A RE-ASSESSMENT OF OLDER DRIVERS AS A ROAD SAFETY RISK

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Older drivers are frequently viewed as overly represented in crashes, particularly when crash involvement per distance travelled is considered. This perception has led to a call for tighter licensing conditions for older drivers, a policy which inevitably results in mobility restrictions for at least some drivers. However there is a growing body of research evidence which shows that as a group, older drivers represent no greater road risk than drivers from other age groups once different levels of driving activity are taken into account. This paper has examined aspects of older drivers' fitness to drive based on survey data and off-road and on-road driving performance from a sample of 905 New Zealand older drivers. The results show that policies which target all older drivers and lead to licensing and mobility restrictions cannot be justified from a safety basis.

Key Words: Older drivers, Low mileage, Assessment of fitness to drive, Crash risk

1. INTRODUCTION

1.1 Older driver risk status – a conventional interpretation

There is widespread agreement that normal ageing is generally accompanied by the onset of specific medical conditions[1-3], resulting in declines in sensory, perceptual, cognitive, psychomotor and physical functioning[1,4,5]. The claim that older drivers subsequently have reduced driving skills and by extension, increased crash involvement, is supported by their apparent over-involvement in crashes. Figure1 shows for New Zealand drivers, the association between age and crash involvement per distance travelled[6]. Drivers' crash involvement increases sharply for the older ages, where the crash rates are rivalled only by those of the very youngest drivers. Equivalent curves have been obtained for most industrialized countries.

The conventional interpretation of older drivers' safety status recognizes that the crash risk curve based on distance driven, exaggerates older drivers' crash risk due to the 'frailty bias'. Older adults' biomechanical tolerances to injury are lower than those of younger persons[7-9], primarily due to reductions in bone strength and fracture tolerance[10,11]. Therefore the energy required to produce an injury reduces as a person ages[12] and thus increases the likelihood of serious injuries among older drivers involved in a crash. This results in a larger share of older drivers' crashes being included in casualty databases, thereby contributing to an apparent over-representation in crashes. However after allowing for fragility, excess fatal crash involvement rates of around 30-45 percent can still be observed for drivers aged 75 years and above[13].

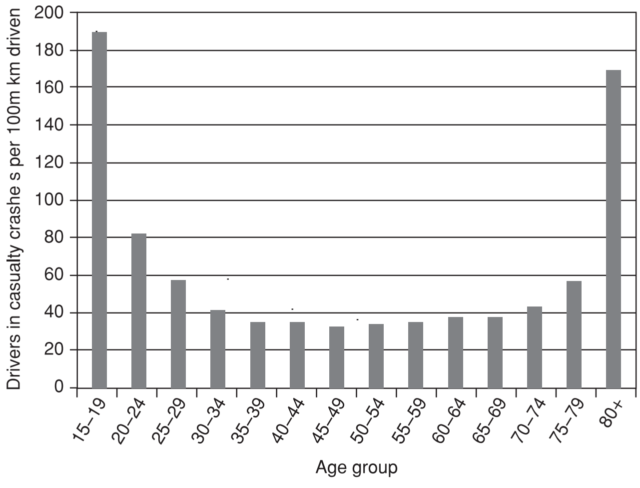

Fig. 1 Drivers involved in fatal and injury crashes by age per 100 million kilometres driven (light 4-wheeled vehicles)

Many jurisdictions around the world interpret older drivers' apparent over-involvement in casualty crashes as indicative of unacceptably risky driver behaviour which can be best managed by regular assessment of fitness to drive as a condition for continued licensing[5]. This policy has been given added urgency by impending demographic changes: over the next four or five decades, there will be a substantial increase in the absolute and proportional number of older drivers in most industrialised countries[5]. The private car is likely to remain the dominant form of transport for these emerging cohorts who, it is predicted, will seek to undertake longer and more frequent journeys than previous cohorts[5,14].

1.2 Older driver risk status – an alternative interpretation

While crash rates per distance driven are generally seen as the most robust measure for demonstrating older drivers' crash risk, this measure is increasingly being called into question. It has been long known that independent of age, drivers travelling more kilometres will typically demonstrate reduced crash rates per kilometre, compared to those driving fewer kilometres[15]. As older drivers typically drive less distance per trip and have lower accumulated distances, Janke warned licensing administrators against becoming overly alarmed about older drivers' apparent high crash risks based on per distance crash rates, without controlling for different annual driving distances.

Hakamies-Blomqvist, Raitanen and O'Neill[16] have empirically demonstrated this finding by using Finnish travel survey data to compare older and young middle-aged drivers' crash rates. The authors first categorized the older and middle-aged drivers according to their extent of annual driving and then compared per-kilometre crash rates for the two age groups, controlling for the different annual driving distances (see Figure 2). When older drivers were compared with younger drivers who had driven equivalent annual mileages, there was no age-related increase in crashes per distance driven. The apparent age-related risk as per Figure 1, was attributed to differences in yearly driving distances and not to age per se, a phenomenon that the authors called Low Mileage Bias. These findings "cast serious doubt on any previous reports of age differences in accident risk per distance driven" (p.274).

Both the original study by Hakamies-Blomqvist et al.[16] and the first replication by Fontaine[17] using French data, were based on relatively small datasets (1080 and 913 respondents, respectively). In addition, the low numbers required that fairly broad age ranges be compared: for example, Hakamies-Blomqvist et al. defined older

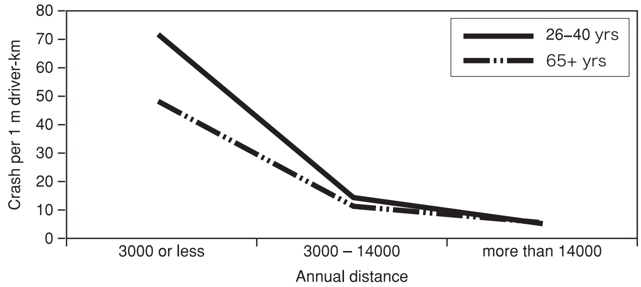

Fig. 2 Annual driving distances and crash rates per 1 million driver-kilometres, by age, (from Hakamies-Blomqvist, Raitanen and O'Neill, 2002)

drivers as aged 65 and above. With the customary risk curves suggesting that increases in crash risk become apparent only from around age 75 years onwards[5,18], it is possible that the broad age ranges used by Hakamies-Blomqvist et al. may be only partly reflecting the oldest drivers' risk factors.

Langford, Methorst and Hakamies-Blomqvist[19] have used travel survey data from a sample of 47,502 Dutch drivers to confirm the earlier demonstrations of the Low Mileage Bias. Figure 3 shows the association between age of driver and crash involvement, controlling for annual distance driven.

After being matched for yearly driving distance, most drivers aged 75 years and above were safer than drivers of other ages. The only age-related increase in crash involvement was for low mileage drivers (comprising just over 10 per cent of older drivers in the survey), where the sustained decline in crash involvement until

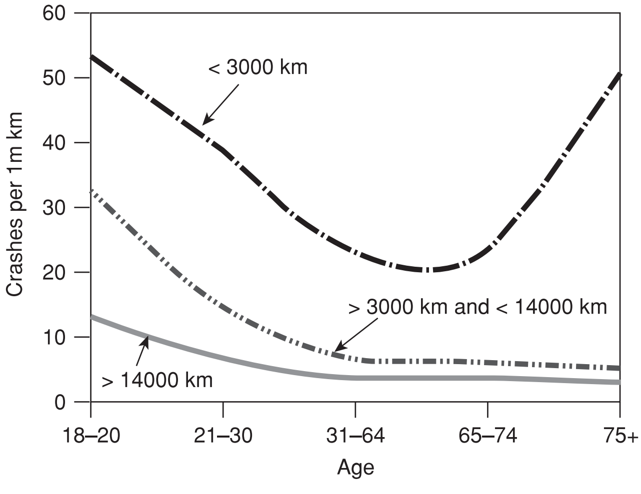

Fig. 3 Annual crash involvement for different driver ages, controlling for annual mileages, (from Langford, Methorst and Hakamies-Blomqvist, in press)

around 75 years of age, was reversed for the oldest drivers. However these increases were not statistically significant and must be regarded as indicative only.

1.3 Next steps in understanding 'the older driver problem'

The conventional interpretation of older driver crash risk emphasizes age and associated declines in functional performance as critical factors. While recognizing that there can be wide variation in the extent of decline across individuals, many policies subsequently target all older drivers for attention. The emerging research suggests that the high crash involvement is closely associated with the amount of annual driving rather than age per se, with any direct age association likely to be restricted to low mileage older drivers.

Janke[15] attributed the mileage/crash association to different driving locations. For example, high mileage drivers are more likely to use freeways and multi-lane divided roadways with limited access. By implication, low mileage drivers do more of their driving on local roads and streets, which have a greater number of potential conflict points and hence higher crash rates per unit distance. Janke noted that there were 2.75 times more crashes per mile driven on non-freeways than freeways. For older drivers with their well-documented difficulties in negotiating intersections[5] urban travel is even more likely to result in crashes[20] – a finding which could partly explain low mileage older drivers' extra crash risk, as indicated by Langford et al.[19]. Hakamies-Blomqvist et al.[16] also pointed to different amounts of freeway and non-freeway driving as explaining the mileage/crash association, while holding open the possibility of other factors contributing to the low mileage/high crash association.

There is a second possible explanatory factor. Some older drivers in response to a perceived decline in driving performance restrict their driving as a safety and/or comfort measure[21-25]. These drivers would be expected to have more medical conditions and greater functional difficulties leading to reduced driving skills, relative to drivers with higher mileages – and intuitively, a higher probability of crashing per distance driven. This factor is likely to affect older drivers particularly, and may also contribute to any extra crash risk for low mileage older drivers.

Keall and Frith[26] have demonstrated that while the proportion of driving distance on urban roads generally decreases as annual distance driven increases, low mileage older drivers have the highest proportion of urban driving even relative to low mileage drivers from other age groups. They have also argued that other factors including a decline in driving competence, may have an impact on driving patterns and the risk of crash involvement. Recognizing that particularly older drivers may be reducing their driving distances to keep their personal risk at an acceptable level, Keall and Frith contend that modelling risk using annual distance driven as the sole explanatory variable would at the very least, present interpretational difficulties.

Given the emerging research relating to older drivers and the mileage/crash association, there is an immediate arising need: to develop a better understanding of the crash risk of low mileage older drivers and in particular, to determine whether they have a reduced fitness to drive. This study aims to analyse data from a sample of New Zealand older drivers to investigate the mileage/crash association and to assess the possible role of fitness to drive in explaining the association.

2. METHOD

2.1 Participants

Participants were recruited from licensed drivers in Wellington, New Zealand who met the following criteria:

- were aged 80 years or older (or had their 80th birthday during the study);
- had undertaken a medical examination (as required for licence renewal); and
- were either about to undertake or had recently completed the on-road New Zealand Older Driver Re-licensing Test (NZODORT), (also required for licence renewal).

The study was conducted from February 2001 to May 2002.

2.2 Data sources

Driver Survey: Participants completed a survey which included items covering demographic measures, ratings of self-reported driving performance, travel patterns, health status, medical conditions, functional performance and self-reported crash history. Crash history was defined as involvement in a crash in the last 2 years where (i) the car was moving (ii) caused occupant injury or vehicle damage (iii) not on private property (iv) either 'at fault' or not. The survey was administered in an interview style and took approximately 10-15 minutes to complete.

On-road driving performance: Participants underwent an on-road driving assessment as part of the standard re-licensing procedures in New Zealand, with results provided by the licensing authority. The on-road results were scored as "pass" or "fail" on the first attempt. That is, those who required two or more attempts before passing were scored as a "fail".

Off-road driving performance: Participants were randomly assigned to complete one of the three off-road screening tests which aimed to assess fitness to drive.

- Gross Impairments Screening Battery of General Physical and Mental Abilities (GRIMPS)

This paper and pencil test, as developed and applied in research sponsored by the US Department of Transportation (National Highway Traffic Safety Administration, NHTSA), consists of 11 sub-tasks covering functional abilities identified through earlier research and expert opinion as leading candidates to predict those at greatest risk of a motor vehicle crash in older age. The sub-tests and their relationship to driving tasks are as follows:

Rapid Pace Walk, Foot-Tapping Test	Demonstrated lower limb strength, endurance and coordination needed to sustain pedal control without fatigue, and to quickly and accurately shift back and forth from the accelerator to the brake pedal.
Arm Reach, Head Neck Rotation	To verify the upper body flexibility needed by the driver to turn the steering wheel quickly in an emergency and to look behind to check for traffic when changing lanes.
Motor-Free Visual Perception, Test Visual Closure Sub-test	To measure a driver's ability to visualize missing information, to help recognise a sign from a partial view or to anticipate unseen or obstructed hazards.
Cued Recall, Delayed Recall	These functions measure working memory, as needed to remember safe driving rules and practices, and to follow simple directions.
Scan Test, Trail-Making Tests	To measure visual search and scanning abilities that make it possible for the driver to detect safety threats ahead and to the sides of the road which is especially important at intersections; and to show how well the driver can divide his/her attention to identify signs, landmarks or other critical information while driving.
Visual Acuity (Standard and low contrast)	These vision test reveal how likely the driver is to have problems reading signs even under good visibility conditions; and if the driver will be able to see less-well-defined roadway features like curbs, medians or the road edge in the fog or at dusk or dawn.

Participants' performance on each of the sub-tasks was classified as being 'average or above' or 'below average' according to criteria developed by the test developers. The overall score is the number of sub-tasks on which they scored 'average or above', with higher scores indicating better performance.

An evaluation of the sub-tasks as crash predictors[27] showed that drivers aged 55-96 years were at significantly higher risk of an at-fault crash if their performance was below average for any of the following measures: leg strength (as reflected in Rapid Pace Walk and Foot-Tapping tasks); head and neck flexibility (Head Neck Rotation); working memory (Delayed Recall); visualizing missing information (Visual Closure); and visual search (Trail-Making).

- DriveABLE™

The DriveABLE™ In-Office test (DriveABLE Inc., Edmonton, Canada) was designed in Canada and comprises six computer-based tasks using touch screen and button push responses. Tasks include the motor speed and control, span of attentional field, spatial judgement and decision making, speed of attentional shifting, executive function and judgement of complex driving situations (a series of videos of traffic sequences, including hazards about which the participant was required to make judgements).

- The Useful Field of View (UFOV) Test

The UFOV is a touch-screen computer-based test that consists of three sub-tests:

- Sub-test 1: Participants are required to respond to an image of either a car or a truck flashed onto the centre of the screen, followed by a distracter screen. Participants are then required to indicate which image was presented (car or truck) by touching the screen over the correct image. This basic task is repeated with the stimulus presentation time being altered in response to the participant's performance. The participant's perceptual processing speed (ms) is recorded;
- Sub-test 2: Participants are again required to identify an image in the centre of the monitor screen, while locating a car simultaneously displayed in the periphery. This is followed by a distracter screen. Two screens then appear requiring participants to indicate which image was presented centrally and where the car in the periphery was located. This is repeated, adjusting the length of stimulus as needed. Participant's perceptual level of divided attention (ms) is recorded;
- Sub-test 3: This 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. Participant's perceptual threshold level of selective attention (ms) is recorded.

For the purposes of this study, only the divided attention and selective attention scores have been used.

2.3 Statistical techniques

Differences between driver groups have been tested for statistical significance using relative risks and 95% confidence intervals, (Epi Info version 3.2) and one way analyses of variance (SPSS version 11.5). For per-mileage crash rate differences, a standard t-test of probabilities based on population confidence limits has been used.

3. RESULTS

3.1 Recruitment rates

Of the 2309 prospective participants eligible for recruitment to the study, a total of 1266 (55%) agreed to participate. Reasons for non-participation included illness (27%), not interested (31%), too busy (22%) and no longer driving (15%). Due to a number of cancellations and 'no shows', the total number of participants assessed was 1042, making an overall participation rate of approximately 45 percent. For the present study, the number of participants was reduced to 905, mainly through the exclusion of those who had been involved in a pilot phase not pertinent to this study.

Individuals who refused to participate were slightly older (M = 83.5 years, SD = 2.9) than participants (M = 82.4 years, SD = 3). Approximately 50 percent of participants and non-participants were aged between 79 and 82 years and approximately 75 percent of participants and non-participants were aged between 79 and 84 years.

A slightly higher percentage of non-participants passed the NZODORT compared to participants (approximately nine percentage points difference).

3.2 Driving distance and crash history

The 905 drivers in the present study were first categorised according to weekly extent of driving, based on self-reported driving activity. Initially five distance categories were used: 20 km or less; 21-50 km; 51-100 km; 101-200 km; and more than 200 km.

The crash rates per 10 million driver-kilometres for each distance category were then calculated, based on self-reported crash involvement during the preceding two years and reported weekly driving distances. The results are shown in Figure 4.

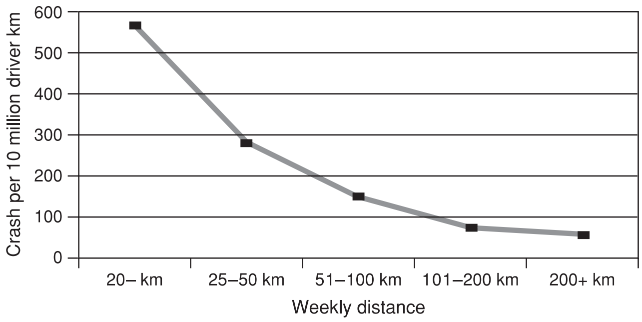

Fig.4 Crash rates per 10 million driver kilometres for all drivers

The crash rates per 10 million driver kilometres varied across the five distance groups, such that the greater the weekly distances driven, the lower the crash rates. Drivers covering 20 kilometres or less per week had approximately nine times the per-distance crash rate of drivers covering 200 kilometres or more per week.

The lowest distance group accounted for just over 12 percent of all older drivers in the sample.

Crash rate differences between the five distance groups were statistically significant in most instances, as reflected in the confidence intervals from a standard t-test of probabilities based on population confidence limits (see Table 1). The group travelling 20 kilometres or less per week had significantly higher crash rates than all other distance groups, except for those travelling 21-50 kilometres (where the difference was marginally significant). Conversely, the group travelling 200 kilometres or more per week had significantly lower crash rates than all other distance groups, except for those travelling 101-200 kilometres.

3.3 Driving distance and self-reported driving performance, health and functional performance

For further analyses and in order to increase statistical power, the five mileage groups in Table 1 have been collapsed to form three categories:

- the low mileage group – those travelling 50 kilometres or less per week;
- the medium mileage group – those travelling 51-100 kilometres per week;
- the high mileage group – those travelling 100 kilometres or more per week.

Table 2 shows the annual crash rates for the three distance categories. Those with the lowest weekly driving distances had a significantly higher crash rate than drivers covering medium weekly distances, who in turn had a significantly higher crash rate than drivers covering the highest weekly distances.

Table 1 The relationship between mileage driven per week and self-reported crash involvement

No. of kilometres driven per week:	No. of all drivers	No. of drivers in crashes in past 2 years No.	%	Annual crash rate per 10 million driver kilometres	Annual crash rate per 10 million driver kilometres, 95% CI
20 kms or less	110	13	11.8	568	278-858
21-50 km	284	29	10.2	281	184-377
51-100 km	301	36	12.0	153	106-200
101-200 km	132	16	12.1	78	42-113
200 kms or more	69	11	15.9	61	28-95
Total	896	105	11.7	…	…

Notes: Missing cases = 9 drivers.
Confidence intervals have been calculated using a standard t-test of probabilities based on population confidence limits. Where the crash rate upper and lower confidence intervals for a given sub-group are outside the upper and lower confidence intervals of any other sub-group, it can be taken with 95 percent confidence that there is a statistically significant difference in crash rates between the two sub-groups.

Table 2 Number and percentage of participants classified according to mileage driven per week

No. of kilometres driven per week:	No. of all drivers	No. of drivers in crashes in past 2 years No.	%	Annual crash rate per 10 million driver kilometres	Annual crash rate per 10 million driver kilometres, 95% CI
Low Mileage (≤ 50 km)	394	42	10.7	281	184-377
Medium Mileage (51-100 km)	301	36	12.0	153	106-200
High Mileage (> 100 km)	201	27	13.4	78	42-113
Total	896	105	11.7	…	…

Notes: Missing cases = 9 drivers.
Confidence intervals have been calculated using a standard t-test of probabilities based on population confidence limits. Where the crash rate upper and lower confidence intervals for a given sub-group are outside the upper and lower confidence intervals of any other sub-group, it can be taken with 95 percent confidence that there is a statistically significant difference in crash rates between the two sub-groups.

The survey asked drivers to rate their current driving performance against the driving performance of others of their own age, against drivers aged 30-50 years and against their own performance twenty years earlier. Drivers were also asked to rate their health or functional performance in a number of areas and to indicate whether they were experiencing problems in certain functional areas. The responses of low and high mileage older drivers are compared in Table 3. (Medium mileage drivers have not been included in the table).

On all sixteen measures, low mileage drivers' responses indicated reduced driving and functional performance and greater frequency of medical conditions relative to high mileage drivers.

Looking just at measures where there were statistically significant differences, low mileage drivers were less likely to describe themselves as better than other drivers of their own age and were less likely to describe themselves as better than other drivers aged 30-50 years. They were less likely to rate their health and functional performance as 'excellent' in regard to day vision, night vision, decision-making and arm strength. Low mileage drivers were also more likely to report problems in regard to memory and arthritis.

3.4 Driving distance and performance on a functional screening test

The 905 drivers in the present study were randomly allocated to one of three screening tests. Table 4 shows the number of participants who completed a screening test.

3.4.1 GRIMPS

Performances on each of the 11 sub-tests were scored as either "average or above" or 'below average', using a variety of criteria (time taken, number of errors etc). Each respondent was awarded a point for each "average or above" rating, meaning a possible score range of 0 to 11. Table 5 shows the mean overall scores on GRIMPS grouped according to the mileage driven per week.

Results from a One Way Analysis of Variance (ANOVA) indicated a significant difference in the mean overall GRIMPS scores across the three mileage groups, $F(2, 241) = 6.454$, $p < 0.01$. Post-hoc comparisons indicated that participants in the lowest mileage group scored significantly lower on the GRIMPS screening test compared to participants in the highest mileage driven per week group ($p < 0.01$). The differences between the medium mileage group's score relative to the low and high mileage groups were not significant.

Table 3 The relationship between mileage driven per week and self-reported driving performance, health and functional performance

Aspects of health and functional performance	No. and proportion of drivers per mileage categories				Relative risk. 95% confidence intervals
	Low		High		
	No.	%	No.	%	
Rating of own driving performance as ‘better’ compared with others of own age*	108	27.5	91	45.3	RR = 0.61; CI 0.49-0.76
Rating of own driving performance as ‘better’ compared with other drivers aged 30-50 years*	65	16.6	53	26.6	RR = 0.62; CI 0.45-0.86
Rating of own driving performance as ‘better’ compared with own performance 20 years earlier	74	18.9	50	25.0	RR = 0.76; CI 0.55-1.04
Rated their general health as ‘excellent’	81	21.1	56	28.1	RR = 0.75; CI = 0.56-1.01
Rated their day vision as ‘excellent’*	124	31.5	88	43.8	RR = 0.72; CI = 0.58-0.89
Rated their night vision as ‘excellent’*	32	8.3	34	16.9	RR = 0.49; CI = 0.31-0.77
Rated their decision making as ‘excellent’*	86	21.9	73	36.5	RR = 0.6; CI = 0.46-0.78
Rated their arm strength as ‘excellent’*	143	36.3	99	49.3	RR = 0.74; CI = 0.61-0.89
Rated their neck flexibility as ‘excellent’	66	16.8	43	21.4	RR = 0.78; CI = 0.55-1.11
Rated their leg strength as ‘excellent’	147	37.4	84	42.0	RR = 089; CI = 0.72-1.10
Reported experiencing vision problems	281	71.5	127	63.2	RR = 1.13; CI = 1.00-1.28
Reported experiencing heart problems	111	28.4	43	21.4	RR = 1.33; CI = 0.98-1.81
Reported experiencing diabetes problems	23	5.9	8	4.0	RR = 1.47; CI = 0.67-3.23
Reported experiencing memory problems*	85	21.7	26	13.0	RR = 1.67; CI = 1.11-2.50
Reported experiencing arthritis problems *	183	46.8	76	37.8	RR = 1.24; CI = 1.01-1.52
Reported experiencing problems with stroke	39	10.7	14	7.4	RR = 1.45; CI = 0.81-2.60
Total	Max 394		Max 201		

Note: * = statistically significant difference between low and high mileage drivers.

Table 4 Number of participants who completed a screening test

Screening Test	Number of Participants
GRIMPS	244
DriveABLE	295
UFOV	284
Total	823

Participants’ performance on the six GRIMPS subtests identified as being significantly related to at-fault crash risk[27] was also examined (see Table 6). The ANO-

Table 5 The relationship between mileage driven per week and performance on the GRIMPS screening test

Mileage driven per week	Number	GRIMPS	
		mean	standard deviation
Low mileage (up to 50 km)	104	7.79	1.82
Medium (51-100 km)	89	8.26	1.48
High (more than 100 km)	51	8.78	1.55
TOTAL	244		

VA indicated a significant difference in participants' performance on these six GRIMPS sub-tasks across the three mileage groups, $F(2, 241) = 5.570$, $p < 0.01$. Post-hoc comparisons indicated that participants in the lowest mileage group performed significantly worse on the six sub-tasks compared to participants in the highest mileage driven per week group ($p < 0.01$). The differences between the medium mileage group's score relative to the low and high mileage groups were not significant.

Table 6 The relationship between mileage driven per week and performance on the six GRIMPS subtasks identified as being significantly related to at-fault crashes

Mileage driven per week	Number	GRIMPS	
		mean	standard deviation
Low mileage (up to 50 km)	103	3.59	1.34
Medium (51-100 km)	88	3.84	1.20
High (more than 100 km)	51	4.33	1.35
TOTAL	242		

3.4.2 DriveABLE™

The overall DriveABLE™ score is a predicted probability of a given candidate failing the DriveABLE™ Road Test, a specially designed on-road driving test designed to identify the driving problems of medically impaired drivers. At least in principle, a score of 0.0 means certainty to pass the test, a score of 1.0 means certainty to fail. Table 7 shows the mean overall scores on the DriveABLE™ In-Office Test grouped according to the mileage driven per week.

There was a significant difference in the mean DriveABLE™ scores across the three mileage driven per week groups, $F(2, 290) = 3.741$, $p < 0.05$. Post-hoc comparisons indicated that participants in the lowest mileage group performed significantly worse on the DriveABLE™ screening test compared to participants in the highest mileage driven per week group ($p < 0.05$). The differences between the medium mileage group's score relative to the low and high mileage groups were not significant.

Table 7 The relationship between mileage driven per week and performance on the DriveABLE screening test

Mileage driven per week	Number	DriveABLE	
		mean	standard deviation
Low mileage (up to 50 km)	125	0.710	0.017
Medium (51-100 km)	95	0.670	0.022
High (more than 100 km)	73	0.627	0.026
TOTAL	293		

Note: Missing cases = 2 drivers.

3.4.3 UFOV

The divided attention and selective attention scores from the UFOV test have been grouped according to participants' mileage driven per week. The results are given in Tables 8 and 9 respectively.

Table 8 The relationship between mileage driven per week and performance on the Useful Field of View screening test (selective attention)

Mileage driven per week	Number	UFOV Selective Attention	
		mean	standard deviation
Low mileage (up to 50 km)	119	212.52	146.24
Medium (51-100 km)	95	208.07	154.55
High (more than 100 km)	63	202.60	131.47
TOTAL	277		

Table 9 The relationship between mileage driven per week and performance on the Useful Field of View screening test (divided attention)

Mileage driven per week	Number	UFOV Divided Attention	
		mean	standard deviation
Low mileage (up to 50 km)	120	373.56	120.57
Medium (51-100 km)	94	364.09	118.77
High (more than 100 km)	63	359.98	107.41
TOTAL	277		

Component scores for the two measures for the UFOV assessment showed that low mileage older drivers performed more poorly, that is, required longer inspection times for both the selective and divided attention tasks compared to the other mileage groups. However these findings were not statistically significant (Selective attention: ($F(2, 274) = 0.097$, $p = 0.9$; Divided Attention: ($F(2, 274) = 0.330$, $p = 0.7$).

3.5 Driving distance and performance on the on-road driving test

All 905 drivers included in the present study were required to sit for the NZODORT on-road driving test. Results from this test were available for 826 participants. Table 10 shows the three distance groups, analysed by on-road test performance.

There was a consistent association between the NZODORT test results and extent of driving, such that low mileage drivers were most likely to fail the on-road test (34.9% compared to 24.8% and 18.5%, medium and high mileage group, respectively). Conversely, high mileage drivers were most likely to pass (81.5% compared to 75.2% and 65.1%, medium and low mileage groups respectively).

The differences between the low mileage and the two other groups were statistically significant (relative risk of failing = 1.41, CI = 1.10-1.80 and relative risk of failing = 1.89, CI = 1.35-2.64 respectively).

4. DISCUSSION

Based on a sample of New Zealand older drivers' self-reported crash involvement and extent of driving, the per-distance crash rates for the different distance groups confirmed the existence of the mileage/crash association [15, 16]. Older drivers travelling 20 kilometres or less per week had higher crash rates than all other distance groups, with there being a consistent and (in most cases) statistically significant decrease in crash rates as weekly distances increased. The lowest mileage drivers – representing 12.3 percent of the total sample -had almost ten times the crash rate of those travelling the longest distances (200 kilometres per week or more).

This finding needs to be tempered by the possibility that a sub-group of higher mileage drivers and involved in crashes, had subsequently reduced their amount of driving by the time of the survey – thereby possibly distorting the mileage/crash association. The available data did not allow this possibility to be directly explored. However in another survey of older drivers[3], two-thirds of lowest mileage older drivers reported that they had reduced their driving in recent years. Stated reasons for reducing their driving included: reduced travel needs arising from either general lifestyle changes (20%) or specific changes in social or business needs (31%); reduced driving confidence and increased difficulties in coping with traffic (15%); and illness and disabilities (11%). Recent crash involvement was not mentioned as a primary factor.

While the possibility of post-crash mileage reduction needs to be further explored, this study has provided strong evidence to support the proposition that at least for the older age groups (drivers 80 years or older), low mileage drivers were characterised by both perceived and actual reduced fitness to drive. Low mileage older drivers reported that their current driving was worse than that of middle-aged drivers and had deteriorated over the last twenty years. High mileage older drivers were significantly less likely to make the latter two responses. Low mileage drivers also generally reported a greater range of health conditions and functional limitations and significantly differed from high mileage drivers regarding night vision, decision-making and memory. Low mileage older drivers' perceptions of their poorer driving performance were substantiated by the results from two of the three off-road tests of driving fitness and from an on-road test of driving performance. Regarding the latter and compared to high mileage drivers, low mileage drivers were significantly and almost twice as likely to fail on their first attempt at the NZDORT on-road driving test currently used in New Zealand.

It needs to be noted that for the above analyses, respondents were grouped into broad mileage categories for reasons of statistical power. It is reasonable to expect that with a larger sample which would allow narrower mileage categories, the differences between the lowest and highest groups would be more pronounced.

It follows from these findings combined with previous research[16,17,19] that it is invalid simply to compare the per-distance crash rates of different driver age groups. Crash rates as represented in Figure 1, cannot be interpreted to show that all older drivers have higher crash risk as a function of age, unless differences in driving mileages for each age group have also been taken into consideration.

Table 10 The relationship between mileage driven per week and on-road test performance

Results of on-road test	No. and proportion of drivers per mileage categories					
	Low		Medium		High	
	No.	%	No.	%	No.	%
Failed	123	34.9	72	24.8	34	18.5
Passed	229	65.1	218	75.2	150	81.5
Total	352	100.0	290	100.0	184	100.0

Notes: Missing cases = 79 drivers.
'Failed' has been defined as failing the first attempt at the NZODORT, 'Passed' as having passed at the first attempt.

A further implication arising from this research is that any program aiming to manage the safety of older drivers, can most readily be justified if it is restricted to low mileage older drivers as a specific sub-group rather than treating all older drivers as a single group. It has been shown that elevated crash rates are most marked for the lowest mileage group (driving 20 kilometres or less per week), with crash rates falling substantially for the other mileage groups. Even in this restricted context however, it cannot be assumed that the lowest mileage older drivers represent a homogeneous group. For example, while some may have restricted their driving as a safety measure arising from perceived and actual driving limitations, others may drive short distances solely because of reduced travel needs.

Further, the nature of any safety management program remains open to discussion. On the one hand, the elevated individual per-distance crash risk of the lowest mileage older drivers might be regarded as unacceptably high, prompting a call for more stringent assessment as a pre-condition for further licensing for this sub-group. On the other hand and looking at the New Zealand sample, it needs to be recognized that crashes involving the lowest mileage older drivers represent only some 10 per cent of all older driver crashes and therefore well under 1 per cent of total road crashes[28]. Further, the evidence is consistent with this sub-group having already restricted their amount of driving in response to perceived and actual driving difficulties. The result of this reduction in driving is to produce a high crash risk over distance driven but a very low crash risk per licensed driver. If it is still considered necessary to review this sub-group's capacity to continue driving, it is urged that review be conducted through more strategic means than an across-the-board age-based mandatory assessment: for example, through an assessment option targeting only older (and other) drivers who have shown some evidence of having an elevated crash risk. The Austroads licencing system currently being developed in Australia is recommended as such an option[29].

The findings of this study also highlight at least three immediate research needs.

First, the various studies which have demonstrated the mileage/crash association have relied upon self-reported crash involvement and driving distances. The accuracy particularly of self-reported crash involvement has been the subject of several studies[30-32], with the findings generally supporting a reasonable level of agreement between self-reported and official crash data. However the possibility that particularly some sub-groups of drivers may mis-report their crash involvement and/or their driving levels[31] needs to be further investigated.

Secondly, there needs to be a better understanding of the underlying causes of the mileage/crash association. The present study has shown that reduced fitness to drive is a factor at least for some older drivers. The relative importance of driving patterns and particularly, which parts of the road network are being used, also needs to be assessed. The extent to which these – and perhaps other - factors contribute to the association between extent of driving and crash rates, has direct consequences for older driver safety countermeasures. For example, if a substantial portion of the association were attributable to heavy use of the urban road network, then priorities would logically include improvements to the road infrastructure and particularly improved intersection design.

Thirdly, future research must explore possible gender differences. Analyses conducted as a background to the current study have shown that 14 percent of male and only 7 percent of female low mileage drivers had been in crashes. In contrast, for the high mileage group, 14 percent of males and 13 percent of females reported crashes. In other words, low mileage female drivers seemed safer relative to males driving the same short distances, with there being no difference for the high mileage group. It may be that women are more likely to drive short distances for social or cultural reasons, whereas men are more likely to drive short distances in response to perceived health and driving performance issues. If a safety program targeting the lowest mileage drivers as the principal at-risk group is to be developed, it is necessary that the safety status of male and female drivers be separately identified.

5. CONCLUSIONS

The sample of New Zealand older drivers showed strong evidence that drivers who travelled low mileages were liable to have more crashes per distance driven than drivers with higher mileages. Older drivers travelling 20km or less per week had around ten times the per-distance crash rate of drivers travelling 200km or more per week. The analyses presented in this paper also showed that low mileage drivers were more likely to report a reduction in their driving performance and to report a range of health and medical conditions. Further, they also performed less well on two of the three off-road fitness to drive screening tests and the NZDORT on-road driving test (an external measure of driving skills).

Reduced fitness to drive is likely to be but one factor in explaining the elevated crash rates for the lowest mileage drivers. However the findings presented in this paper are valuable in further refining our understanding of the so-called older driver problem - particularly through identifying a small, more precisely defined target group for road safety countermeasures, while excluding most older drivers from any special safety scrutiny.

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