

Some Factors that may Increase Crash Risk of Older Female Drivers

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ABSTRACT

Older drivers are over-involved in serious injury and fatal crashes per licensed driver compared to younger drivers. This may be due to age-related changes in functional performance and health status as well as changes in driving factors. Moreover, there may be some gender-specific factors that may place older female drivers at increased risk of crash involvement. Indeed, crash statistics show that their fatality rate is increasing more rapidly than that of older men and is likely to increase markedly in the years ahead as the population ages. Using data from i) a self-administered survey of 673 older female drivers, and ii) a case-control study of 48 crash-involved and 44 non crash-involved older female drivers, some factors that may predict crash involvement were identified. Poor attentional, cognitive, executive and motor skills as well as the presence of multiple medical conditions were associated with crash involvement, suggesting that women with more pronounced functional changes were at highest crash risk. 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. The findings have enhanced our understanding of which female drivers are at increased risk, particularly through identifying a more precisely defined target group for road safety countermeasures.

KEY WORDS: older driver, gender, crash risk, behaviour, functional performance, travel patterns, countermeasures, mobility.

1 INTRODUCTION

The majority of older drivers are generally considered safe and cautious drivers, and in general, they represent a reasonably modest proportion of road fatalities (approximately 13% of all fatalities) and serious injuries (approximately 10% of all serious injury crashes) (ATSB, 2001). International figures show similar trends. However, there are relatively fewer older people in the population, fewer are licensed, they tend to drive less frequently and shorter annual distances, and they are more fragile than younger drivers. With these factors taken into consideration, the safety of older drivers is clearly of some concern. Moreover, it seems that the fatality and serious injury crash rates of older female drivers is increasing more rapidly than men of similar ages, and is likely to increase markedly in the years ahead as the population ages (Fildes et al., 2001; OECD, 2001).

In the past, little attention has been given to elderly women in traffic and, consequently, there is little consideration of the effect of gender on mobility and safety. This may result in an under-estimation of and lack of understanding of differences between sub-groups of older drivers. However, given that the majority of the elderly in the population are women and this proportion is growing, more women are licensed, and they are driving further, it is essential to understand their transportation needs, their behaviour in traffic and their risks.

There are a number of health and driving-related factors that may place older women at increased crash and injury risk, including frailty, fitness to drive, and driving behaviours. For example, frailty is a major determinant of crash outcomes. While it has long been recognised that frailty, susceptibility to injury and poorer capacity to recover from an injury can explain a large proportion of the excess death and serious injury rates amongst older drivers (Evans, 1991; Li et al., 2003), women of all ages are more likely to suffer more serious injury than men, given the same insult (Abdel-Aty & Abdelwahab, 2001; Ulfarsson & Mannering, 2004). Physiological differences can arise from average differences in male/female size and weight and their interaction with vehicle safety design, as well as differences in the body to withstand impacts.

Driving, at least in some situations, is a complex task that demands a host of age-sensitive functions such as processing and integration of multiple sources of information and quick interpretation of the most important stimuli in fast-moving and busy traffic. Most people experience some level of functional decline as they age, particularly in sensory, physical and cognitive areas. There are noted gender differences in older adults' mortality and morbidity rates. Despite longer survivorship, older females report both greater prevalence of illness and more utilisation of health services than older males (Verbrugge, 1983), spend a larger proportion of their lifetime disabled (US Administration on Aging, 2002), and report poorer functions in activities of daily living, social relationships and well-being (Cornoni-Huntley et al., 1993). While there is some evidence that some health factors influence crash risk of older female drivers (e.g., Hu et al., 1998; Margolis et al., 2002), very little is known about how these gender differences affect driving performance and crash risk.

In addition, there are some driving factors that may increase crash risk. Older adults typically reduce their exposure by driving fewer annual kilometres, making shorter and fewer trips, and limit their driving in some situations. While these changes may be effective in keeping older driver crashes at lower levels, it may be that those who reduce their driving may also be those who are at greatest risk of crash involvement. 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. It is well documented that older female drivers have less driving experience, both quantitatively and qualitatively, compared with males of similar ages. Older female drivers tend to drive fewer kilometres and drive shorter distances than younger females and older males (Rosenbloom, 2004; Charlton et al., 2006). In addition, there are reports that, compared with older male drivers, older female drivers report more difficulties in traffic situations (Bishu et al., 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). There are also reports of gender differences in overall confidence in driving, self-ratings of driving ability (Parker et al., 2001; Charlton et al., 2006). However, there are few studies that have established a link between the effect of gender on driving practices and crash risk.

This paper presents the results from a study examining the impacts of driving experience, practices and confidence, functional performance and health-related factors on crash risk among a group of older female drivers.

2 METHOD

This study was conducted in two parts, incorporating a self-administered survey of 673 older female drivers and a case-control study of a sub-set of 92 survey respondents.

Mail-out surveys were sent to a random sample of 2,000 older females aged 60 years and older (stratified according to age group within the population) who had Senior Card membership in the ACT (over 98% of the elderly population in the ACT hold a Seniors Card). In total 839 (42%) of surveys were returned. Of the 726 completed and returned surveys, 673 respondents considered themselves current drivers and 53 considered themselves former drivers. The results presented in this paper are drawn from the 673 respondents who reported to be current drivers. Logistic regression modelling was used on the survey data to identify the 'at-risk' older female driver, using information on health status, demographic characteristics, travel patterns, driving decisions, experience and confidence and crash history. Odds ratios and ranked conditional probabilities were calculated to identify potential contributing factors.

A sub-set of the survey respondents were invited to take part in a follow-up study: 48 crash-involved drivers (those reporting having been involved in a crash in the last five years) and 44 non crash-involved drivers (those reporting not having been involved in a crash in the last five years, and matched with cases on age, marital status, amount of kilometres travelled per week and self-reported health status). Functional performance, driving experiences and driving practices were compared between groups. Functional performance was assessed using a range of screening tools designed to assess visual, perceptual, attentional, cognitive and motor functioning. These tools were selected on the basis of previous findings linking functional performance measures and driving competence and crash experience (Owsley et al., 1998; Janke, 1994; Fildes et al., 2004). For brevity, a selection of analyses will be reported in this paper and are outlined below (Table 1):

Table 1: Selected functional performance assessments

Assessment	Description
Gross Impairments Screening (GRIMPS) battery of General Physical and Mental Abilities (Scientex, 1999)	The GRIMPS measures a range of abilities that are related to the driving task. It comprises 11 non computer-based sub-tests including the rapid-paced walk, foot tap test, cued recall, arm reach, head/neck & upper body rotation, visual scan test, Trails parts A & B & visual acuity.
Useful Field of View Test (UFOV) (Owsley et al., 1998)	The UFOV (a touch screen computer-based test) measures the visual field extent that is available to a person focussing on a task in the central part of the visual field. It comprises computer-based 3 sub-tasks that involve perceptual-response time, visual search, divided and selective attention.
Mattis Organic Mental Syndrome Screening Examination (MOMSSE) (Mattis, 1976)	The MOMSSE measures mental status using 8 sub-tests. It is non computer-based and assesses general information knowledge, verbal abstraction, digit span, orientation, visual and verbal memory, language, construction and block design.

3 RESULTS – Survey Data

General demographic information of survey participants is summarised in Table 2. The majority of drivers were married (44%), aged between 65 and 74 years (56%), retired (84%), living independently (95%) and close to local shops and services (75% lived less than 2 kilometres, with 24% living between 2 and 5 kilometres). They generally drove frequently and travelled substantial distances each week, with most travelling between 21 and 100 km per week. Younger drivers tended to drive longer distances than older drivers, $\chi^2_{(18)}=29.65$, $p<0.05$. Seventy % 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.

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 of being a safe driver. Confident drivers were generally also principal drivers, $\chi^2_{(3)}=9.17$, $p<0.05$, and drivers who did not prefer to have a passenger, $\chi^2_{(15)}=25.65$, $p<0.05$. Level of confidence did not vary by age ($p=0.55$). Although many drivers indicated they did not have any difficulty with specific driving situations, substantial proportions of drivers (30-50%) reported experiencing problems with driving at night or in poor weather conditions, driving on unfamiliar roads or in unfamiliar areas, and the driving style of others. Approximately one quarter reported difficulty driving on busy roads (Figure 1). Other reported problems included reversing into parking bays, getting lost, car breaking down and being tail-gated by other drivers.

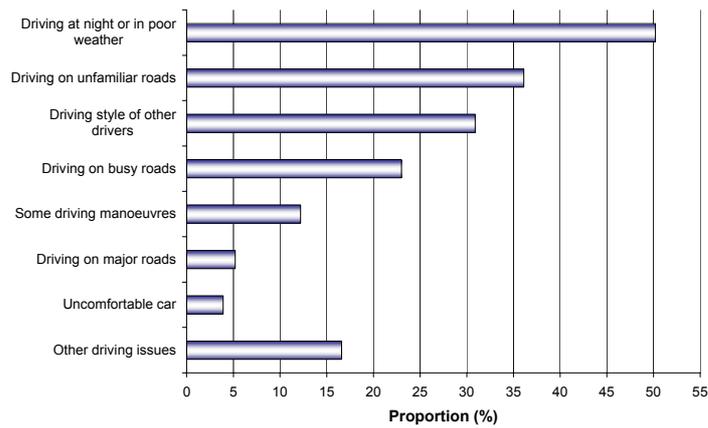


Figure 1: Summary of driving situations that were reported as being a problem by current drivers.

Seventy-five drivers (11% of the sample) reported having been involved in a crash in the last five years. Logistic regression was used to model the ‘at-risk’ older female driver, using crash involvement (in the last 5 years) as the dependent variable and taking into account correlations between variables. Potentially important predictor variables were selected on the basis of a priori knowledge (from previous research) and preliminary analyses of survey data using bi-variate techniques. They included various demographic variables such as age group and health-related variables, distances travelled per week, principal driver status, and driving experience variables such as confidence of being a safe driver, sharing driving on long-distance trips, difficulty in driving situations and feelings about driving (whether participants enjoyed driving or not and if this had changed). During the model building process, interaction terms were selected if a relationship was found between any variable. Summary figures for multivariate regression analyses for predicting crash involvement in the last five years are shown in Table 2.

This model indicates that principal drivers were more likely to have been involved in a crash in the last five years compared to non-principal drivers (adjusted odds ratio: 5.97). Confidence of being a safe driver was also associated with crash involvement. The odds of a driver who was moderately or not at all confident of being a safe driver to have been crash-involved was 1.94 times that of a driver who was very confident of being a safe driver.

In addition, two interaction effects were significant predictors of crashes and post hoc Logit Transformations were performed to show where the differences were and these analyses revealed the following: For those who had problems with other drivers, the odds of being involved in a crash were 3.18 times greater if they also shared long-distance driving, compared to those who did not share the driving on long-distance trips, CI = [1.29-7.84], $p < 0.05$. Further, for those who had problems with other drivers, the odds of being crash-involved for those who also had problems driving on unfamiliar roads was 1.15 times higher than those who did not have problems driving on unfamiliar roads, CI = [0.49-2.72], $p < 0.05$.

As the variable having problems with the driving style of other drivers was present in both interactions, it was necessary to analyse this separately for the four different co-variate groups. The key findings from the analysis were: For those who shared long-distance driving and had difficulty driving on unfamiliar roads, the odds of being crash-involved were 7.93 times higher for those who also had problems with the driving style of other drivers compared to those who did not have problems with the driving style of other drivers, CI = [2.27-27.77], $p < 0.05$. Amongst those who did not share long-distance driving but also had difficulty driving on unfamiliar roads, the odds of being crash-involved were 2.44 times higher for those who also had problems with the driving style of other drivers compared to those who did not have these problems, CI = [0.65-0.09], $p > 0.05$.

Table 2: Multivariate model statistics for prediction of crash involvement in the last five years.

Variable	Ref.	Sig.	Rel. Odds Ratio (95% CI)
Principal driver status	Not principal driver	0.001	5.97 (2.49, 14.29)
Confidence of being a safe driver	Very confident	0.02	1.94 (1.12, 3.37)
Sharing the driving on long-distance trips	Not sharing driving	0.95	0.98 (0.48, 1.99)
Problems with driving style of other drivers	No problems	0.23	0.54 (0.18, 1.64)
Problems driving on unfamiliar roads	No problems	0.01	0.25 (0.09, 0.75)
Problems with driving style of others X problems with driving on unfamiliar roads	No problems	0.03	4.54 (1.15, 17.92)
Problems with driving style of other drivers X sharing the driving on long-distance trips	No problems or not sharing	0.05	3.25 (1.03, 10.24)

Interestingly, self-reported health status measures were not associated with increased likelihood of being involved in a crash amongst this group of drivers. However, the numbers of reported crashes were low amongst this sample of drivers, and may explain the lack of association.

4 RESULTS – Case-Control study

Analyses revealed no significant group differences between crash-involved cases and controls on variables used in the matching criteria, suggesting that the two groups were matched well. There were similar proportions of cases and controls across age group (60-64 years, 65-74 years and 75+ years), $\chi^2_{(2)}=1.93$, $p>0.05$, marital status (married/defacto, widowed, never married, divorced/separated), $\chi^2_{(3)}=3.19$, $p>0.05$, distances travelled each week (<20km, 21-50km, 51-100km, 101-200km, >200km), $\chi^2_{(6)}=7.01$, $p>0.05$, and self-reported health status (excellent, very good, good, fair/poor), $\chi^2_{(3)}=5.99$, $p>0.05$.

Table 3 shows the mean scores on selected 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-tests or chi-square tests. Eleven separate scores and an overall score (max. = 11) were derived from the GRIMPS test. Overall, the non crash-involved group performed better compared to those who were crash-involved, $t(89.09) = 2.61$, $p < 0.001$, 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% scored ‘average or above’ on only 6-7 sub-tests (Figure 2).

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Table 3: Mean score on functional assessment by group.

Assessment	Non crash-Involved group	Crash-involved group	p-value
	Mean Score (<i>sd</i>)	Mean Score (<i>sd</i>)	
GRIMPS: Overall	9.68 (1.03)	9.06 (1.25)	< 0.001
GRIMPS sub-test: Rapid paced walk	5.74s (1.04s)	6.59s (1.61s)	< 0.001
GRIMPS sub-test: Foot tap	4.99s (1.40s)	5.59s (2.24s)	= 0.06
GRIMPS sub-test: Trails B	72.69s (25.04s)	80.90s (27.47s)	= 0.07
GRIMPS sub-test: MVPT	9.45 (1.07)	9.50 (1.54)	> 0.05
GRIMPS sub-test: Visual acuity (high contrast)	0.76 (0.26)	0.87 (0.41)	= 0.08
GRIMPS sub-test: Visual acuity (low contrast)	0.46 (0.19)	0.45 (0.17)	> 0.05
UFOV: Divided attention	65.34ms (53.32ms)	105.25ms (133.64ms)	< 0.05
UFOV: Selective attention	199.82ms (99.81ms)	208.52ms (117.06ms)	> 0.05
MOMSSE: Overall	51.18 (2.76)	49.92 (4.16)	= 0.05

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, $t(81.22) = -3.04.99$, $p < 0.001$, one-tailed. Other sub-test scores revealed small or no differences between groups: Foot tap: $t(90) = -1.54$, $p = 0.06$, one-tailed; Trails B: $t(89.99) = -1.49$, $p = 0.07$, one-tailed; Motor-free visual perception test: $t(83.84) = -0.17$, $p > 0.05$, one-tailed; visual acuity (average of monocular scores for both eyes in high contrast condition): $t(79.59) = -1.40$, $p = 0.08$, one-tailed; and visual acuity (average of monocular scores for both eyes in low contrast condition): $t(87.07) = 0.04$, $p > 0.05$, one-tailed.

Component scores for the two measures for the UFOV assessment showed a small, but insignificant difference between groups for the divided attention task, $t(90) = -1.85$, $p = 0.06$, 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, $t(89.55) = -0.39$, $p > 0.05$, one-tailed.

A 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. This difference, however, failed to reach significance, $t(90) = 1.70$, $p = 0.05$, one-tailed.

In addition, participants were asked to complete a medical checklist indicating whether they experienced medical conditions including eye diseases, cardiovascular diseases, dementia, and physical conditions. The non crash-involved group reported significantly fewer medical conditions, (mean: 1.28, sd: 1.0) compared to the crash-involved group (mean: 1.83, sd: 1.0), $t(77.8) = -2.45$, $p < 0.001$, one-tailed.

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.

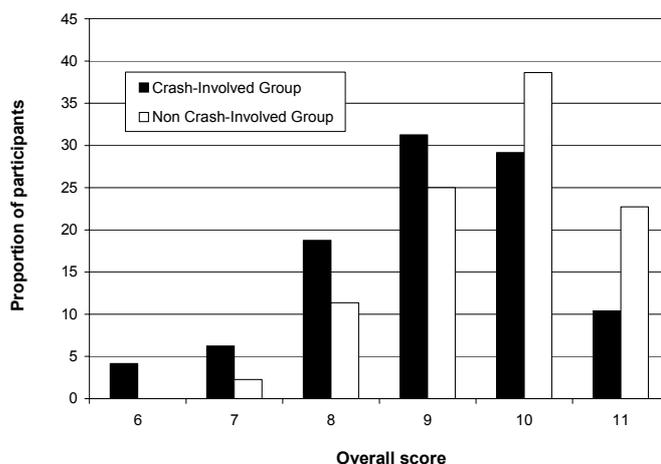


Figure 2: Proportion of sub-tests passed on GRIMPS by group

It is possible that, due to the small sample size, there was insufficient power to detect some expected group differences, particularly in some of the subtests of GRIMPS, the selective attention component of UFOV, and specific medical conditions.

Logistic regression modelling was therefore 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. Potential variables included: GRIMPS overall score; rapid pace walk (s); foot tap (s); Trails B (s); MVPT; UFOV scores – divided attention (ms) and selective attention (ms); MOMSSE overall score; visual acuity (average score of both eyes in high and low contrast conditions); number of self-reported medical conditions; principal driver status; and, confidence level. 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.

The model resulted from these analyses is summarised in Table 4. This model indicates that the odds of participants who scored high on the GRIMPS and MOMSSE were only 37% and 43% 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% that of participants who were moderately or not all confident of being a safe driver of having had a crash. That is, those 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.

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)
- have performed more poorly in the MOMSSE (scoring in the lowest 50th percentile),
- be only moderately or not at all confident of their safety as a driver, and
- do most (or an equal) amount of driving in the household.

Table 4: Multivariate model for predicting crash-involvement in the last five years

Variable	Ref.	Sig.	Rel. Odds Ratio (95% CI)
GRIMPS Overall score	High score in upper 50 th %ile	0.04	0.37 (0.14, 0.96)
MOMSSE Overall score	High score in upper 50 th %ile	0.08	0.43 (0.17, 1.11)
Confidence of being a safe driver	Highly confident	0.01	0.27 (0.10, 0.68)
Principal driver status	Not principal driver	0.03	3.56 (1.12, 11.28)

5 DISCUSSION

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 et al., 1998; OECD, 2001), increased vulnerability (Evans, 2001; Ulfarsson & Mannering, 2004; Li et al., 2003), prevalence of medical conditions and poor health status (Dobbs, 2001), limited driving experience and low driving confidence (Hu et al., 2000; 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 and cognitive performance, presence of multiple medical conditions, and some important driving factors.

The current findings suggest that crash risk status may lie within limitations in higher order functions such as attentional, cognitive and executive skills. The MOMSSE examines skills such as visual memory, attention span and problem-solving. In the driving context, these 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. A number of recent studies also indicate that poor driving skills and crash involvement are associated with age-related declines in memory (Duchek et al., 1998), cognitive capacity, executive function and reduced processing capacity (Valcour et al., 2002; Daigneault et al., 2002; Stutts et al., 1998) and dementia (Zuin et al., 2002; Freund et al., 2005; Brown et al., 2005). In addition, the finding that a higher number of medical conditions was associated with crash involvement was not unexpected, given past evidence that some health factors can influence crash risk of older female drivers. Hu et al. (1998) found that women who live alone or who experience back pain had a higher crash risk than similar aged men. According to Margolis et al. (2002), increased risk factors associated with older female drivers (after adjusting for age and miles driven) include exposure (each additional 50 miles driven 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 and sensory decline (orthostatic systolic blood pressure drop, poor visual acuity and an increased foot reaction time were associated with 10% higher crash risk).

Most people experience some level of functional decline as they age, particularly in sensory, physical and cognitive areas. Driving, at least in some situations, is a complex task that 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. The current findings support the argument that moderate functional changes do not appear to lead to a discernible increase in crash risk.

Rather, it seems that simultaneous deteriorations of several relevant functional and/or specific functional deficits linked to certain illnesses (for example, dementia) increases crash risk considerably (OECD, 2001; Charlton et al., 2003).

Principal driver status was associated with crash involvement. 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 led support to this argument. A lack of current driving experience and associated lack of confidence in driving is a noted risk factor in the literature (Noble, undated; Cedersund, 1990). Alternatively, 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). Independent of age, drivers travelling more kilometres will typically demonstrate reduced crash rates per kilometre travelled, compared to those driving fewer kilometres. It is possible that those who reduce their driving may also be those who are at greatest risk of crash involvement. These drivers may also 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 (Parker et al., 2001; Hakamies-Blomqvist & Sirén, 2003; Stutts et al., 2001). In addition, these drivers may also be drivers who do their driving on local roads which have more potential conflict points (especially intersections) and hence higher crash rates per unit distance (Keall & Frith, 2004). The explanation is certainly complex and warrants further research, however, the findings of the case-control study that poor functional skills and low to moderate confidence were associated with crash involvement provides good evidence of the associations between poor functional performance and crash risk.

6 CONCLUSIONS

Driving is a fundamentally important part of today's society and is an essential determinant of 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 current emphasis around the world stresses the need for older people to maintain their mobility for as long as possible, it is also important to ensure that they remain safe drivers.

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. This information is a valuable resource on which to base 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.

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