ASSESSING OLDER DRIVER'S FITNESS TO DRIVE ALLOWING FOR A LOW MILEAGE BIAS: USING THE GRIMPS SCREENING TEST

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ABSTRACT
Data from 244 older drivers in New Zealand have been used to demonstrate that older drivers who travel low mileages are liable to have more crashes per distance driven than older drivers who travel higher mileages. The results showed that drivers travelling 50 km or less per week had a considerably higher per-distance crash rate than drivers travelling 100 km or more per week. Low mileage drivers also performed significantly worse on both a screening test of fitness to drive (the GRIMPS screening test) and on the New Zealand Older Driver Re-licensing Test (NZODORT). With reduced driving performance likely to be a major factor in explaining the association between extent of driving and crash involvement, the findings presented in this paper are valuable in identifying a small, more precisely defined target group for road safety countermeasures, while excluding most older drivers from any special safety scrutiny.

KEY WORDS: older drivers, crash risk, low mileage bias, functional impairments

INTRODUCTION
The issue of "older drivers" has received a great deal of attention within the road safety literature in recent years. Part of the impetus for this increased interest is attributable to demographic factors: over the next four or five decades, there will be a substantial increase in the absolute and proportional number of older drivers on the roads in most industrialised countries (OECD, 2001). This increase is due to three principal factors: first, the proportion of elderly people in the population of most Western societies is increasing, mainly as a result of increasing life expectancy and declining birth rates; secondly, there will be an increase in older drivers' licensing rates for the emerging cohorts of elderly people (Hakamies-Blomqvist, 1993; 1994); and thirdly, the private car is likely to remain the dominant form of transport for the successive cohorts of older drivers who, it is predicted, will be undertaking longer and more frequent journeys than previous cohorts (Hakamies-Blomqvist, 1996; OECD, 2001).

However, while distance or mileage driven is 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 the relationship between travel distances and crash rates is not linear (Janke, 1991). That is, all else being equal, crashes will tend to rise at a low and decreasing rate as mileage increases beyond a certain point (Janke, 1991). That is, independent of age, gender or other demographic factors, drivers travelling more kilometres will typically demonstrate reduced crash rates per kilometre, compared to those driving fewer kilometres. Older drivers typically drive less distance per trip and have lower accumulated mileages. Janke subsequently warned licensing administrators against becoming overly alarmed about older drivers' apparent high crash risks when comparisons were based on per distance crash rates, without controlling for different annual kilometres driven. Hakamies-Blomqvist and her colleagues (2002) compared older and young middle-aged drivers' crash rates, controlling for annual distances driven. When older drivers were compared with younger drivers who had equivalent driving exposure, there was no age-related increase in crashes (both casualty and non-casualty) per distance driven. Thus, the commonly perceived age-related risk was due not to age per se but to yearly driving distances, 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" (Hakamies-Blomqvist et al, 2002, p. 274). After the original study by Hakamies-Blomqvist et al., these findings were independently replicated using French (Fontaine, 2003) and Dutch (Langford et al., submitted) data sets, lending credibility to the robustness of the low mileage bias.

Janke (1991) attributed the association between distance driven and crash rates to the different levels of mileage driven on different types of roads by the different mileage groups. For example, high mileage drivers typically accumulate most of their mileage on freeways and multi-lane divided roadways with limited access. By implication, low mileage drivers undertake a higher proportion of their driving on local roads and streets, with greater number of potential conflict points and hence higher crash rates per unit road distance. Janke noted that there were 2.75 times more crashes per mile driven on non-freeways than freeways. Hakamies-Blomqvist et al. (2002) also looked to the possibility of different amounts of freeway and non-freeway driving as explaining the mileage/crash association – but also held open the possibility of low mileage drivers as being otherwise more accident-prone than their higher mileage counterparts.

One explanation for low mileage older drivers being relatively accident-prone runs thus. Some older drivers in response to a perceived decline in driving performance restrict their driving as a safety and/or comfort measure (Eberhard, 1996; Evans, 1988; McGwin & Brown, 1999; Preusser et al., 1998; Smiley, 1999). 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.

The current study investigates the hypothesised relationship between mileage driven, crash risk and the possibility of functional impairment amongst different mileage groups.

Aims
This paper seeks to re-examine data from 244 older drivers in New Zealand:

- to determine whether the association between distances driven and crash involvement (the low mileage bias) holds true for a sample of New Zealand older drivers;
- to determine whether low mileage older drivers can be identified by a range of functional performance measures;
- to determine whether low mileage older drivers can be identified by external measures of driving performance (the NZODORT).

METHOD

Participants[1]: At the time of conducting the study in New Zealand, drivers aged 80 years and older were required to undertake a biennial medical check and also complete the New Zealand Older Driver Re-licensing Test (NZODORT) in order to maintain their driving licence.

Participants for the current study were recruited from a Land Transport Safety Authority (LTSA) database of drivers who met the following inclusion criteria:

[1] Participants were recruited for a larger study that sought to assess the validity of three leading screening tests of fitness to drive (Austroads, 2004). Full details of the participants, recruitment procedures and assessment procedures can be found in this publication.

- were aged 80 years or older (or had their 80th birthday during the study);
- had undertaken a medical examination (as required for their licence renewal); and
- were either about to undertake the NZODORT in the 3-month period following the commencement of the study, or had completed the NZODORT in the 9 months prior to commencement of the study.

The study was conducted in Wellington, New Zealand from February 2001 to May 2002.

Data sources: Driver Survey: Participants completed a survey which included items covering demographic measures, ratings of self-reported driving performance and information on travel patterns, health status, medical conditions and functional performance and self-reported crash history as a car driver. 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 (ii) 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.

Driving performance: Participants in the present study underwent a driving assessment as part of the standard re-licensing procedures in New Zealand. Results of the driving assessment were made available by the licensing authority with participants' approval. The NZODORT was developed by LTSA and has been used in New Zealand since May 1999. There are three parts to the test, each of which has a set of performance criteria. Part 1 is a sequence of four driving manoeuvres including leaving the kerb, driving straight, turning left and returning to the kerb, to ensure a 'warm-up' period for the driver. Parts 2 and 3 are more detailed, with the difference between the two parts being the level of 'traffic demand', i.e., speed, traffic, density and type of manoeuvre. Driving manoeuvres assessed in Part 2 include turning left and right (unburdened and at stop and give-way signs), straight through roundabout, and hazard detection. For the hazard detection task, drivers are required to pull to the side of the road at certain points and are asked to identify potential hazards on the road ahead. Part 3 assesses the following driving manoeuvres: driving through a shopping/commercial precinct; turning right across traffic and at stop and give-way signs; driving straight. Drivers are permitted multiple attempts on the NZODORT. However, for the purpose of this study, the on-road results were scored as "pass" or "fail" on the first attempt. That is, those who had two or more attempts before passing were scored as a "fail".

Screening Test: Participants in the present study also completed the Gross Impairments Screening Battery of General Physical and Mental Abilities (GRIMPS) (Scientex, Washington). This paper and pencil test 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. 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 an increased risk of crashing. The GRIMPS test is comprised of 11 sub-tasks. Performances for each task are scored (timed, number of errors etc,) as either "average or above" or 'below average', using criteria established by the test developers. A description of each sub-task and the criteria required to score "average or above" is listed below.

1. Rapid-Pace Walk – Participants were required to walk along a line (approximately 10 feet long) on the ground as quickly as they could. This task was timed. Participants who completed the task in 7 seconds or less scored an "average or above" rating.
2. Foot-Tap Test – Participants were required to sit in a chair and tap their foot from side to side (five times on each side of a folder). This task was timed. Participants who completed the task in 8 seconds or less scored an "average or above" rating.

3. Cued Recall – The assessor read three short words (e.g. bed, apple, shoe) to the participant and asked the participants to repeat the three words. Following this, the assessor told the participant that they would be asked to remember the same three words later in the assessment. Participants scored an “average or above” rating for this task if they could recall all 3 items after the first presentation.
4. Arm Reach – Participants were asked to raise both arms (one at a time) as high over their head as they could. Participants who could lift each arm so that their elbow was shoulder height or above scored an “average or above” rating for this task.
5. Head/Neck & Upper Body Rotation – Participants were required to sit in a chair with a lap sash seat belt on and were then asked to look over each shoulder and read the time on a clock face held up behind them. Participants who could turn and correctly read the presented time scored an “average or above” rating for this task.
6. Motor-Free Visual Perception – Participants were shown 11 incomplete objects and were then required to identify what each object would look like if the object was completed from a selection of choices. Participants who made 2 or less errors on this task scored an “average or above” rating.
7. Delayed Recall – Participants were asked to remember the three words presented to them earlier in the “cued recall” task. Participants scored an “average or above” rating for this task if they could correctly recall 2 or 3 of the items that were presented earlier.
8. Scan Test – Participants were 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 that were presented. Scan patterns were scored in the following categories: normal (clockwise, by rows etc); erratic (all shapes were identified but in a haphazard way) or neglect (two or more shapes weren’t identified at all). Participants who demonstrated a “normal” scanning method scored an “average or above” rating for this task.
9. Trails A - Participants were required to connect a series of numbers in ascending order from 1 through to 8 on a sheet of paper as quickly as they could. This task was timed. Participants who completed the task in 30 seconds or less scored an “average or above” rating.
10. Trails B - Participants were 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 was timed. Participants who completed the task in 210 seconds or less scored an “average or above” rating for this task.
11. Visual Acuity – In the last task, participants were required to read a series of letters (high and low contrast) on a chart. Participants with an acuity score of 20/40 (i.e., able to read line 5 without errors) and who had a high/low contrast difference score of 0, 1 or 2 scored an “average or above” rating for this task.

The following scores were derived (i) individual sub-test scores (i.e., “average or above” or “below average”; (ii) individual raw scores (where appropriate); and (iii) a total score (maximum score = 11).

Analyses

A series of analyses were undertaken to examine the hypothesised relationship between mileage driven, crash risk and functional impairment. For per-mileage crash rate differences, a standard t-test of probabilities based on population confidence limits has been used. Differences between driver mileage groups have been tested for statistical significance using analysis of variance (ANOVAs) and chi-square tests (SPSS version 11.0).

RESULTS

General Description of the Sample

A total of 244 older drivers volunteered to participate in this study. Participants ranged in age from 79 years to 94 years (M = 82.30 years, SD = 2.90 years). Table 1 shows the average age of participants by gender.

Table 1 Mean Ages (and Standard Deviations) of Participants by Gender

Gender	Number	Mean (Standard Deviation)
Male	141	82.53 (3.01)
Female	100	81.98 (2.61)
TOTAL	241	82.30 (2.90)

Note: Missing cases = 3

Self-reported crash involvement was available for 241 participants. Of these, 12 percent reported that they had been involved in a motor vehicle crash during the previous two years. Table 2 shows the number of participants who reported having a motor vehicle crash in the past two years by gender.

Table 2 Self-reported Crash history by Gender of Participants

Self-reported Crashes	Gender		Total
	Male	Female	
Yes	19	10	29
No	122	90	212
TOTAL	141	100	241

Note: Missing cases = 3

Participants who reported that they had been involved in a motor vehicle crash in the past two years were significantly older (M = 83.41 years, SD = 3.34 years) than participants who had not been involved in a motor vehicle crash during the past two years (M = 82.15 years, SD = 2.81 years), $t(241) = 2.216$, $p < 0.05$.

Driving distance and crash history: In order to investigate the ‘low mileage bias’, drivers were categorised according to weekly distances driven:

- low mileage –up to 50 km driving per week;
- medium mileage –between 51 and 100 km driving per week; and
- high mileage – more than 100 km driving per week.

The crash rates for each distance category were then calculated, based on self-reported crash involvement during the preceding two years and using both driver numbers and driver kilometres as the base measures. The results are given in Table 3.

Table 3 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 2 most recent years	Annual crash rate per 10,000 drivers	Annual crash rate per 10 million driver kilometres
Less than 50 km	104	12	577	342
51-100 km	88	13	739	189
More than 100 km	51	4	392	43
Total	243	29		

Note: Crashes relate to crashes of all severity, both casualty and non-casualty.
Missing cases = 1

Based on population confidence limits, drivers travelling the lowest weekly distances (i.e., 50 kilometres or less) were significantly more likely to have had a crash per kilometre (95% CL: 3-84), relative to drivers travelling higher distances (100 kilometres or more) (95% 148-486). This does not, of course, necessarily imply a direct explanatory link between mileage driven and crash involvement.

Tables 4 shows participants grouped by weekly distance driven and mean age.

Table 4 Mean Ages (and Standard Deviations) of Participants by Mileage Driven per Week groups

Mileage driven per week	**Number**	**Mean Age (Standard Deviation)**
Low mileage (up to 50 km)	104	82.59 (3.04)
Medium (51-100 km)	87	82.17 (2.53)
High (more than 100 km)	51	81.92 (3.19)
TOTAL	242	

Note: Missing cases = 2

There was no significant difference in mean age across the three mileage driven groups ($F(2, 239) = 1.03$, $p > 0.05$).

Performance on a functional screening test and driving performance: Eleven separate scores and an overall score (maximum = 11) were derived for the GRIMPS test. Screening task outcomes were available for 243 participants. Figure 1 shows the number of sub-tests passed. The majority of participants scored ‘average or above’ (i.e., passed) on 6-10 sub-tests. Approximately 5 percent of participants scored ‘average or above’ the maximum possible 11 subtests, while approximately 5 percent of participants scored ‘average or above’ on 5 or less subtests.

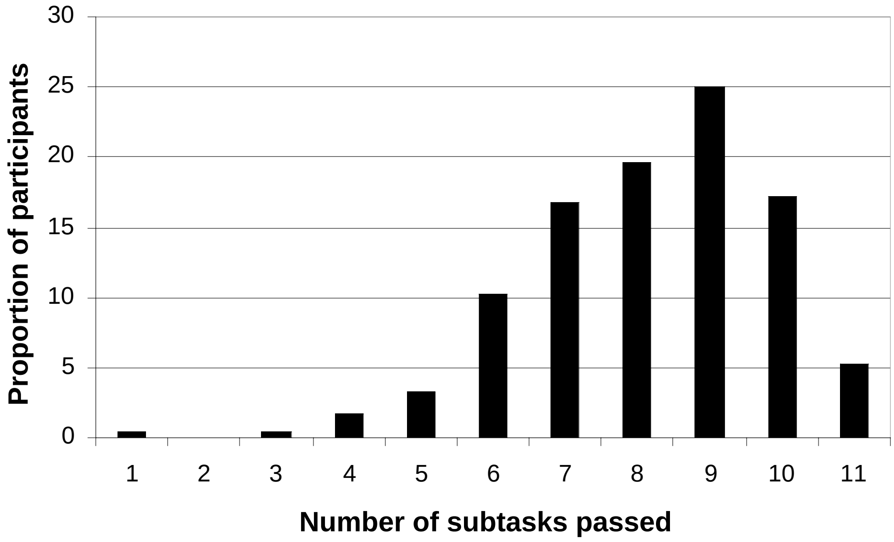

Figure 1 Number of sub-tasks passed in GRIMPS

Table 5 presents a summary of the participants' overall performance on the GRIMPS by age.

Table 5 Mean Ages (and Standard Deviations) of Participants by GRIMPS performance

GRIMPS performance	**Number**	**Mean Age (Standard Deviation)**
Low GRIMPS score (1-7)	80	82.99 (3.39)
Medium GRIMPS score (8-9)	109	82.14 (2.70)
High GRIMPS score (10-11)	54	81.63 (2.26)
TOTAL	243	

There was a significant difference in the mean age of participants across the three GRIMPS groups, $F(2,240) = 3.967$, $p < 0.05$. Post-hoc comparsions indicated that participants in the lowest GRIMPS performance group (i.e., who performed worst on the GRIMPS task) were significantly older than participants in the high GRIMPS performance group ($p < 0.05$).

Table 6 shows the mean overall scores on GRIMPS (maximum = 11) grouped according to the mileage driven by participants per week.

Table 6 The relationship between mileage driven per week and performance on the GRIMPS screening test

Mileage driven per week	Number	Mean GRIMPS score (Standard Deviation)
Low mileage (up to 50 km)	104	7.79 (1.82)
Medium (51-100 km)	88	8.26 (1.49)
High (more than 100 km)	51	8.78 (1.55)
TOTAL	243	

Note: Missing cases = 1

The results indicate a significant difference in the mean overall GRIMPS scores across the three mileage driven per week groups, $F(2,240) = 6.435$, $p < 0.01$. Post-hoc comparisons indicated that participants in the lowest mileage driven per week group scored significantly lower on the GRIMPS screening test compared to participants in the highest mileage driven per week group ($p < 0.05$). Drivers in the medium mileage group were not significantly different from either the low or high mileage groups.

Chi-square analyses of individual GRIMPS sub-tests scored as 'average or above' or 'below average' against distance driven per week revealed significant differences for the Foot-Tap Test (χ^2 (2) = 14.654, $p < 0.01$), Delayed Recall (χ^2 (2) = 7.658, $p < 0.05$) and a trend towards significance for Head/Neck rotation (χ^2 (2) = 5.716, $p = 0.06$). No significant differences were found for the remaining GRIMPS subtests (p values ranged between 0.273 and 0.767).

There was a significant relationship between mean overall scores on GRIMPS (maximum = 11) performance on the NZODORT on-road driving test: Those who passed the NZODORT on-road driving test had significantly higher overall scores on GRIMPS than those who failed the driving test, $t(240) = -4.048$, $p < 0.001$. On the other hand, there was no relationship between mean overall scores on GRIMPS and self-reported crash involvement, $t(242) = -1.042$, $p > 0.10$.

Driving distance and the on-road driving test

Driving test outcomes were available for 239 participants. Of these, 68 percent passed the NZODORT and 32 percent failed. Those who passed the on-road driving test were significantly younger (M = 81.90, SD = 2.58) than those who failed (M = 83.10 years, SD = 3.32 years), $t(120.452) = 2.816$, $p < 0.01$. Table 7 shows participant's performance on the NZODORT (pass/fail) grouped according to the mileage driven by participants per week.

Table 7 On-Road Test Results grouped according to Weekly Distance Driven (Low/Medium/High mileage)

	On-road test results		Total
Mileage driven per week	Pass	Fail	
Low mileage (up to 50 km)	56	45	101
Medium (51-100 km)	66	22	88
High (more than 100 km)	43	8	51
Total	165	75	240

Note: Missing cases = 4
'Failed' has been defined as failing the first attempt at the NZODORT, 'Passed' as having passed at the first attempt.

Chi square analyses revealed a significant relationship between mileage driven per week and performance on the NZODORT such that low mileage drivers were most likely to fail the on-road test and conversely, long distance drivers were most likely to pass (χ^2 (2) = 15.67, $p < 0.001$).

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 low mileage bias (Janke, 1991; Hakamies-Blomqvist et al., 2002). Older drivers travelling 50 kilometres or less per week (i.e., the low mileage group) had higher crash rates than the medium and high mileage groups, with there being a consistent decrease in crash rates as weekly distances increased. Low mileage drivers had a significantly higher probability of crashing compared to those travelling the longest distances (100 kilometres per week or more).

Consequently, there appears to be inter-relationships between functional impairment ability and driving performance; functional impairment and distance driven; distance driven and self-reported crash involvement; distance driven and driving performance.

This demonstration of the low mileage bias is consistent with previous research conducted by Hakamies-Blomqvist et al. (2002), Fontaine (2003) and Langford et al. (submitted) and confirms that it is not advisable simply to compare the crash rates of different driver age groups without making some allowance for different driving distances.

The full range of factors contributing to the association between extent of driving and crash risk has not been explored in this paper. However the paper has provided strong evidence to support the proposition that, at least for the older age groups, low mileage drivers were characterised by a reduced fitness to drive. Firstly, relative to high mileage drivers, low mileage older drivers performed significantly worse on the GRIMPS screening test, a paper and pencil test used to measure skills and abilities that are believed to be important for the driving task including tests of cognitive and gross motor functioning. More specifically, low mileage drivers were more likely to perform worse on the 'Foot-Tap Test', the Delayed Recall test. Secondly, low mileage older drivers were significantly more likely to fail the NZODORT test than high mileage older drivers.

The findings presented in this paper are consistent with the theory that older drivers may restrict their driving as a safety and/or comfort measure in response to a perceived decline in functional abilities and therefore driving performance (Eberhard, 1996; Evans, 1988; McGwin & Brown, 1999; Preusser et al., 1998; Smiley, 1999).

Arguably the most productive safety strategy for this sub-group might be to develop targeted educational, physical and/or cognitive rehabilitative measures aimed at improving their driving without at the same time encouraging them to drive higher mileages.

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 (or given the inter-relationships, drivers with functional impairment) as a specific sub-group rather than treating all older drivers as a single group. Even in this restricted context however, it cannot be assumed that low mileage older drivers represent a fully homogeneous group. For example, while some may restrict their driving as a safety measure arising from perceived and actual driving limitations, others may drive short distances solely because of reduced travel needs while maintaining full fitness to drive. Future research should investigate in more depth the factors influencing the different distances driven by various older drivers. Further, the nature of any safety management program remains open to discussion. On the one hand, the elevated individual per-distance crash risk of low 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, it needs to be recognised 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 (Frith, 2001).

However, there is a major qualification that needs to be made before the mileage/crash association for older drivers can be accepted at face value. It is possible that some proportion of the association is attributable to a sub-group of reasonably high mileage drivers who once involved in a crash, reduced their amount of driving. These drivers would have correctly reported at the time of the appropriate survey that they were low mileage drivers and were recently involved in crashes, but would have been unable to indicate that the crashes occurred under higher mileage conditions. If true, this adjustment in driving would serve at least to exaggerate the low mileage/high crash association and to minimize the high mileage/low crash association.

An acceptance of the low mileage/high crash association assumes that most if not all of the reported crashes occurred under the same mileage conditions as were reported at the time of the survey. This assumption cannot be directly tested from either set of survey data, as there were no items relating to weekly mileage at the time of the crash. This issue will need to be addressed in future research.

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. Low mileage drivers had approximately eight times the crash rate of those travelling the longest distances (100 kilometres per week or more).

The analyses presented in this paper also showed that low mileage older drivers performed significantly worse on both a screening test of fitness to drive and the NZDORT on-road driving test (an external measure of driving skills) compared to high mileage older drivers. Reduced fitness to drive is likely to be but one factor in explaining the elevated crash rates for low 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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