results, there is some suggestion, however, that crash-involved participants performed slightly more poorly on some tests compared with non crash-involved participants. For example, Figure 14 shows the digit span score by group and shows that a greater proportion of the crash-involved group score a low rating of either 8 or 9, while a greater proportion of the non crash-involved group scored a high rating of 12 and above.

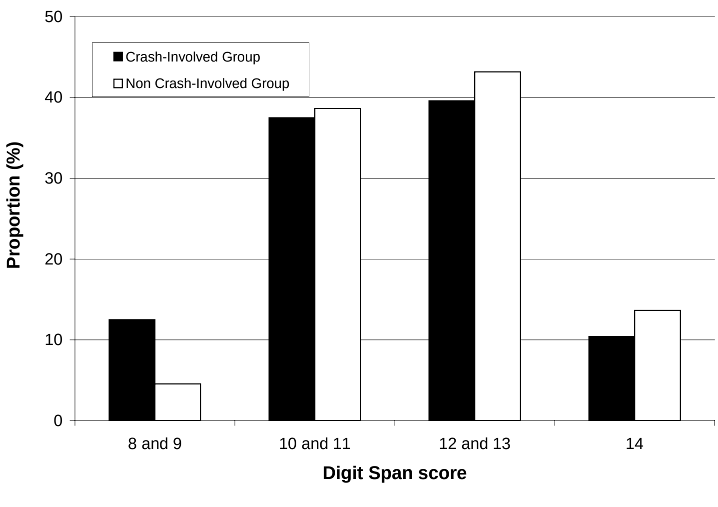

Figure 14: MOMSSE sub-test digit span score by group

In addition, Figure 15 shows the construction score by group and shows that a greater proportion of the crash-involved group scored 1 (i.e., correctly copied only 1 design), while a greater proportion of the non crash-involved group scored 2 (i.e., correctly copied both designs).

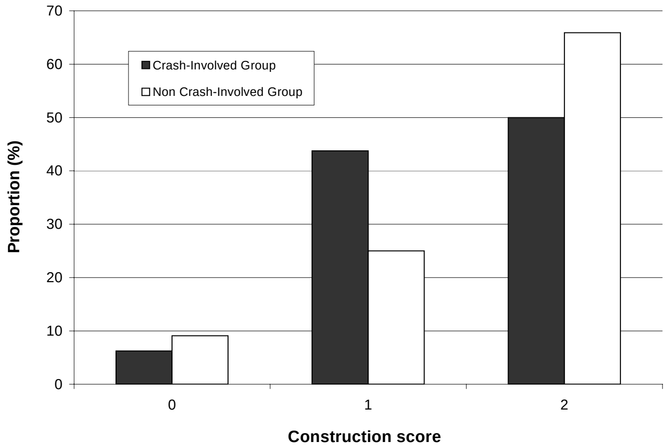

Figure 15: MOMSSE sub-test construction score by group

A significant group difference was found for Verbal abstraction, t(90)=-0.17, $p<0.05$. Crash-involved participants were more likely to score lower in this sub-test compared with non crash-involved participants. As shown in Figure 16, 8 percent of the crash-involved group scored between 3 and 5, but no participant in the non crash-involved group scored under 5. A greater proportion of non crash-involved participants than crash-involved participants obtained the maximum score of 12 points (40% vs. 25%).

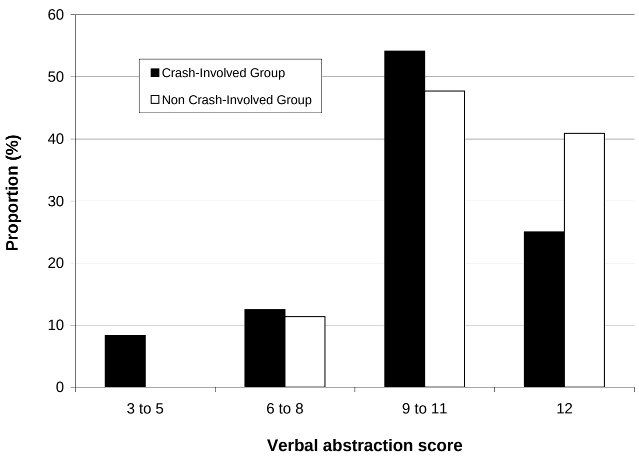

Figure 16: MOMSSE sub-test verbal abstraction score by group

Examples of participant responses to MOMSSE sub-tests are shown in Figure 17.

Figure 17: Examples of participants completing sub-tests of MOMSSE

Performance on the SCIT revealed no group differences in overall proportion of errors (crash-involved: 35.6% vs. non crash-involved: 34.7%) Figure 18 shows the proportion of errors by exposure duration conditions for both groups. Both crash-involved and non-crash-involved participants made more errors when exposure time was short (close to 50 percent errors in the 16ms exposure duration conditions) and fewer errors as exposure duration increased (reduced to approximately 12 percent errors in exposure duration times of 96ms and above).

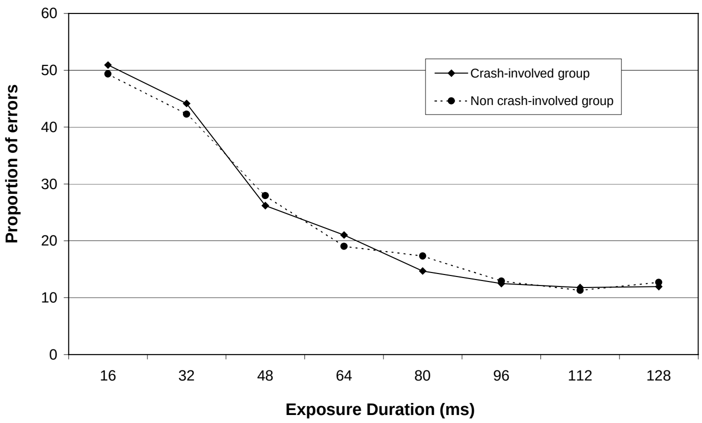

Figure 18: Proportion of errors by exposure duration for both groups.

Overall SCIT response times showed small but insignificant group differences, with the crash-involved group showing slightly longer response times (crash-involved: 740.8ms vs. non crash-involved: 708.5ms). Both groups showed longer response times in short exposure duration conditions (851ms and 820ms in 16ms exposure duration condition for crash-involved and non crash-involved groups, respectively), and shorter response times as exposure duration times increased. The response times of the crash-involved group were slightly longer than the non crash-involved group for the three shortest exposure duration conditions of 16, 32 and 48ms and for the 80ms exposure duration condition (approximately 30ms longer), but similar for all other conditions (Figure 19).

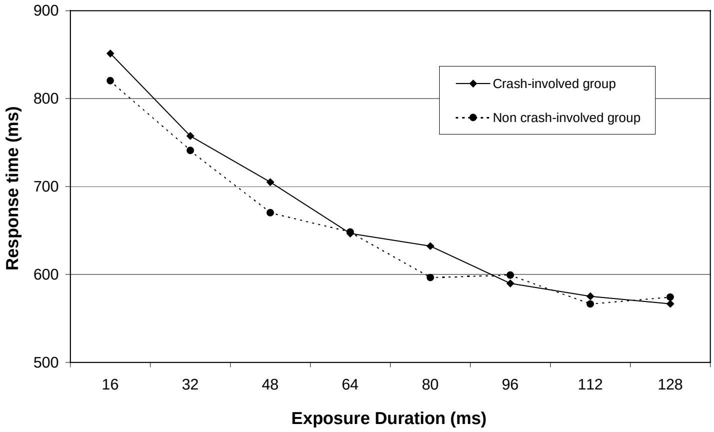

Figure 19: Response time by exposure duration for both groups.

It was interesting to note that many of the participants found this assessment extremely difficult, with the majority experiencing difficulty seeing the stimulus in short exposure duration conditions. Moreover, the findings revealed that a substantial proportion of participants in each group displayed signs of early cognitive decline (crash-involved group: 26.1%; non crash-involved group: 24.4%). Figure 20 shows a participants undertaking the SCIT test.

Figure 20: Example of participant undertaking SCIT assessment

3.2.3 Driving characteristics

Participants provided some details on their driving habits, experiences and travel patterns in the follow-up questionnaire. Given that principal driver status was a strong predictor of crash-involvement in the first survey, some additional questions on this issue were included in the follow-up questionnaire. First, participants were asked to indicate if they were the one who did most of the driving in their household. Only a small but insignificant group difference was found amongst this sample, $\chi^2_{(1)}=3.24$, p=0.07. Figure 21 shows that, overall, the majority of participants indicated that they were the principal driver, and this was particularly so for the crash-involved group, of whom over 85 percent indicated that they did most of the driving in the household. A smaller proportion of non crash-involved participants indicated that they did most of the driving in the household (70%).

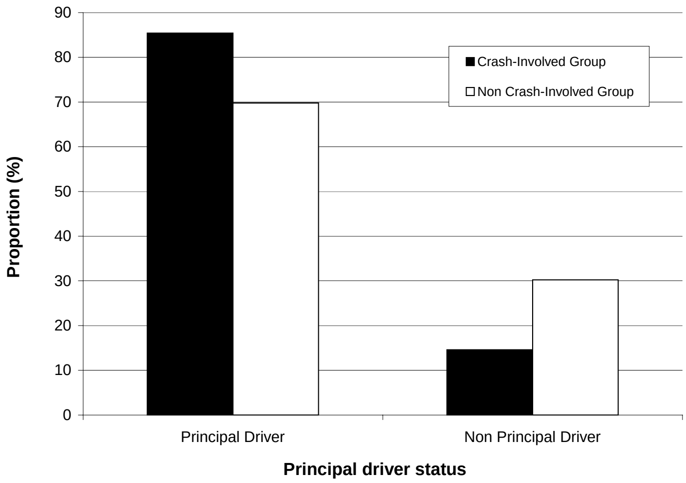

Figure 21: Principal driver status by group

As expected, principal driver status was associated with marital status, $\chi^2_{(3)}$=42.97, p<0.001, and sharing the driving, $\chi^2_{(4)}$=45.02, p<0.001. All participants who indicated they were not the principal driver in the household were married. Of those who indicated that they were the principal driver, 80 percent indicated that they were either widowed, divorced, separated, or had never married. Only 20 percent of married participants were the principal driver in the household. There was also some indication that principal driver status was associated with distance travelled per week, however, this was insignificant, $\chi^2_{(6)}$=10.82, p=0.09. Not surprisingly, principal drivers were more likely to drive more than 100 km per week, compared to those who were not the principal driver in the household. In contrast, the majority of non principal drivers drove between 51 and 100 km per week.

For those who were the principal driver in the household, the majority of both crash-involved and non crash-involved participants (over 85%) had been the principal driver for over 5 years. The most common descriptions of the circumstance under which they became the main driver in the household were that they were living alone (single, divorced or separated), or that their husband had died (widowed). A number also indicated that their husbands were ill and could not drive, or that they drove independently to many outings without their husbands.

Participants were asked to indicate the average length of their trips. The majority of participants indicated that most of their trips were over 5 kms, and a greater proportion of crash-involved participants, compared with non crash-involved participants indicated that their average trip was over 5 kms (Figure 22). Non crash-involved participants were more likely than crash-involved participants to indicate that most of their trips were between 3 and 5 kms. These differences, however, were not significant, $\chi^2_{(3)}$=3.71, p=0.30.

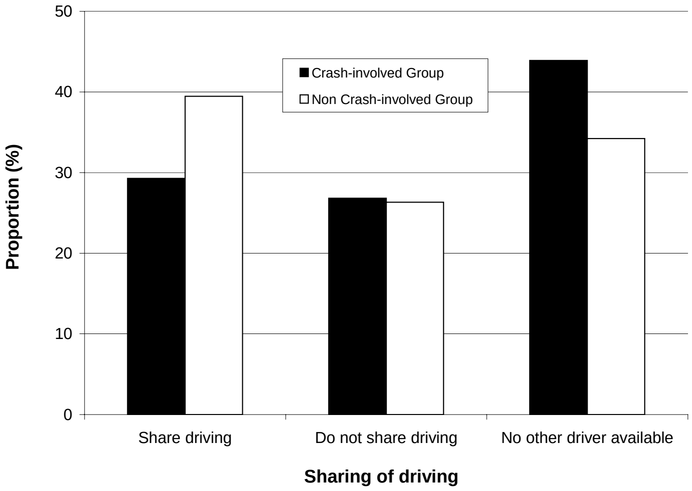

Figure 22: Average distance of trips by group

Participants were asked some questions on their practice of sharing the driving. Crash-involved participants were less likely to share the driving if there was another driver in the household, but also more likely to indicate that there was no other driver in the household, compared with non crash-involved participants (Figure 23). These differences, however, were not significant, $\chi^2_{(2)}$=1.08, p=0.58.

Of those who indicated they shared the driving, they also reported the reasons for sharing or situations in which driving was shared. The main reasons given for sharing the driving were: driving on long distance trips (32%), driving to social outings (25%), on regular shopping trips (18%) and other driver unavailable (15%). In contrast, of those who indicated that they did not share the driving, the majority reported the main reason was that they lived alone and were the only driver. Two participants indicated that they preferred to be the passenger, one reported that her daughter drove her when she needed, and one reported that she preferred not to drive someone else's car.

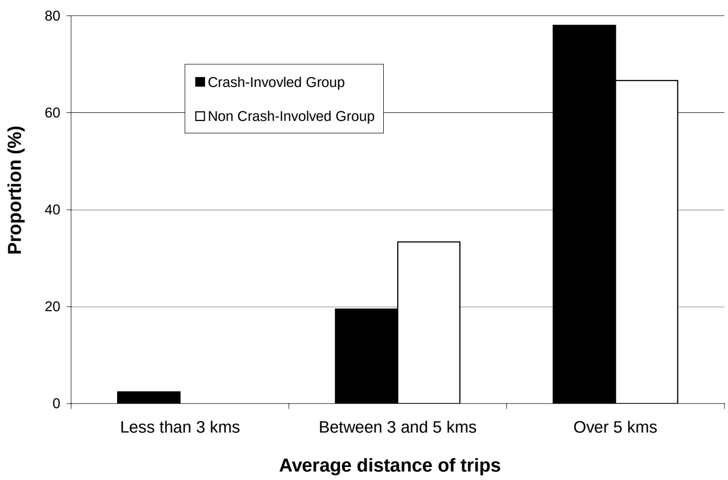

Figure 23: Sharing the driving by group

3.2.4 Driving situations: confidence, difficulty and avoidance

Drivers were then asked a series of questions about driving in different traffic situations and how they have felt in these situations in the last six months. These questions were designed to examine confidence, difficulty and avoidance of driving situations that are thought to cause problems for older drivers and included situations such as driving in the rain, in busy traffic, at night when wet, through roundabouts, through different kinds of intersections, and driving tasks such as merging, making right hand turns, and changing lanes.

For each of these driving situations, drivers were asked first to rate their level of confidence, second to rate how difficult they find this driving situation, and third, to indicate whether they intentionally avoided driving in this situation and if so, how and why. In addition, drivers were asked to identify any other situations in which they experienced difficulty or intentionally avoided.

3.2.4.1 Confidence in driving situations

Drivers' ratings of confidence in various driving situations are shown in Table 9.

Table 9: Summary of confidence ratings for all driving situations by group

Driving Situation	Very Confident (%)		Moderately Confident (%)		Not at all Confident (%)	
	Crash-involved	Non Crash-involved	Crash-involved	Non-Crash-involved	Crash-involved	Non crash-involved
Merging	42.6	44.2	53.2	55.8	4.2	0.0
Rain	28.6	35.9	66.7	64.1	4.8	0.0
Busy traffic	33.3	51.3	66.7	46.2	0.0	2.6
Roundabouts	56.3	46.5	41.7	53.5	2.1	0.0
Intersections with no traffic lights	50.0	46.5	45.8	53.5	4.2	0.0
RH turns with no traffic lights	48.8	48.7	48.8	51.3	2.4	0.0
RH turns with traffic lights and no arrow	56.1	53.9	43.9	46.1	0.0	0.0
RH turns with traffic lights and arrow	89.4	81.4	10.6	18.6	0.0	0.0
Driving at night	36.2	27.9	57.4	65.1	6.4	7.0
Driving at night when wet	21.4	21.1	52.4	65.8	26.2	13.2
Changing lanes	43.9	53.8	56.1	46.2	0.0	0.0

In general, participants indicated that they were either very or moderately confident in the majority of driving situations, with few indicating low confidence levels. Participants were more likely to report moderate to low confidence when driving in the rain, in busy traffic, driving at night and driving at night when wet. The great majority of participants reported high confidence (over 80%) making right hand turns with traffic lights and right-turn arrow, however, much less confidence making right hand turns at intersections with no traffic lights (around 49%).

Some group differences were apparent for confidence ratings in some driving situations, however, there were no statistically significant differences. Notwithstanding, the crash-involved group were generally less likely to report high confidence driving in the rain, in busy traffic and when changing lanes, compared with the non crash-involved group, but more likely to report high confidence driving through roundabouts and driving at night compared with the non crash-involved group. Interestingly, a relatively high proportion of crash-involved participants (26%) reported low confidence when driving at night when wet, compared with the non crash-involved group (13%).

Despite the lack of associations between confidence ratings in driving situations and crash-involvement, confidence ratings were compared across other variables including performance on functional assessments, overall health status and number of medical conditions to investigate the interactions between health-related characteristics and confidence. A significant association between performance on the GRIMPS and confidence making right had turns at intersections without traffic lights was found, $\chi^2_{(10)}=22.91$, $p<0.05$. There was also some suggestion of an association between performance on the GRIMPS and confidence driving through intersections without traffic lights, $\chi^2_{(10)}=17.13$, $p=0.07$, and between performance on the GRIMPS and confidence changing lanes whilst driving, $\chi^2_{(10)}=10.15$, $p=0.07$ (see Figure 24). Somewhat unexpected, these findings suggest that those who performed more poorly on the GRIMPS were more likely to report high confidence in these driving situations than those who performed better.

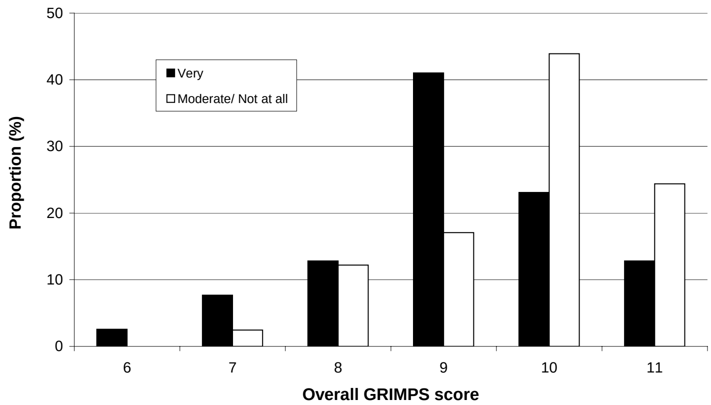

Figure 24. Confidence ratings for changing lanes whilst driving by overall GRIMPS score

In addition, there appeared to be some associations between confidence ratings and self-reported medical conditions: driving through intersections without traffic lights and number of medical conditions, $\chi^2_{(10)}=44.28$, $p<0.001$; making right hand turns at intersections without traffic lights, $\chi^2_{(10)}=80.32$, $p<0.001$; and, making right hand turns with traffic lights and right turn arrow, $\chi^2_{(5)}=10.56$, $p=0.06$. Some trends were also apparent for associations between confidence ratings and overall health status: driving in the rain, $\chi^2_{(6)}=11.28$, $p=0.08$; driving through roundabouts, $\chi^2_{(6)}=13.40$, $p<0.05$; making right hand turns at intersections without traffic lights, $\chi^2_{(6)}=11.95$, $p=0.06$; and making right hand turns with traffic lights and no right turn arrow, $\chi^2_{(3)}=6.79$, $p=0.08$. These findings suggest that those with fewer medical conditions and report better overall health were more likely to rate their confidence for driving in these traffic situations as high than those with more medical conditions and poorer overall health.

3.2.4.2 Difficulty in driving situations

Participants were also asked if driving situations caused them difficulty or not. Table 10 shows, for each driving situation, the proportion of participants who reported that the situation was not difficult, a little difficult, or very difficult for them.

Table 10: Summary of difficulty ratings for all driving situations by group

Driving Situation	Not Difficult (%)		A Little Difficult (%)		Very Difficult (%)	
	Crash-involved	Non Crash-involved	Crash-involved	Non-Crash-involved	Crash-involved	Non crash-involved
Merging	58.7	59.5	36.9	40.5	4.3	0.0
Rain	31.7	39.5	60.9	60.5	7.3	0.0
Busy traffic	41.5	56.4	53.7	41.0	4.9	2.6
Roundabouts	76.6	65.1	21.2	34.9	2.1	0.0
Intersections with no traffic lights	57.4	51.2	38.3	48.8	4.3	0.0
RH turns with no traffic lights	61.5	76.9	35.9	23.1	2.6	0.0
RH turns with traffic lights and no arrow	67.5	74.4	32.5	25.6	0.0	0.0
RH turns with traffic lights and arrow	97.8	93.0	2.2	7.0	0.0	0.0
Driving at night	47.8	44.2	50.0	48.8	2.2	7.0
Driving at night when wet	21.9	23.1	58.5	61.5	19.5	15.4
Changing lanes	51.2	76.9	48.8	23.1	0.0	0.0

Like for the confidence ratings, no significant group differences were found for ratings of difficulty in driving situations, except for changing lanes whilst driving. A greater proportion of the crash-involved group reported that they had a little difficulty changing lanes whilst driving, compared with the non crash-involved group who were more likely to indicate no difficult in this driving situation, $\chi^2_{(1)}=5.71$, $p<0.05$. Despite the non-significant results, there was an overall trend for a greater proportion of crash-involved participants to report finding some of the driving situations very difficult, particularly driving at night when wet, driving in the rain, in busy traffic, merging and driving through intersections with no traffic lights, compared with the non crash-involved group.

There were some associations between difficulty in some traffic situations and other health-related factors. Overall health status was significantly associated with reported difficulty in the following traffic situations: driving in the rain, $\chi^2_{(6)}=14.77$, $p<0.05$; making right-hand turns at intersections with traffic lights and with no turning arrow,

$\chi^2_{(3)}$=17.34 p<0.01; making right-hand turns at intersections with traffic lights and with turning arrow, $\chi^2_{(3)}$=12.02, p<0.01; and driving at night when wet, $\chi^2_{(6)}$=11.24, p= 0.08. Number of medical conditions was significantly associated with reported difficulty in the following traffic situations: driving through intersections without traffic lights, $\chi^2_{(10)}$=45.22, p<0.001; making right-hand turns at intersections without traffic lights, $\chi^2_{(10)}$=79.39, p<0.001; and making right-hand turns at intersections with traffic lights and right turn arrow, $\chi^2_{(5)}$=26.80, p<0.001. The overall GRIMPS test score was also significantly associated with difficulty driving in the following traffic situations: driving through intersections without traffic lights, $\chi^2_{(10)}$=21.30, p<0.05; making right-hand turns at intersections without traffic lights, $\chi^2_{(15)}$=29.31, p<0.05; and making right-hand turns at intersections with traffic lights and with arrows, $\chi^2_{(5)}$=11.45, p<0.05. These findings indicate that, for these traffic situations, those with fewer medical conditions, who reported better health and performed well on the GRIMPS were less likely to report difficulties, compared to those with more medical conditions, poorer health and poor performance on the GRIMPS.

3.2.4.3 Avoidance of driving situations

In addition to rating confidence and difficulty in driving situations, participants were asked if they intentionally avoided these situations (see Table 11).

Table 11: Summary of avoidance ratings for all driving situations by group

Driving Situation	Always (%)		Sometimes (%)		Never (%)	
	Crash-involved	Non Crash-involved	Crash-involved	Non-Crash-involved	Crash-involved	Non crash-involved
Merging	0.0	0.0	30.4	16.3	69.6	83.7
Rain	2.5	0.0	45.0	44.7	52.5	55.3
Busy traffic	0.0	2.6	43.9	31.6	56.1	65.8
Roundabouts	0.0	0.0	10.6	7.0	89.4	93.0
Intersections with no traffic lights	0.0	0.0	19.1	4.7	80.9	95.3
RH turns with no traffic lights	0.0	0.0	12.8	12.8	87.2	87.2
RH turns with traffic lights and no arrow	0.0	0.0	7.7	0.0	92.3	100.0
RH turns with traffic lights and arrow	0.0	0.0	0.0	0.0	100.0	100.0
Driving at night	6.5	2.3	28.3	39.5	65.2	58.1
Driving at night when wet	12.2	10.3	41.5	53.9	46.3	35.9
Changing lanes	0.0	2.6	21.9	15.4	78.1	82.1

Overall, the majority of participants indicated that they did not avoid the various driving situations, particularly driving through roundabouts, making right hand turns at intersections with different types of traffic control (especially when a right-turn arrow was available), and changing lanes. Some group differences were apparent. Crash-involved participants were more likely to indicate that they sometimes avoided driving through intersections with no traffic lights, $\chi^2_{(1)}=4.40$, $p<0.05$, and that they sometimes avoided making right turns at traffic lights without a right turn arrow, $\chi^2_{(1)}=3.12$, $p=0.08$, compared with non crash-involved participants who were more likely to indicate that they never avoided these driving situations. A greater proportion of crash-involved participants indicated that they sometimes avoided merging, driving in busy traffic, and changing lanes compared with non crash-involved participants. A greater proportion of crash-involved participants also indicated that they never avoided driving at night or driving at night when wet, compared with the non crash-involved group. These differences, however, were not significant.

No associations were found between avoidance of any driving situation and performance on the GRIMPS, nor between avoidance of any driving situation and overall health status. However, making right hand turns at intersections with traffic lights but without a right turn arrow was associated with performance on the MOMSSE, $\chi^2_{(14)}=32.33$, $p<0.01$, and number of medical conditions, $\chi^2_{(5)}=9.42$, $p=0.09$, indicating that participants with a higher number of medical conditions and who performed poorly on the MOMSSE were more likely to avoid this driving situation.

If participants indicated that they avoided any driving situation, they were asked to describe how and why they avoided that situation. For most of the driving situations, participants indicated that they would choose a different route or time to avoid the situation, ask someone else to drive, or catch public transport. Some examples of responses for how traffic situations are avoided were:

> *'Husband drives in busy traffic'.*
>
> *'Choosing a different route and avoiding peak hour traffic'.*
>
> *'Avoiding the particular roundabouts that are the hardest'.*
>
> *'To avoid turning at intersections with no traffic lights I go an extra block or so when I know there are lights or a roundabout'.*
>
> *'I avoid night time activities as much as possible and concentrate social activities in daylight'.*
>
> *'I try to anticipate the lane I need to be in well before or I wait for a better opportunity'.*

There was a wide range of comments in response to the question of why traffic situations were avoided. In general, they centred around lack of confidence, stress related to the behaviour of other drivers, poor vision and responses and responsibility to avoid accidents. Some examples of responses for why traffic situations are avoided were:

> *'Don't trust other drivers'.*
>
> *'If traffic is too heavy and cars too close together, I'm nervous but learning to keep my speed up and just do it (merging)'.*
>
> *'I find it difficult to see especially at night and fear skidding'.*

'I sometimes don't know which is the lane I need because you can't see the markings early enough in busy traffic'.

'Traffic is too erratic, I could be involved in an accident'.

'With large ones (roundabouts) it is hard to see how to get on and off them – one in Canberra is so big it doesn't register in my mind as a roundabout at all. Confusing!'

'Some drivers at large roundabouts don't slow down or change lanes and exit without indicating'.

'Don't want to cause an accident or hold up traffic'.

'I don't feel as decisive as I used to and don't trust the other fellas entirely'.

'Unsure of my own reactions and what I should do'.

'I do not drive in situations which may suddenly be awkward'.

'In the dark it can be difficult to find a destination – a bit unnerving when travelling alone'.

I'm not completely confident that my vision in 100%, the bright lights are disturbing, straining eyes to see ahead'.

'I don't want someone else who is driving too fast to cause an accident I can't avoid'.

'Vision at night in the rain is very bad and the last time I drove in these circumstances I determined never to do so again as I did not feel in control'.

'I'm not always confident that the person behind me will let me in (when changing lanes)'.

'I feel a bit frightened coming round sharp blind bends and if I'm slow I worry about the chaps behind'.

'I can be hesitant if I'm looking for an unfamiliar street of place and some local drivers can be impatient'.

'I'm not confident in an emergency'.

'I haven't good enough vision or responses to drive in really busy city traffic'.

3.2.5 Predictors of crash-involvement: The characteristics of crash-involved drivers and non crash-involved drivers

Logistic regression modelling was used to examine the impact of functional performance, health-related factors and driving-related factors on the likelihood of having been involved in a crash in the last five years. Table 12 lists the potential confounders and covariates that were selected for inclusion in the regression analysis.

Table 12: Factors identified as potential confounders of crash involvement in the last five years.

Independent Variable	Possible Responses	p-value of Univariate Analysis
Age Group	60-64 years 65+ years	 p=0.34
Overall GRIMPS score	Low (6-9) High (10-11)	 p<0.05
Overall MOMSSE score	Low (40-50) High (51-57)	 p=0.14
UFOV – divided attention score	Low (16-46) High (50-500)	 p=0.69
UFOV – selective attention score	Low (3.16-180) High (183-500)	 p=0.83
SCIT - % errors	Low (2.5-30) High (32.5-92.5)	 p>0.05
SCIT – response time	Low (394.3-905.4) High (914.1-1433.8)	 p>0.05
GRIMPS sub-test: Rapid Pace Walk	Low (3.46-5.94) High (5.97-14.12)	 p=0.16
GRIMPS sub-test: Trails B	Low (1.25-70) High (71-151)	 p=0.83
GRIMPS sub-test: MVPT	Low (1-9) High (10-11)	 p=0.49
GRIMPS sub-test: Foot tap	Low (2.84-4.75) High (4.84-14.22)	 p=0.14
GRIMPS sub-test: Visual acuity (high contrast average score)	Low (0.3-0.75) High (0.8-2.9)	 p=0.25
Principal driver status	Yes No	 p=0.11
Distance driven per week	≤50km 51-100km 100+km	 p=0.27 p=0.66
Overall health status	Excellent Good Fair or poor	 p=0.71 p=0.31
Marital status	Married/defacto Widowed Never married Divorced/separated	 p=0.91 p=0.34 p=0.15
Confidence	High confidence Low to moderate confidence	 p<0.01
Number of medical conditions	Low (0-1) High (2-5)	 p<0.05

Overall performance on all assessments was included, as well as performance on selected sub-tests of GRIMPS. In addition, some driving characteristic variables were included.

Variables were selected based on preliminary bivariate analyses and a priori knowledge of previous literature. Continuous test scores were dichotomised, using the median as a division between the two groups of values for each variable and were classified as being high or low, for scores above or below the median, respectively.

It should be noted here that many of the variables selected for inclusion in the regression analysis were correlated. For instance, performance on GRIMPS correlated significantly with performance on MOMSSE, the UFOV divided attention and selective attention tests, heath status, number of medical conditions and the reaction time component of the SCIT, p's<0.05. Performance on MOMSSE was significantly correlated with performance on GRIMPS and both UFOV divided attention and selective attention components, p's<0.05. Both UFOV components also correlated with SCIT error rate and reaction time components, p's<0.05. Health status and number of medical conditions also correlated highly, p<0.01.

The model resulting from the analyses is summarised in Table 13. This model indicates that the odds of participants who scored high on the GRIMPS and MOMSSE were only 37 percent and 43 percent respectively that of participants who scored low of having had a crash. Another way of expressing this is that the odds of participants who scored low on the GRIMPS and MOMSSE were 2.7 and 2.3 times, respectively, greater than participants who scored high on the GRIMPS and MOMSSE of having had a crash. The odds of participants who were very confident of being a safe driver was 27 percent that of participants who were moderately or not at all confident of being a safe driver were 3.76 times more likely than confident drivers of having had a crash. Last, the odds of participants who said they did most or an equal amount of the driving in the household were 3.56 times greater than non principal drivers to have had a crash.

Table 13: Multivariate model for predicting crash-involvement in the last five years

Crash involvement	Odds Ratio	SE	Wald statistic	p-value	95% Conf. Interval	
GRIMPS: Overall score	0.37	0.18	-2.03	0.04	0.14	0.96
MOMSSE: Overall score	0.43	0.21	-1.73	0.08	0.16	1.11
Principal driver status	3.56	2.09	2.16	0.03	1.12	11.28
Confidence	0.27	0.13	2.16	0.03	1.12	11.28
Log. Likelihood = -53.42						

In sum, compared with non crash-involved participants, those who had been involved in a crash in the last five years were more likely to:

- Have performed more poorly in the GRIMPS (scoring in the lowest 50th percentile): odds ratio = 2.7;
- Have performed more poorly in the MOMSSE (scoring in the lowest 50th percentile): odds ratio = 2.3;
- Be only moderately or not at all confident of their safety as a driver: odds ratio = 3.8; and

- Do most (or an equal amount) of driving in the household: odds ratio = 3.6.

3.2.6 Details of crashes amongst crash-involved participants

The last section of the questionnaire sought to gather detailed information about crashes that participants had been involved in when they were the driver in the last five years. The majority of crashes occurred at an intersection (58.1%). Other locations included roadway section (20.9%), in a parking areas (16.3%) and in driveways (4.7%). Drivers were also asked to indicate what driving task they were undertaking when the crash occurred. Figure 15 shows the proportion of responses by driving task. The majority of crash-involved participants (40%) indicated that they were driving straight at the time of the crash. Fifteen percent indicated that they were turning right at the time of the crash and 13 percent each were stopped at an intersection or reversing at the time of the crash.

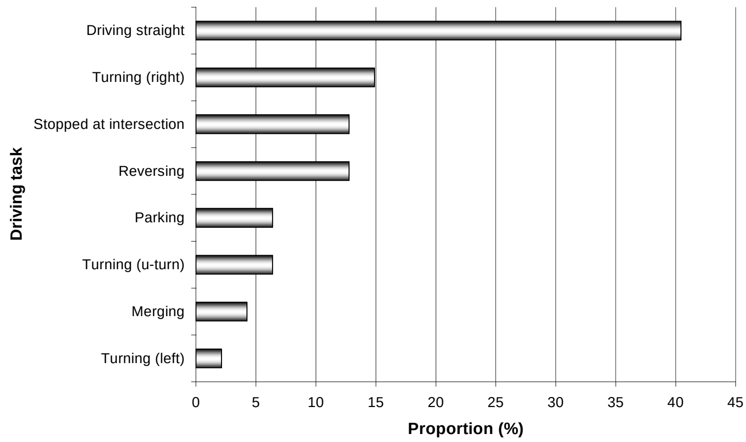

Figure 15: Driving task at time of crash

Other crash details included time of day and road conditions. The majority of crashes occurred in the afternoon (58%), and 21 percent each occurring in the morning and evening/night. The vast majority were driving on familiar roads (93%), not in busy traffic (60%), and in dry weather (96%). While this indicates that many crashes occur on regular outings with few adverse conditions, there were a number of reports of additional circumstances. Some examples follow:

> *'Driving on cruise control, put my foot on accelerator instead of brake. Avoided crashing into car in front by swerving out but swiped both cars slightly'.*

> *'I was approaching traffic lights and looked away momentarily. When I looked back the traffic in front had stopped at the lights and I couldn't stop in time'.*

> *'My passenger distracted me and asked about something on a building'.*

In addition, most of the crashes were not severe and there were no injuries sustained by the driver, only property damage (81%). In 15 percent of cases minor injuries were sustained by the driver. There was only one case where the driver was hospitalised with head injuries. Seven drivers reported sustaining neck injuries, one driver sustained chest injuries, one driver sustained upper limb injuries and two drivers sustained lower limb injuries.

Last, participants were asked to indicate if the crash had changed their driving behaviour or travel patterns and if so, to describe the changes. Fifty five percent of the crash-involved group reported that their behaviour and/or travel patterns had changed since the crash. Generally, participants indicated that they were now more aware of other traffic, especially at intersections and were more cautious and vigilant in checking before proceeding through intersections and in ensuring longer headways between them and vehicles in front. Others indicated that they no longer drove on long trips. Some examples of how behaviour had changed were:

> *'I think the accident has been a 'wake up' call for me. It has made me much more attentive when driving and more aware of not allowing myself to be distracted'.*
>
> *'I'm a little more nervous when driving now'.*
>
> *'I'm more careful when parking to judge distance'.*
>
> *'It was a 'gentle' crash ….., but it's made me realise more serious collisions can happen in a flash without clue and conscious awareness'.*

3.3 SUMMARY

This study was conducted in two parts. First, follow-up analyses of survey data of 673 older female current drivers were undertaken to understand the contributing factors to crash risk and to model the 'at risk' older female drivers. Second, a case-control study of a sub-set of crash-involved and non crash-involved older female drivers was undertaken to examine in detail the contribution of functional performance and driving characteristics to crash-involvement.

The survey data analyses revealed that five factors predicted crash involvement. The most 'at risk' older female drivers were those who:

- Were the principal driver,
- Were moderately or not at all confident that they were a safe driver,
- Shared the driving on long-distance trips,
- Had problems with the driving style of other drivers, and
- Experienced problems driving on unfamiliar roads.

The case-control analyses confirmed the survey data analyses and revealed that a number of medical and functional performance factors and additional driving characteristics predicted crash involvement amongst this group of women. Those who had been involved in a crash in the last five years were those who:

- Were the principal driver,
- Were moderately confident or not at all confident that they were a safe driver, and
- Showed some functional declines in visual, perceptual, attentional and cognitive functions associated with driving ability.

4 DISCUSSION

Safe and efficient driving intuitively requires the adequate functioning of a range of functional abilities and good health. Furthermore, loss of efficiency in any function may reduce performance and increase crash risk. In addition, low confidence and driving experience may reduce performance and increase crash risk further. Given that a number of functional changes, driving characteristics and travel patterns are more likely to occur as age increases, it is reasonable to predict that judgements and performance may be hampered when driving, at least in some traffic circumstances, and that this may contribute, in part, to crash risk.

The broad aim of this research was to examine the impact of driving experience, practices and confidence, functional performance and health-related factors on the crash risk of older female drivers. Past research has suggested that the over-representation of older female drivers in fatal and serious injury crashes may be associated with age-related changes in functional performance (Marottoli & Richardson, 1998; OECD, 2001), increased vulnerability (Evans, 2001; Ulfarsson & Mannering, 2004; Li, Braver & Chen, 2003), prevalence of medical conditions and poor health status (Dobbs, 2001), limited driving experience and low driving confidence (Massie et al., 1995; Hu et al., 200l Margolis et al., 2002).

The current findings generally support these contentions, and have highlighted a number of additional and interesting findings relevant to the safety of older female drivers. Of particular interest are the findings that the likelihood of being involved in a crash is associated with factors such as declines in motor, perceptual, attentional and cognitive performance and presence of multiple medical conditions. In addition, some driving factors such as driving experience, driving confidence and difficulty in driving situations were associated with the likelihood of being involved in a crash. These findings are discussed in the following sections.

4.1 FUNCTIONAL AND HEALTH FACTORS

The likelihood of being involved in a crash amongst this sample of older female drivers was associated with a number of health- and performance-related factors including declines in motor and cognitive performance and presence of medical conditions.

It was not surprising to find that presence of a higher number of medical conditions was associated with increased crash risk. Those with multiple medical conditions were more likely to have been involved in a crash in the last five years, compared with non crash-involved drivers. This finding supports previous evidence that some health factors and medical conditions influence crash risk of older female drivers (Collia, Sharp & Giesbrecht, 2003), particularly back pain (Hu et al., 1998), a history of falling, physical and sensory decline, (Margolis et al., 2002), stroke (Fisk, Owsley & Mennemeier, 2002). Rabbitt and Parker (2002) showed that drivers aged 49 to 90 years reporting a relatively poor health score had a crash liability about 1.7 times that of those who reported a relatively good health score.

Clearly, not all medical conditions affect crash risk to the same extent and not all individuals will be affected in the same way. Moreover, it is not necessarily the medical condition and/or the medical complications per se that affect driving performance and therefore crash risk, but rather the functional impairments that may be associated with these conditions. Indeed, in his discussion of the merits of focusing on impairments in assessing risk, Marottoli points out that functional impairments are '…the common pathway through which medical conditions affect driving capability' (2001, p.11). In addition, the extent to which individuals may be able to adapt or compensate for their impairment while driving will undoubtedly have some bearing on their likelihood of crash involvement. While more research is warranted to better understand the links between crash risk, medical conditions and levels of functional impairments and the impact of compensatory strategies in moderating this risk, the current findings lend support to the contention that presence of multiple medical conditions do increase crash risk, possibly because of their effect on functional performance but it is also possible that the presence of comorbid conditions may make adoption of compensatory behaviours more difficult, i.e., may overwhelm the normal attempts at compensation (Sabey, 1988; Yanik & Monforton, 1991).

Visual acuity was not a strong predictor of crash involvement. This was not a surprising finding, despite the continued argument that vision is fundamental to driving, providing an estimated 90 to 95 percent of all sensory input in the driving environment (Shinar & Scheiber, 1991). There is no doubt that vision is important to perform daily activities, however, static visual acuity may not be the most appropriate measure of visual skill for drivers, particularly as it relates to crash risk. Indeed, previous studies have shown that the relationship between static visual acuity and increased crash risk for drivers is weak at best (Owens & Andre, 1996). In comparison, crash risk has been shown to increase in older drivers with eye conditions such as cataracts, glaucoma and macular degeneration, and in those drivers with impairments in selected visual functions including visual fields, dynamic visual acuity, contrast sensitivity, visual search, visual attention and visual processing. For instance, studies by Wood and her colleagues, using a closed road circuit, have shown that simulated vision impairment, specifically cataracts and visual field restriction, and true vision impairment including cataracts, glaucoma and age-related maculopathy, significantly impaired driving performance (Wood, 2002; Wood & Troutbeck, 1994; 1995). Owsley et al. (1998) assessed the contribution of visual impairments to crash risk amongst older drivers in Alabama. They found that restricted useful field of view and glaucoma predicted injurious crash involvement. Odds ratios for reductions in useful field of view of 23-40 percent, 41-60 percent, and greater than 60 percent were 4.2, 13.6 and 17.2, respectively. The odds ratio for glaucoma was 3.6. These findings imply that impaired visual processing and glaucoma may play a role in injurious crash involvement. While the current data did not reveal any significant association between crash involvement and presence of visual conditions, most likely due to small sample sizes (and therefore no firm conclusions can be drawn), there was some suggestion that a greater proportion of crash-involved participants had age-related macular degeneration, compared with non crash-involved participants.

Interestingly, the findings suggested that physical functioning was associated with increased crash risk. Crash-involved drivers walked more slowly and took longer to complete the foot tap test compared with non crash-involved drivers. There is no doubt that motor control and physical agility are important skills for driving performance and declines in these skills may increase crash risk. Poor motor control, strength and endurance, slowed movement and poor reaction times can impact on driving performance, particularly when faced with a traffic emergency where actions need to be executed quickly (Stelmach & Nahom, 1991). This finding may also be related to the fact that cognitive and executive function declines are powerful predictors of poor walking ability and falling. While walking is generally viewed as an automated and over-learned motor task, it seems that this is a simplistic view and that, for many older adults, walking is a more complex task requiring integration of a number of visual, cognitive, and psychomotor skills (Hausdorff, Yogev, Springer, Simon & Giladi, 2005; DiFabio, Zampieri, Henke, Olson, Rickheim & Russell, 2005; Hauer, Pfisterer, Weber, Wezler, Kliegel & Oster, 2003; Yaffe, Barnes, Nevitt, Liu & Covinsky, 2001).

This leads us to consider the effect of higher order functions on crash risk. The current findings suggest that crash risk status may lie within higher order functions such as attentional, cognitive and executive function skills. The MOMSSE examines skills such as visual memory, attention span and problem-solving, the GRIMPS examines skills such as visual search, memory, division of attention, and scanning strategies, and the UFOV examines visual processing speed, selective and divided attention. These test were associated (albeit at various levels) with crash involvement. In the driving context, these kinds of skills are likely to be important in tasks such as understanding and remembering traffic rules and signs, following directions, utilising executive functions, allocating attention, processing information quickly and accurately, and minimizing the effects of distraction. These findings are supported by other international studies providing evidence of the effects of age-related declines in memory (Duchek, Hunt, Ball & Morris, 1998), cognitive capacity, executive function and reduced processing capacity (Daigneault, Joly & Frigon, 2002; Stelmach & Nahom, 1992; Valcour, Masaki & Blanchette, 2002; Lundberg, Hakamies-Blomqvist, Almkvist & Johansson, 1998) and dementia (Freund, Gravenstein, Ferris, Burke & Shaheen, 2005; Zuin, Ortiz, Boromei & Lopez., 2002; Snellgrove, 2005; Brown, Stern, Cahn-Weiner, Rogers, Messer, Lannon, Maxwell, Souza, White & Ott, 2005) on road safety outcomes for drivers including crashes, infringements, and driving performance.

It is worth noting here that there is much debate in the literature regarding the level of impairment at which drivers with dementia are at increased crash risk. It is suggested that those in early stages of dementia are able to drive relatively competently, particularly when driving in familiar areas, but at moderate and severe stages of the disease there are observed mental status changes and an increased inability to drive competently, with generalised disorientation and no insight into the presence of the condition and its effect on performance (O'Neill, Neubauer, Boyle, Gerrard, Surmon & Wilcock, 1992; Messinger, 1993; Dobbs, 1997; Reger, Welsh, Watson, Cholerton, Baker & Craft, 2004). There is very little evidence of the crash risk amongst drivers with early stages of dementia, however, more substantive evidence of poor driving performance and increased crash risk amongst drivers with moderate to severe dementia, with estimates that drivers with dementia are up to six times more likely to be crash-involved compared with cognitively intact drivers (Cooper, Tallman, Tuokko & Beattie, 1993).

The current findings support the contention that it is the more pronounced changes associated with cognitive and executive function decline and impairment (particularly dementia) that may lead to driving difficulties and increase crash risk. Performance on the SCIT, a test of very early stages of cognitive impairment, did not predict crash involvement in this sample (although it did correlate significantly with performance on both components of the UFOV, and GRIMPS overall score, suggesting some association with crash-involvement). In contrast, performance on the MOMSSE, a screening test for mild, moderate and severe dementia of the Alzheimer's type, strongly predicted crash involvement.

The crash details of the crash-involved group provide further support of this assertion. While the majority of crashes occurred in normal driving conditions (not in busy traffic, on familiar roads and in dry weather), most crashes occurred at intersections, while driving straight or turning. Moreover, the additional circumstances described by some participants suggested some attentional, cognitive and executive function limitations.

Intersections are complex parts of the road network and numerous studies have shown that a large proportion of older driver crashes occur at intersections (Stamatiadis, Taylor & McKelvey, 1991; Insurance Institute for Highway Safety, 1993; McKnight, 1996; Fildes, Oxley, Corben & Langford, in press). In a national US analysis of crash data, Hauer (1988) found that 37 percent of fatalities and 60 percent of injuries experienced by older drivers occur at intersections. More recently, Preusser, Williams, Ferguson, Ulmer and Weinstein (1998) argued that drivers aged 85 years and older were 10.6 times more at risk of being involved in multiple-vehicle crashes at intersections than younger drivers (aged between 40 and 49 years).

Negotiating an intersection demands a host of age-sensitive functions, such as processing and integration of multiple sources of visual information and quick interpretation of the most important stimuli in fast-moving and busy traffic. These are difficult tasks for many older adults and a decline in cognitive and executive functional performance means that, at least some older drivers, will experience difficulty coping with the demands of complex intersections and may result in inaccurate perception of the approach of vehicles or even disregard of important perceptual cues altogether (Salthouse, 1991; Madden, Connelly & Pearce, 1994; Staplin, Lococo, Byington & Harkey, 2001; Brébion, Smith & Ehrlich, 1997). Rizzo, McGehee, Dawson & Anderson (2001) found that drivers with moderate cognitive impairment due to dementia of the Alzheimer's type were at greater risk for intersection crashes while driving on a virtual highway in a simulator scenario, compared to drivers without dementia. Individuals with deficits of attention, perception, response selection, response implementation and psychomotor declines were more likely than normal drivers to commit the kinds of errors that cause crashes (that is, failing to release the accelerator, apply the brake and make steering corrections to remain in the lane while averting a crash with a vehicle entering an intersection). Predictors of crash involvement included visuospatial impairment, disordered attention, reduced processing of visual motion cues and overall cognitive decline.

It is interesting to note that, in addition to crash-involved participants, a substantial proportion of non crash-involved participants also showed signs of subtle cognitive impairment (as measured by the SCIT). This is an important point, as it is likely that those in the early stages of cognitive impairment are those who continue to drive. Lipski (2002) and Snellgrove (2005) estimated that there may be a substantial number of licensed drivers with mild cognitive impairment or early dementia on Australian roads. Moreover, there is evidence that at least 50 percent may continue to drive for up to three years following the onset of dementia, well into the moderate stages of the dementing illness (Carr, Duchek & Morris, 2000; Hopkins, Kilik, Day, Rows & Tseng, 2004). It is also important to point out that large proportions of people with mild cognitive impairment will progress to dementia, with estimates of 15 percent in one year after diagnosis, 40 percent over two years, 53 percent over three years and 100 percent over five years (Davis & Rockwood, 2004; Petersen, 2003). Early detection of mild cognitive impairment may raise the awareness of the progress of the disease and the impact on driving and assist drivers and their families to appropriately plan for driving reduction and cessation.

4.2 DRIVING FACTORS

It is clear that age-related changes in functional performance (particularly those affecting cognitive and executive functions), health and vulnerability increase crash risk amongst some older drivers, and that older female drivers may be further at risk compared with older male drivers as a result of greater prevalence of illness, higher levels of disability, and poorer overall health status and well-being (Smith & Baltes, 1998; Jylhä et al., 2001; US Administration on Aging, 2002; OECD, 2001). This study has shown that other driving factors, too, play some role in the risk of crash involvement among older female drivers.

It was unexpected to find that principal drivers were more likely to have been involved in a crash, and could be interpreted by the ‘increased exposure’ hypothesis (those who drive more are exposed for longer periods of time to the risks of crashes). However, principal driver status may not be a good indicator of distance travelled (particularly as participants were matched on weekly distance driven). Moreover, it is well recognised that, independent of age, drivers travelling more kilometres will typically demonstrate reduced crash rates per kilometre travelled, compared with those driving fewer kilometres. Therefore, this hypothesis cannot fully explain crash risk.

There are two possible explanations. First, it is possible that current principal drivers are those women who may have taken on the role of principal driver when their male partner became unfit to drive or who passed away, and possibly when they lacked up-to-date driving experience. The correlations between marital status and principal driver status and descriptions of the circumstances participants became principal drivers lend support to this argument. A lack of up-to-date driving experience and associated lack of confidence in driving is a major risk factor for older female drivers identified in the literature (Noble, undated).

Second, given that low confidence and difficulty in some driving situations were also associated with crash risk, we may consider the ‘low-mileage’ hypothesis (Janke, 1991; Hakamies-Blomqvist et al., 2002). ‘Low-mileage’ drivers may be those who restrict their driving in response to a perceived decline in driving performance, may have more medical conditions, greater functional difficulties, avoid travel under conditions which are perceived to be threatening or causing discomfort, lack quantitative and qualitative driving experience and lack confidence, and intuitively, a higher probability of crashing (Eberhard, 1996; Smiley, 1999; McGwin & Brown, 1999; Parker et al., 2001; Charlton et al., 2003; Hakamies-Blomqvist & Sirén, 2003; Stutts et al., 2001). In addition, ‘low-mileage’ drivers may also be those drivers who do their driving on the urban road network. Particularly for older drivers, urban travel is more likely to result in crashes, due to greater numbers of possible traffic conflict points, especially intersections (Keall & Frith, 2004). Moreover, self-report could be especially problematic for those with cognitive impairment and with little insight into their functional ability and poor memory of past crash event. The explanation is certainly complex and warrants further research, however, the current findings that poor functional skills and low to moderate confidence were associated with crash involvement provide good evidence of the associations between poor functional performance and crash risk.

Some research has suggested that females are especially at risk in intersection manoeuvres (Baker, Falb, Voas & Lacey, 2003; Finison & Dubrow, 2002; Guerrier, Manivannan & Nair, 1999; Staplin, Gish, Decina, Lococo & McKnight, 1998). Goggin and Keller (1996) found that older women drive in different locations and at slightly different times than older men. They also reported that fewer women drove on highways and more drove on local roads compared to men of the same age, and differed in overall driving habits and abilities.

The current study and others (Hakamies-Blomqvist & Wahlström, 1998; Charlton et al., 2003) found that older female drivers, particularly those who have been involved in a crash, report lower levels of confidence when driving, more traffic-related stress, difficulty in many traffic situations and avoidance of difficult conditions compared with older men, and compared with non crash-involved drivers. These findings indicate that confidence is an important factor in driving performance and crash risk.

While these differences in driving behaviour may indicate appropriate adoption of behaviours to compensate for (real or perceived) changes in performance, these behaviour may also be counter-productive from the viewpoint of crash risk. Reduction of travel, particularly on high-speed roads such as highways and freeways (roads with relatively high safety records) leads to greater travel on low-speed local urban roads which generally have many more conflict points including intersections and relatively low safety records. In addition, reduced travel means that important driving experience and confidence levels are reduced, thereby increasing crash risk. Last, premature driving reduction and cessation amongst women means that their mobility options are substantially limited and is likely to result in ain increase in pedestrian travel and therefore increase in the risk of pedestrian trauma.

4.3 LIMITATIONS

There are some limitations of this study that warrant some discussion. First is the possibility of a bias sample in both the survey and case-control study. In any research where participants are recruited from a random sample of a population and participation is voluntary, the sample has the potential to be biased and we may not be targeting those older drivers who are at high crash risk. In addition, the case-control study was based on self-reported crashes. Again, this introduces a bias in the sample and, in this case, it was not possible to check driver records. Second, the small sample sizes in the case-control study may have prevented detection of some important group differences and risk factors. Third, crash responsibility was not considered here. Self-reported crash details indicated that, for some participants, they were not responsible for the crash. Nevertheless, the study has provided some interesting and valuable information on which to base countermeasures and further research.

4.4 SUMMARY AND RECOMMENDATIONS

The results of this study confirmed some previous findings related to increased crash risk for older drivers. In addition, it identified a number of predictors of crash involvement amongst older female drivers. The findings that poor attentional, cognitive and executive skills as well as low confidence were related to increased risk of crash involvement have enhanced our understanding of which drivers are at increased risk, particularly through identifying a small, more precisely defined target group for road safety countermeasures.

4.4.1 Countermeasure recommendations

Awareness and identification of the factors that may increase crash risk is an important first step in the development of appropriate countermeasures and the information provided in this report provides a valuable resource on which to base a number of appropriate countermeasures. Recommendations for countermeasures are as follows and include behavioural and educational resources, improvements to licensing procedures, and improvements to road design and system operation:

- Development of educational and awareness material for older female drivers, with a particular focus on how they can reduce risk and maintain mobility by adopting safe driving practices. Such material should provide the following information:

    - General information on crash and injury risk – increased risk of crash and injury with increasing age, with emphasis on the fact that older female's crash and injury risk will increase in the years ahead because of population, licensing and travel pattern changes;

    - Information on particular risk factors – the factors that place older female drivers at higher risk of crash involvement and sustaining a severe injury. For instance, information should be provided on the effect of declining health and functional abilities, and onset of medical conditions on the ability to drive safely and risk of crash involvement. In addition, information on the consequences of lack of up-to-date driving experience and lack of confidence on crash risk is essential;

    - Information on adoption of safe driving practices – ways to maintain safe driving for as long as possible (such as sharing the driving with partner or family/friends, driving as much as possible in safe and familiar areas, and undertaking a training course designed for older drivers, buying a car that is comfortable and easy to manage and has safety features, changing driving patterns to avoid stressful driving situations, planning trips, and driving with a passenger for company and to assist with driving if necessary), recognition of risk factors and planning reduction and cessation of driving successfully and at an appropriate time; and,

    - Information on successful reduction and cessation of driving – including the benefits and disbenefits of reduction and cessation. In particular, the specific issues of excessive driving reduction and premature driving cessation should be addressed, along with hints on ways to maintain satisfactory mobility without the car including making different lifestyle choices and exploring alternative transport options.

- Appropriate identification of 'at-risk' drivers by licensing authorities. The majority of current older driver re-licensing requirements in Australia are age-based, discriminatory, and may be ineffective in discriminating good from poor drivers. A more strategic targeted licensing re-assessment procedure that uses screening tests to identify drivers who have an increased risk of crashing due to health conditions or functional deficits is clearly important and would effectively and efficiently improve the safety of older drivers.

- Engineering countermeasures that modify the physical environment of the transport system can provide quick and effective mobility and safety benefits. Intersection negotiation for older and all drivers can be made safer through design measures that reduce the reliance of older drivers on declining gap selection abilities and therefore the risks associated with this task. Potentially beneficial measures include:

- Provision of roundabouts. There are many reports of major benefits of roundabouts, contributing substantially to reductions in both crash and injury risk to vehicle occupants. Roundabouts result in fewer and simplified conflicts, reduced speed, and more favourable collision angles. For older drivers, roundabouts means that they need only select a gap in one direction of traffic at a time. This is a fundamentally simpler and safer task than choosing a coincident gap in two streams of traffic.

- Speed reduction. Speed has a fundamental relationship with both crash and injury risk. Substantial improvements are achievable for ***all*** crash types from minor reductions in travel speed and even smaller reductions in impact speed. Introduction of lower speed limits and/or traffic-calming devices on approaches to intersections can greatly reduce the frequency and severity of crashes;

- Provision of adequate sight distance. Older drivers require more time to scan the environment, gather important information about traffic movements, and act upon the information. Improving the amount of sight distance at intersections controlled by 'stop' or 'give-way' signs gives older drivers more time to select a safe gap in which to enter or cross traffic;

- Introduction of full-control signals. Given that the major problem for older drivers at intersections is choosing an appropriate gap while turning across oncoming traffic, the provision of full-control signals would assist older drivers to make safe right-turns by reducing the problems associated with gap selection and can dramatically reduce the incidence and severity of these types of crashes.

4.4.2 Recommendations for further research

While this study provides some evidence of an effect of functional performance declines, health factors and some driving characteristics on crash risk, there is still much to be learned about the extent to which these factors contribute to changes in driving performance amongst older female drivers, how these factors interact, how older female drivers may change their behaviour in order to compensate for these changes, and the effects of poor health and functional status on the decision to stop driving. It is recommended that further research be conducted to address some of the constraints of this study and explore further some of the current findings. Further research opportunities include:

- A more detailed investigation to explore the effect of functional performance declines, onset of medical conditions, driving experience, low mileage and confidence on driving performance and crash risk using a larger sample of older female drivers and a comparison group of older male drivers;

- A detailed analysis of travel patterns using a travel diary and survey methodology to determine gender differences in driving conditions and locations, driving frequency and amount of driving.

- An in-depth examination of the issues surrounding the onset of dementia and driving, and particularly to examine gender differences. Issues that require investigation include: i) the prevalence of dementia amongst older male and female drivers with dementia, ii) the types of crashes of older male and female drivers with dementia, iii) the relationship between functional performance declines associated with advancing levels of dementia and crash risk, and iv) the relative risk of cognitive impairment amongst crash-involved and non-crash-involved older female and male drivers.

- An examination of gender effects on changes in self-regulatory practices in a cohort of drivers using a longitudinal study method (e.g., over 5 years);

- An examination of gender differences on the decision to stop driving and consequent mobility restrictions and psychological/social consequences to quantify the costs and other health outcomes associated with driving cessation and to identify cost-effective strategies to promote community mobility and reduce social isolation in older age.

4.4.3 Conclusions

Older female drivers are the fastest growing segment of the driver population due to a proportional increase of women in the population, increased licensing rates and increased driving and it is predicted that crash and injury rates amongst older females drivers will exceed that of older male drivers in the coming decades. Older females also have a higher prevalence of illness, disability and long-term medical conditions and utilise health services more than older men. Given these factors, the safety and mobility of older females has become an important community and road safety issue.

There are obvious mobility benefits of continuing to drive, particularly for older females, who, in the event of their partner being unable to drive, may be forced into principal driver status after years of reduced driving and therefore little up-to-date driving experience. This study has enhanced our understanding of 'at-risk' older female drivers by identifying the predictors of crash involvement including declines in functional performance, onset of medical conditions, and driving-related factors such as lack of confidence, low mileage, and lack of up-to-date driving experience. This information has led to a number of recommendations for countermeasures aimed at maintaining their safe mobility and identified a number of areas worthy of further research.

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APPENDIX A: EXPLANATORY STATEMENT

MONASH University
Accident Research Centre

Contributing factors to crash risk of older female drivers in the ACT

Letter of Invitation/Explanatory Statement

<date>

Dear <name>,

Thank you for agreeing to take part in our study of older female driver safety. Crashes involving older drivers are of great concern to road safety. While male drivers have tended to be over-represented in road crashes, it appears that increasing numbers of female drivers are involved in fatal and serious injury crashes. Of particular concern is the increasing rate of older female driver crash and injury rate. This increase may be due to changing travel and driving patterns of older female drivers.

The Monash University Accident Research Centre is carrying out a project for the NRMA-ACT Road Safety Trust to examine the driving patterns of older female drivers in the ACT, particularly relating to driver's experiences, reasons why drivers may change their behaviour on the road and how this relates to crash risk. It is hoped that this study will identify important issues surrounding older female driver safety and mobility and help develop safety initiatives for older women drivers.

If you have received this letter of invitation, you will have already participated in a study with the Monash University Accident Research Centre at which time you indicated that you may be willing to participate in future research and you have received a phone call from our research staff. This in no way means that there is any obligation for you to participate in this study.

For this study, we invite you to complete a 'functional performance assessment' in which we will administer a series of assessments that are designed to assess functions that may contribute to crash risk including cognitive, perceptual, attentional, visual and physical functioning. This assessment will take approximately 60 minutes to complete.

We will also ask you to complete a short survey that will ask questions about your health, driving experiences, changes in driving patterns, reason for change, your driving confidence and your thoughts on reducing or stopping driving. It will also ask some questions about any crashes you have been involved in, including details of the crash and any injuries you or others involved in the crash incurred. This will take approximately 15 to 20 minutes to complete and you can complete it at your convenience and post it back to us in a reply paid envelope that we will supply.

We have booked you in for the functional performance assessment on:

Date:	**<date>**	Time:	**<time>**
Address:	**Council On The Ageing,** **Wisdom St,** **Hughes**		

We will confirm this time again with you closer to the date.

The information we will collect is for research purposes only and will be treated in the strictest confidence. No identifying information will be reported or published. Only members directly involved in the research will have access to the data, which will be stored securely for a minimum period of seven years in accordance with Monash University regulations. Other parties will not be able to identify the individuals participating in the study because responses will be de-identified.

The results of test scores MAY indicate early signs of change in mental capacities that might have an affect on driving. You may wish to be informed of your test outcome and can indicate on a consent form whether or not you prefer to be informed of the outcome of your assessment. In any event, the general implications of performance for safe driving will be discussed with all participants. In addition, at the conclusion of the study, you may obtain group findings from Monash University Accident Research Centre website. The findings will be made available to the sponsors of the project (MUARC) in the form of a report and conference papers and journal articles may also arise from this research project.

If you have any further queries about the study or would like to change your booking time, please don't hesitate to contact me at Monash University. Looking forward to meeting you on <date>.

Kind regards,

Dr Jennie Oxley
Senior Research Fellow
Accident Research Centre
Monash University
Building 70,
Monash University. Vic. 3800

Tel: (03) **9905 4374**

Fax: (03) **9905 4363**

E-mail: Jennie.Oxley@general.monash.edu.au

Should you have any complaint concerning the manner in which this research is conducted, please do not hesitate to contact The Standing Committee on Ethics in Research on Humans at the following address:

The Secretary
The Standing Committee on Ethics in Research on Humans
P.O. Box 3A, Monash University, Victoria 3800

Telephone: (03) 9905 2052 **Fax: (03) 9905 1420**

APPENDIX B: LETTER OF CONSENT / REVOCATION OF CONSENT

MONASH University
Accident Research Centre

Contributing factors to crash risk of older female drivers in the ACT

Consent Form

I agree to take part in the above Monash University research project. I have had the project explained to me and I have read the Letter of Invitation/Explanatory Statement, a copy of which I will keep for my records. I understand that agreeing to take part means that I am willing to:

- ❑ Complete a 'functional performance assessment' in which I will complete a series of assessments designed to assess functions that may contribute to crash risk including cognitive, perceptual, attentional, visual and physical functioning, and

- ❑ Complete a survey about my health, driving experiences, changes in driving patterns, reason for change, my driving confidence and my thoughts on reducing or stopping driving.

I understand that any information I provide is confidential and that no information that could lead to the identification of any individual will be disclosed in any reports on the project or to any other party.

I also understand that my participation is voluntary, that I can choose not to participate in part or all of the project, and that I can withdraw within 4 weeks of my participation, without being penalised or disadvantaged in any way. Withdrawal beyond 4 weeks will not be possible as there will be no means of linking the unique identifier assigned to my details. If I choose to withdraw, my details will be destroyed.

I understand that I can indicate whether I prefer to be informed of my test performance. I, therefore,

❒ DO ❒ DO NOT

wish to be informed of the outcome of my assessment.

I have been informed that only group results will be reported in all publications and will be available from the Monash University Accident Research Centre upon request, once the study has been completed.

I have also been informed that the information collected will be stored in a secure location at the Monash University Accident Research Centre for a minimum of seven years, as required by Monash University regulations.

Participant's Name:…………………………………..……………(please print)

Signature:…………………………………..…………..Date:……………………

MONASH University
Accident Research Centre

Contributing factors to crash risk of older female drivers in the ACT

Revocation of Consent

I hereby wish to withdraw my consent to participate in the research project named above and understand that such withdrawal will not have any consequences for me.

Participant's Name:………………………………..………………………..…...(please print)

Signature:…………………………………………………………….…….……..…………..

Date:…………..…….………………………………………………………………………
………

APPENDIX C: QUESTIONNAIRE

MONASH University
Accident Research Centre

Thank you for participating in this research.
We would like to ask you some further questions on your driving experiences.

Please post the form back to us in the reply-paid envelope.

This section asks questions about you. Please read each question carefully and place a tick in the box that best describes you. If you make a mistake, just cross it out and place a tick in the correct box.

A1. What is your current marital status?

❒ Married ❒ Widowed ❒ Never married
❒ Divorced ❒ De facto ❒ Separated
❒ Other, please specify ____________________

A2. Overall, how would you best describe your current health status?

❒ Excellent ❒ Fair
❒ Very Good ❒ Poor
❒ Good

A3. Do you have difficulty with any daily living task? (e.g. walking without assistance, lifting, climbing stairs)

❒ Yes ❒ No

If yes, please describe ____________________
____
____

SURVEY – OLDER FEMALE DRIVERS IN THE ACT 1

MONASH University
Accident Research Centre

A4. Do you suffer from any of the following medical conditions? Please answer i) yes or no, ii) whether you are taking prescribed medication for the condition, and iii) whether you think the condition affects your driving.

Medical Condition	Yes/No	Prescribed medication	Affects driving
Cataract	❒ Yes ❒ No	❒ Yes ❒ No	❒ Yes ❒ No
Glaucoma	❒ Yes ❒ No	❒ Yes ❒ No	❒ Yes ❒ No
Macular degeneration	❒ Yes ❒ No	❒ Yes ❒ No	❒ Yes ❒ No
Diabetic retinopathy	❒ Yes ❒ No	❒ Yes ❒ No	❒ Yes ❒ No
Other eye disease Please specify _______________	❒ Yes ❒ No	❒ Yes ❒ No	❒ Yes ❒ No
Coronary heart disease	❒ Yes ❒ No	❒ Yes ❒ No	❒ Yes ❒ No
Cardiac arrhythmia	❒ Yes ❒ No	❒ Yes ❒ No	❒ Yes ❒ No
High blood pressure	❒ Yes ❒ No	❒ Yes ❒ No	❒ Yes ❒ No
Stroke or mini-stroke	❒ Yes ❒ No	❒ Yes ❒ No	❒ Yes ❒ No
Diabetes mellitus	❒ Yes ❒ No	❒ Yes ❒ No	❒ Yes ❒ No
Alzheimers disease	❒ Yes ❒ No	❒ Yes ❒ No	❒ Yes ❒ No
Parkinsons disease	❒ Yes ❒ No	❒ Yes ❒ No	❒ Yes ❒ No
Arthritis (osteo- or rheumatoid) Please specify _______________	❒ Yes ❒ No	❒ Yes ❒ No	❒ Yes ❒ No
Other medical condition Please specify _______________	❒ Yes ❒ No	❒ Yes ❒ No	❒ Yes ❒ No

This section asks questions about your driving experiences. Please place a tick in the box next to the response that best describes you. If you make a mistake, just cross it out and place a tick in the correct box. All answers are acceptable and there are no wrong answers.

A5. Are you usually the one who does most of the driving in your household?

- ☐ Yes (please go to question A6)
- ☐ No (please go to question A7)

If yes, please describe the circumstances under which you became the main driver in your household

____

____

____

A6. How long have you been the one who does most of the driving in your household?

- ☐ Under 6 months
- ☐ Between 6 to 12 months
- ☐ Between 1 to 2 years
- ☐ Between 3 to 5 years
- ☐ More than 5 years
- ☐ Not sure

A7. Do others rely on you for transportation?

- ☐ Yes
- ☐ No

If yes, please describe who relies on you for transportation and the types of trips you undertake

____

____

A8. Would you say that most of your trips are…..?

- ❐ Less than 3 kilometres
- ❐ Between 3 and 5 kilometres
- ❐ Over 5 kilometres

A9. Roughly, how many kilometres did you drive on your very last trip?

_________ kms

A10. Do you share the driving with another driver in the household?

- ❐ Yes
- ❐ No
- ❐ No other driver available in the household (please go to question A12)

A11. In what driving situations do you share the driving?

- ❐ On regular shopping trips
- ❐ On social outings such as visiting family and friends
- ❐ On long-distance trips
- ❐ When the other driver is unable to drive due to poor health
- ❐ When the other driver does not drive due to avoidance of driving situations or traffic conditions (e.g., unfamiliar roads, driving at night)
- ❐ No other driver available in the household

Go to question A13.

MONASH University
Accident Research Centre

A12. If you do NOT share the driving, please indicate your reasons why

- ❐ Other driver prefers to drive at all times when driving together
- ❐ I feel nervous driving when the other available driver is in the car
- ❐ I prefer to be the passenger when other driver is available to drive
- ❐ Other, please indicate ____________________

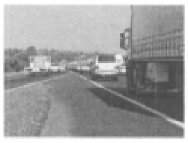
____

____

____

The next set of questions asks about how you feel in different driving situations. We would like you to think about how you have felt in these driving situations in the last 6 months.

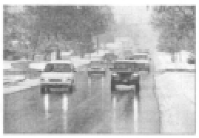
A13. How do you feel about merging into traffic?



I am:	Merging into traffic is:	Do you avoid it?
❑ Very confident	❑ Not difficult	❑ Always
❑ Moderately confident	❑ A little difficult	❑ Sometimes
❑ Not at all confident	❑ Very difficult	❑ Never
If you avoid it, please describe HOW… ____________________		
If you avoid it, please describe WHY… ____________________		

MONASH University
Accident Research Centre

A14. How do you feel about driving in the rain?

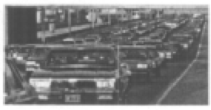


I am:	Driving in the rain is:	Do you avoid it?
❑ Very confident	❑ Not difficult	❑ Always
❑ Moderately confident	❑ A little difficult	❑ Sometimes
❑ Not at all confident	❑ Very difficult	❑ Never

If you avoid it, please describe HOW…

If you avoid it, please describe WHY…

A15. How do you feel about driving in busy traffic?



I am:	Driving in busy traffic is:	Do you avoid it?
❑ Very confident	❑ Not difficult	❑ Always
❑ Moderately confident	❑ A little difficult	❑ Sometimes
❑ Not at all confident	❑ Very difficult	❑ Never

If you avoid it, please describe HOW…

If you avoid it, please describe WHY…

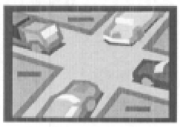
A16. How do you feel about driving through roundabouts?

I am:	Driving through roundabouts is:	Do you avoid it?
❑ Very confident	❑ Not difficult	❑ Always
❑ Moderately confident	❑ A little difficult	❑ Sometimes
❑ Not at all confident	❑ Very difficult	❑ Never

If you avoid it, please describe HOW…

If you avoid it, please describe WHY…

A17. How do you feel about driving through intersections without traffic lights?

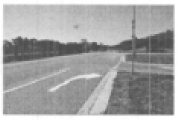


I am:	Driving through these intersections is:	Do you avoid it?
❑ Very confident	❑ Not difficult	❑ Always
❑ Moderately confident	❑ A little difficult	❑ Sometimes
❑ Not at all confident	❑ Very difficult	❑ Never

If you avoid it, please describe HOW…

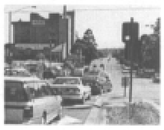
If you avoid it, please describe WHY…

A18. How do you feel about making right-hand turns at intersections without traffic lights?



I am:	Making turns at these intersections is:	Do you avoid it?
❑ Very confident	❑ Not difficult	❑ Always
❑ Moderately confident	❑ A little difficult	❑ Sometimes
❑ Not at all confident	❑ Very difficult	❑ Never
If you avoid it, please describe HOW…		
If you avoid it, please describe WHY…		

A19. How do you feel about making right-hand turns at intersections WITH traffic lights but without a right-hand turn arrow?



I am:	Making turns at these intersections is:	Do you avoid it?
❑ Very confident	❑ Not difficult	❑ Always
❑ Moderately confident	❑ A little difficult	❑ Sometimes
❑ Not at all confident	❑ Very difficult	❑ Never
If you avoid it, please describe HOW…		
If you avoid it, please describe WHY…		

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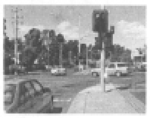
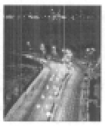
A20. How do you feel about making right-hand turns at intersections with traffic lights and with right-turn arrows?



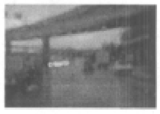
I am:	Making turns at these intersections is:	Do you avoid it?
❑ Very confident	❑ Not difficult	❑ Always
❑ Moderately confident	❑ A little difficult	❑ Sometimes
❑ Not at all confident	❑ Very difficult	❑ Never
If you avoid it, please describe HOW…		
If you avoid it, please describe WHY…		

A21. How do you feel about driving at night?



I am:	Driving at night is:	Do you avoid it?
❑ Very confident	❑ Not difficult	❑ Always
❑ Moderately confident	❑ A little difficult	❑ Sometimes
❑ Not at all confident	❑ Very difficult	❑ Never
If you avoid it, please describe HOW…		
If you avoid it, please describe WHY…		

A22. How do you feel about driving at night when it is wet?



I am:	Driving at night when it is wet is:	Do you avoid it?
❑ Very confident	❑ Not difficult	❑ Always
❑ Moderately confident	❑ A little difficult	❑ Sometimes
❑ Not at all confident	❑ Very difficult	❑ Never

If you avoid it, please describe HOW…

____

If you avoid it, please describe WHY…

____

A23. How do you feel about changing lanes while driving?

I am:	Changing lanes while driving is:	Do you avoid it?
❑ Very confident	❑ Not difficult	❑ Always
❑ Moderately confident	❑ A little difficult	❑ Sometimes
❑ Not at all confident	❑ Very difficult	❑ Never

If you avoid it, please describe HOW…

____

If you avoid it, please describe WHY…

____

A24. Are there any other driving situations that you are not confident in, find difficult or try to avoid?

Driving situation: ______________________________

In this driving situation, I am:	I find this driving situation:	Do you avoid it?
❑ Very confident	❑ Not difficult	❑ Always
❑ Moderately confident	❑ A little difficult	❑ Sometimes
❑ Not at all confident	❑ Very difficult	❑ Never
If you avoid it, please describe HOW…		
If you avoid it, please describe WHY…		

In this last section, we would like to ask you some questions regarding crashes. We hope that you will be comfortable answering these questions, but we understand if you choose not to answer. We are not interested in who was at fault in crashes and we would like you to think about only crashes where YOU were the driver.

A25. In the last survey you completed for us, we asked if you had been involved in a crash over the last five years. Can you please confirm if you had been in a crash or not where you were the driver?

❑ Yes, I was involved in a crash
(Please answer questions A26 to A37).

❑ No, I was not involved in a crash
(Thank you. There are no more questions. Please go to the end).

A26. If you had been involved in a crash, please indicate where the crash occurred.

Please state location and postcode of the crash

____

____

A27. Was the crash at an intersection or other road environment?

- ☐ Intersection
- ☐ Not sure / Don't remember
- ☐ Other, please specify __________________________

A28. What driving task were you doing at the time of the crash?

- ☐ Making a right-hand turn
- ☐ Merging into a traffic lane
- ☐ Changing lanes
- ☐ Making a U-turn
- ☐ Not sure / Don't remember
- ☐ Making a left-hand turn
- ☐ Stopped at an intersection
- ☐ Driving straight
- ☐ Other, please specify ____________________

A29. What time of day did the crash occur?

- ☐ Morning
- ☐ Afternoon
- ☐ Evening/night
- ☐ Not sure / Don't remember

A30. Were you driving on an unfamiliar road?

- ☐ Yes
- ☐ No
- ☐ Not sure / Don't remember

A31. Were you driving in busy traffic?

- ❐ Yes
- ❐ No
- ❐ Not sure / Don't remember

A32. Was it raining at the time?

- ❐ Yes
- ❐ No
- ❐ Not sure / Don't remember

A33. Were you injured in the crash?

- ❐ Serious injury (hospitalised)
- ❐ Minor injury (medical treatment)
- ❐ No injury, property damage only
- ❐ Not sure / Don't remember

A34. If you were injured, what types of injuries did you have?

- ❐ Head injury
- ❐ Neck injury
- ❐ Upper limb injury
- ❐ Not sure / Don't remember
- ❐ Chest injury
- ❐ Lower limb injury
- ❐ Other, please specify

____

____

A35. Was anyone else injured in the crash?

- ❐ Other passenger in your car
- ❐ Occupant(s) in other car
- ❐ Other road user (e.g., motorcyclist, pedestrian, cyclist)
- ❐ Not sure / Don't remember

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A36. Has the crash changed your driving behaviour or travel patterns?

- ❒ Yes
- ❒ No
- ❒ Not sure / Don't remember

If yes, please give details ____

____

____

____

A37. Are there any other details of the crash you would like to describe?

- ❒ Yes
- ❒ No

If yes, please give details ____

____

____

____

THANK YOU AGAIN FOR PARTICIPATING IN THIS RESEARCH.

This survey will provide valuable information on driving and crash experiences of older women and will assist us in developing educational and awareness programs for older women in the ACT.