CHARACTERISTICS AND RISKS OF DRIVERS WITH LOW ANNUAL DISTANCE DRIVEN

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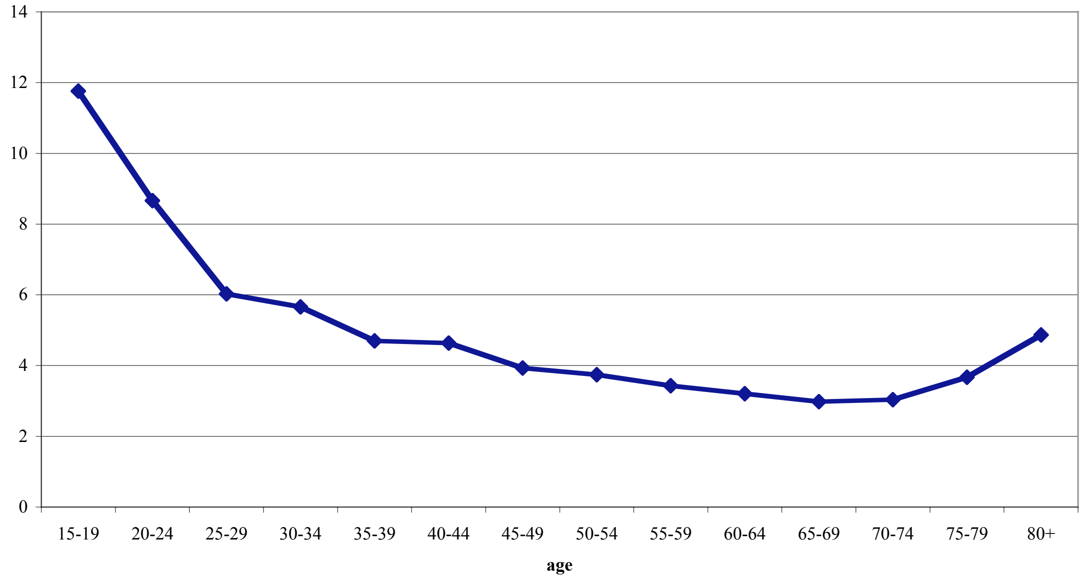
ABSTRACT

It has been noted by several authors that risk (defined in terms of total expected numbers of crash involvements per total distance driven) paints a misleading picture of crash liability, particularly for the young and the old. They typically drive less than other age groups, and low km drivers are thought to drive under conditions that lead to higher crash rates per distance travelled. This has led to the coinage of the term "low mileage bias" to describe apparently higher risk estimates at either end of the driver age scale where these low mileage/kilometrage drivers are most common. This paper is the first to the authors' knowledge to analyse these driving patterns of low km drivers and to evaluate the risk of these patterns. It is found that older drivers who drive less tend to have higher risk per kilometre due to their mainly urban trips. Nevertheless, because those older drivers who are not low km drivers manage to minimise their risk, the overall risk of older drivers as a group is not overestimated in terms of overall crashes per total distance driven. Despite being quite different from one another, the low and high km driving patterns of younger drivers were found to impose identical risks. Also discussed are characteristics (income, workforce membership, age and gender) of low kilometrage drivers in New Zealand.

INTRODUCTION

Janke (1991) was one of the first researchers to discuss the potential for risk estimates of crash involvement per distance driven to mislead policy makers and result in unfair regulation of driver licensing. She argued that many older and younger drivers drive low distances annually under conditions of higher risk per km driven (for example, in congested urban settings). The relationship between driver age and risk of crash involvement appears almost universally as a U-shaped curve, with higher risk for older and younger drivers and relatively low risk for ages in between. Janke (1991) considered that these curves were misleading as they do not take into account the type of driving being undertaken. She gave the example of urban driving, with its many opportunities for collisions, as an example of a situation with a potentially high risk per distance driven. Drivers (such as older drivers) whose driving activity is focused in urban areas may therefore be unfairly identified as being less competent drivers, when at least some of their increased risk is just associated with exposure to higher risk environments. She recommended that risk curves should be disaggregated by road type to produce risk curves against age specific to each road type to avoid this form of confounding, which has sometimes been referred to as "low mileage bias" (e.g., by Hakamies-Blomqvist et al 2002). Although opportunities to undertake such analyses are rare owing to high demands of the data sources used (specifically, the ability to quantify driving distance and crashes by the road type on which they occur), we have attempted this in previous research (Keall and Frith 2004c). Our analyses showed that the classic U-shaped curves, with elevated risk for older and for young drivers relative to risk for the middle-aged, were still estimated for all road types, apart from high-grade motorways. Although this analysis did show that young drivers had somewhat lower risks than middle-aged drivers in some driving situations, there were other situations, such as young male drivers driving at night, which showed highly elevated risks (Keall and Frith 2004c). Older drivers are more liable to be injured in a given crash owing to their age-related fragility. Once fragility was accounted for following subsequent analysis (Keall and Frith 2004a), it was apparent that the upturn in risk for older drivers was quite minimal and placed even the oldest groups analysed (80-85-year-olds) at similar daytime risk per distance driven as 25-year-old drivers. Despite these attempts to address confounding variables in the estimation of risk, it has been argued (e.g., by Keall and Frith 2004b) that those determining licensing policies, particularly policies targeted at older drivers, should instead use the sort of data presented in Figure 1. This curve represents New Zealand risk of injury crash involvement per licensed driver, calculated from the number of drivers involved in injury crashes in 2001, divided by the number (in thousands) of licensed drivers in 2001. This represents the expected risk of a licensed driver of a given age per year of driving. Factors affecting such risk estimates include: exposure (the amount and type of driving undertaken); factors affecting risk per distance travelled, such as propensity to take risks, cognitive limitations, inexperience, fragility (the liability that a driver or passengers will be injured given crash occurrence), crashworthiness of the vehicle, etc (Keall 2005). Figure 1 shows that drivers aged 80 plus present a similar risk of crash involvement, given licensure, as drivers aged in their 30's. As crashes involving older drivers so frequently result in injury to the older driver, Evans (2000) analysed US data in terms of pedestrians killed in order to assess risks imposed on *other* road users, concluding that: "Granting a licence for another year to an 80-year-old driver poses substantially less threat to other road users than granting a license to a 40-year-old driver".

Figure 1: Risk of crash involvement per 1,000 licensed drivers by age group (2001 data).



The driving patterns of young drivers in New Zealand will be influenced to some extent by graduated driver licensing regulations, which have been shown to be effective in reducing novice driver crashes (Langley et al 1996). Although able to be licensed from age 15, NZ novice drivers are required to have a "supervisor" (a front seat passenger over 20 years old who has been licensed for more than two years) when driving between 10pm and 5am (driving curfew hours) and drivers under 20 years old have a blood alcohol concentration legal limit of 30 mg/dL compared to 80mg/dL for other drivers. Older drivers in NZ are currently subject to licensing regulations that require proof of medical fitness to drive at age 75, age 80 and biennially after that, and on-road testing at age 80 and biennially thereon. Thus, the population of older drivers in NZ may differ from that in jurisdictions without such regulation.

Although disaggregating risk into driving on different road types under different conditions was the approach recommended by Janke (1991), data to enable this approach are difficult and expensive to obtain. Another approach has been used by Hakamies-Blomqvist et al. (2002) to make use of information on annual distance driven to infer the nature of exposure of the driver. They attempted to control for the so-called "low mileage bias" by obtaining self-reported driving information from a sample of Finnish drivers and estimating risk per distance driven within bands defined by annual distance driven. This approach has potential pitfalls, discussed below. Whether or not low mileage bias is an issue with low mileage drivers, older people as a group (defined as aged 70 plus) in New Zealand have been shown to have driving patterns that reduce their risk per distance driven relative to the driving patterns of other age groups (Keall and Frith 2004c), so low mileage bias cannot be considered to lead to overestimation of risk for this group as a whole.

It is likely that low km drivers have distinctive driving patterns leading to different inherent risks per km as drivers, as suggested by Janke (1991). These inherent risks are amenable to investigation using data from a comprehensive New Zealand travel survey combined with crash data to estimate the risks associated with the low km driving patterns, in a similar manner to our previous study of older drivers' driving patterns (Keall and Frith 2004c). These same data sources also enable us to describe some characteristics of low km drivers, which have not been investigated previously in the literature, to our knowledge.

METHOD

Travel Survey

Over a period of a year – from mid-1997 to mid-1998 - approximately 14,000 people were surveyed from 7,000 randomly sampled households (LTSA 2000). Interviewed in person at their homes, people were asked to describe all of their travel for two particular days. As these days were spread out over a whole year, information could be scaled up to represent a year's travel by all New Zealanders. There was a very high response rate with 75% of households providing full information from all household members, each of whom was personally interviewed. At least one valid interview was completed for 79% of households. The distance of each driving trip was computer-calculated by locating the trip origin map co-ordinates, the destination map co-ordinates, and by measuring the road distance between the two. This last calculation was performed by an algorithm that calculated the shortest route (in terms of driving time) from the trip origin to the destination. Where a respondent took a route that was not the shortest (for example, a scenic drive), an intermediate address or road was specified so that the route generated passed through this intermediate point. The routes were then matched to a digitised map of all NZ roads to enable distances to be calculated, classified by the six types of road, Major Urban, Minor Urban - where "urban" means that the speed limit is less than or equal to 70 km/h - and rural speed limit road types: Motorway, Divided State Highway[1], Undivided State Highway and Other rural roads. For the sake of this analysis, these road types were further grouped into pairs of road types with similar levels of risk per kilometre driven (according to estimates presented in Keall and Frith 2004c). These were (1) Urban speed limit roads; (2) High grade roads with speed limit over 70km/h (including motorways and divided state highways); and (3) Other rural speed limit roads. For those trips that began in daylight and finished after dark, driving distance was classified as night driving according to the proportion of total trip duration that was at night (from the nearest hour to

[1] State Highways are state-administered roads that link most New Zealand towns and cities.

sunset to the nearest hour to sunrise for the city of Wellington, the approximate mid-point of New Zealand).

Crash data

Information about motor vehicle crashes was extracted from the Ministry of Transport's database of coded information derived from Traffic Crash Reports of reported injury crashes. As the travel survey began and ended in the middle of consecutive calendar years, it was appropriate to form risk estimates that combined crash data from both years spanned by the survey. Thus, numbers of crashes were averaged over the two calendar years 1997/98, to form estimates of average annual crashes or crash involvement. There were 23,912 crash-involved drivers in 1997 and 1998. The crashes were also classified according to their location into the three road types listed above (urban speed limit roads, high grade rural speed limit roads, and other rural speed limit roads) and according to when they occurred (day/night).

Crude risks and driving patterns

As described in Keall and Frith (2004a), crude risks (crash involvements per 100 million km driven) were calculated by combining crash and travel survey data for common variables. Using these estimates, it was possible to estimate crash rates of given driver age groups supposing that they adopted another driver group's driving patterns. For each of four age groups, the driving patterns of low km drivers and high km drivers were assessed in terms of the proportion of driving done at night and during the day on three classes of roads: motorways, urban speed limit roads (with speed limit less than 70km/h, mostly with speed limit of 50km/h) and other roads with higher speed limits (maximum speed limit 100km/h). Using the respective age group's risk per km driven under each of these six driving conditions (three road types by night or by day), the risk imposed by any given group's driving pattern could then be estimated, assuming that total driving distance remained unchanged. Of particular interest was to compare the risk of the driving pattern low km drivers in a given age group with the risk of the driving pattern of high km drivers of that age group. The definition of high and low levels of annual driving is somewhat arbitrary. For this paper, we have used the same levels defined by Hakamies-Blomqvist et al. (2002) for "low" annual km drivers, but defined a higher cut-off of 20,000 annual km for discriminating between "medium" and "high" km drivers, to reflect the reported driving by our sample of drivers. The overall proportions of drivers estimated to be in these three categories, "low", "medium" and "high" were 18%, 65% and 17% respectively. The distribution by age group is shown in Figure 2, below.

RESULTS

Figure 2 shows the constitution of each age group according to their classification as low, medium or high annual distance drivers. The age groups with the highest proportion of low km drivers are clearly teenage drivers and drivers aged 80 plus.

Figure 2: Estimated percentage of drivers from each age group who drove low, medium and high km per year.

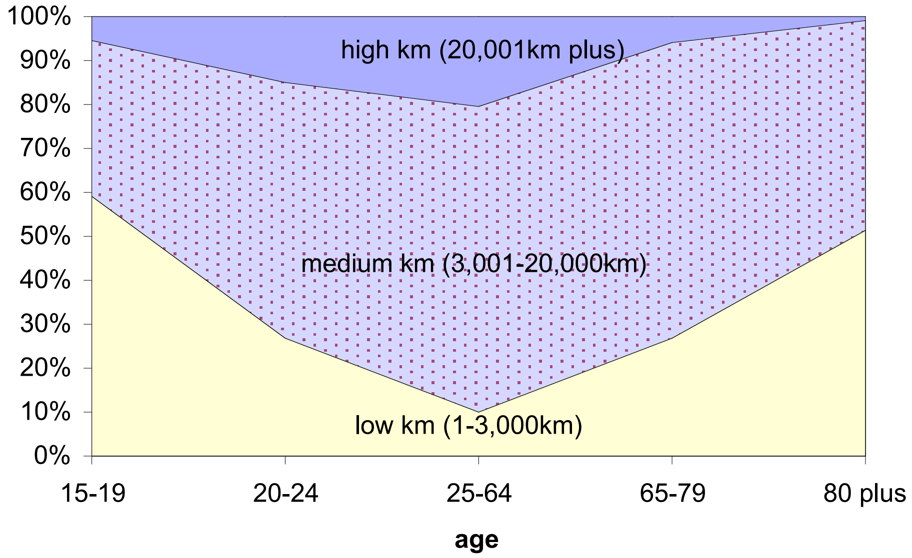
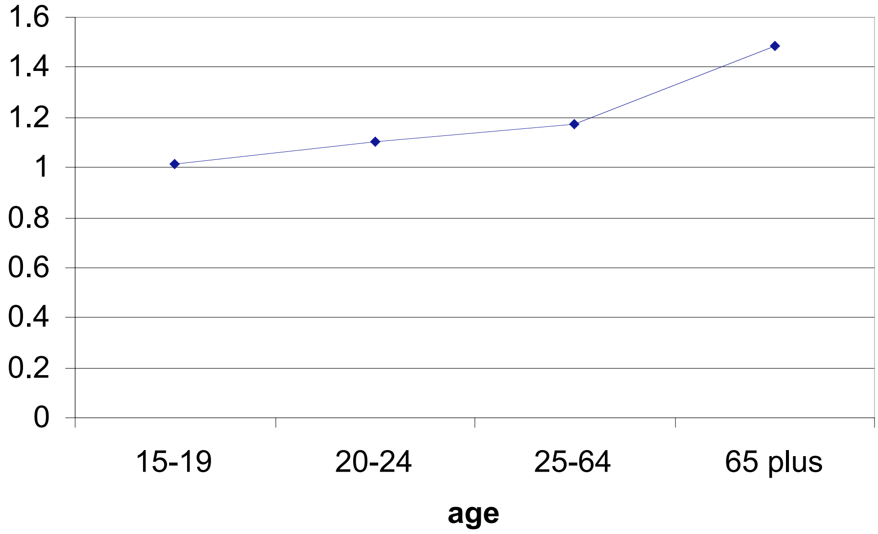


Figure 3: Relative risk (of injury crash involvement per distance driven) at low annual km driving patterns compared to risk at high annual km driving patterns for respective age group.



Driving patterns in relation to risk

For each given age group, risks were calculated for driving patterns of high km drivers and for driving patterns of low annual km drivers. Figure 3 shows the comparison of these risks for each age group featured. There was estimated to be little difference in risk between the high and low km driving patterns of young drivers (low km pattern risk divided by high km pattern risk was almost exactly 1), but there were larger differences in risk between the high and low km driving patterns of middle aged and still more for older drivers, whose low km driving patterns imposed about 50% more risk than their high annual km driving patterns.

Note that what is being compared in Figures 3 and 4 is the effect of driving *patterns* on risk. As crash data could not be classified according to the annual distance driving by the crash-involved drivers, risk estimates for low km drivers, for example, could not be estimated here.

Figure 4 shows the effect on risk of injury crash involvement per km driven of an average driver supposing that they drove with the driving patterns of eight different driver groups: for each of the four age groups, the subsets of drivers with high reported annual km (the dotted line) and those with low reported annual km (the solid line) relative to the risk of teenage driving patterns. The second points from the left represent the estimated risk for average drivers if they were to drive with the driving patterns of 20-24-year-olds who drive high annual kms (dotted line) or low annual kms (solid). Of the high km driving patterns evaluated, it is apparent that the teenage driving patterns are the most risky for all driver groups, shown by the diminishing risks against driving pattern age in Figure 4. There is very little variation in the risk of the low km driving patterns against age, however: all age groups' driving patterns are at an equal level of relatively high risk.

Figure 4: Relative risk for drivers adopting low km and high km driving patterns of the specified age group (relative to risk at teenage driving patterns).

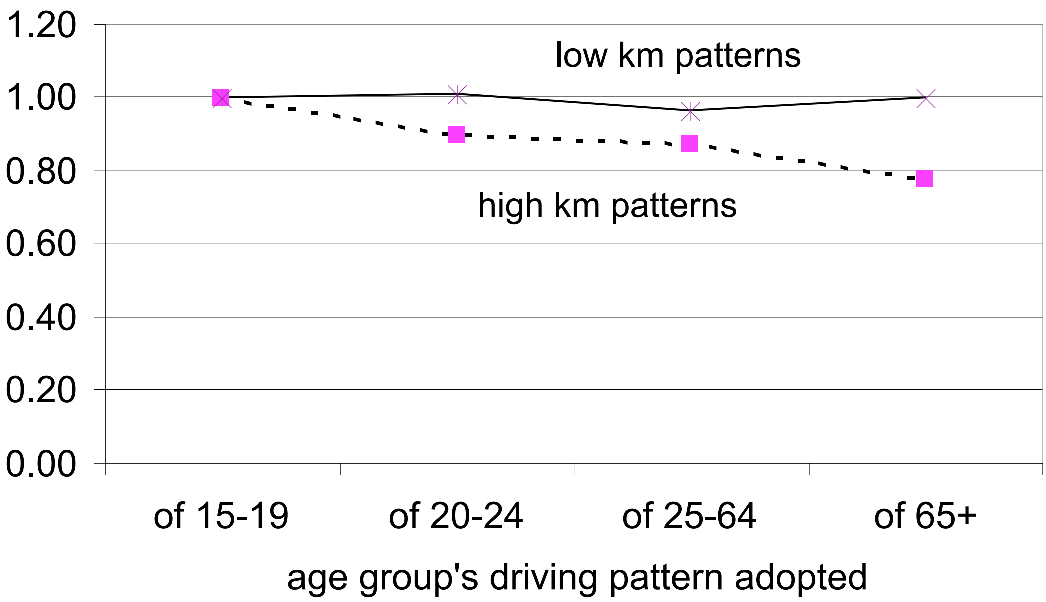


Figure 5 shows that low km older drivers drive a large proportion of their distance on urban speed limit roads during the day time. These roads are often relatively congested and hence have a relatively high risk of injury crash involvement per km driven. It might have been expected that the risk of the low km driving patterns shown in Figure 4 would have had a similar shape to the top line of Figure 5, reflecting the proportion of driving on these relatively high risk roads. However, night driving poses extra risks (see Keall et al 2005), and the low level of night driving exposure of older drivers counterbalances their high exposure to risk on urban roads. Figure 6 has a closer look at the driving patterns of older drivers, whose annual km driving classes have the largest differences in percentages of urban speed limit driving according to Figure 5. Older drivers do little driving after dark, although high annual km older drivers drive proportionately more at night than the low annual km drivers. The high and low annual km groups are most strongly distinguished by the amount of driving undertaken during the day on urban speed limit roads and on "other" rural speed limit roads, which have no median barrier separating opposing streams of traffic. Figure 6 shows that the high annual km group drive a considerably higher percentage of distance on these other rural roads, and a considerably lower percentage on urban speed limit roads.

Figure 5: Percentage of distance driven by age group and annual km class that is on urban roads during the day.

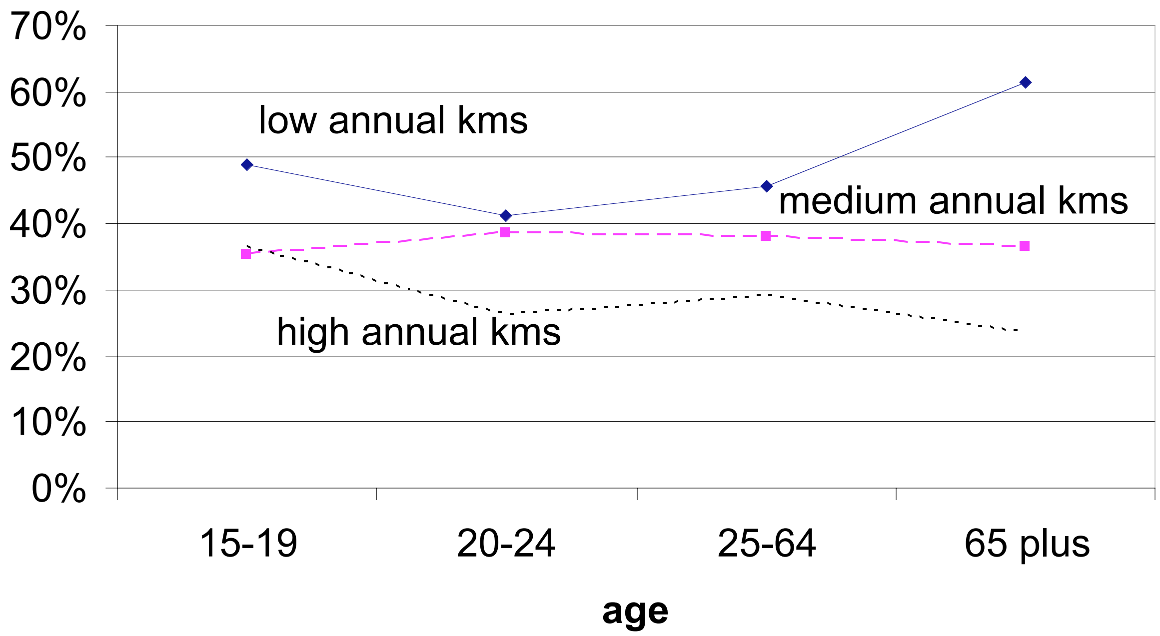
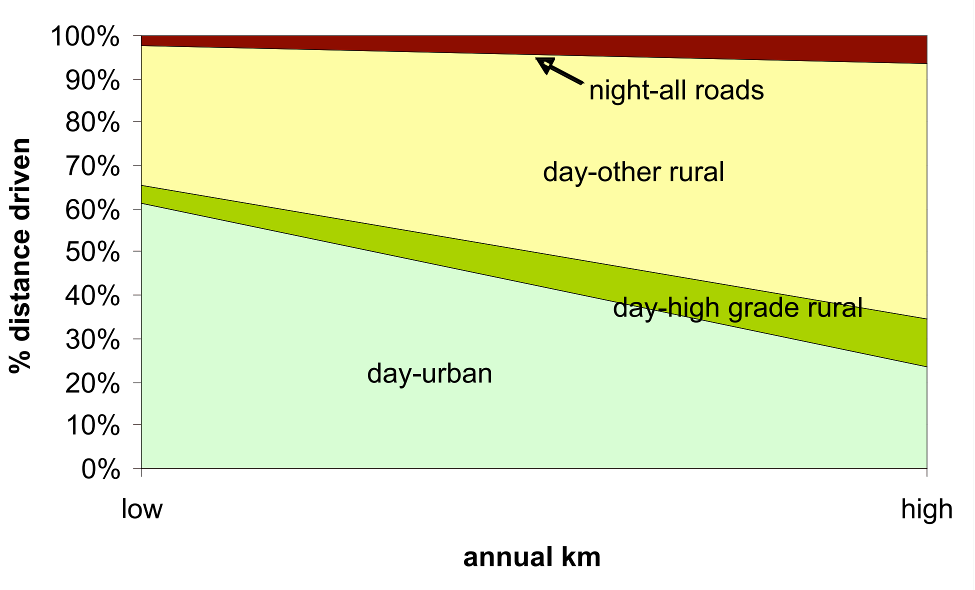


Figure 6: Percentage of distance driven by drivers aged 65+ with low or high annual km driven that is on specified road type and time of day.



Characteristics of low km drivers

It is possible that there are other factors that differentiate low annual km drivers from other drivers, which may have an impact on their driving patterns, their risk of crash involvement, and on the efficacy and equity of any policies that may be directed at this group. These are examined in the current section.

Figure 7 shows data from the 1997/98 travel survey indicating the proportion of drivers from the given age and annual km driven class who were employed full-time. There is a clear trend for drivers who drive low annual kms to have low rates of full-time employment and drivers with high annual kms to have high rates of full-time employment (although it is likely that it is the employment status, related to both the economic status and travel demands of the drivers, which was determining the levels of annual kms driven, not the other way around). These data are related to income data from the 1997/98 travel survey that show that most low km drivers earned under $15,000 (NZ dollars, 1997/98 values) compared to a minority of high km drivers (see Table 1). Summarising the information presented by Figure 5, Table 1 indicates that the proportion of driving distance on urban roads, which have the highest risk per distance driven, generally decreases with increasing annual distance driven and average trip length increases. Table 1 shows that for the young drivers only, there were large differences in the sorts of licenses held, with only 23% of low km young drivers on a full licence (compared to 82% of high km young drivers).

Figure 7: Percentage of drivers who were full-time employed by age group and annual km driven classes.

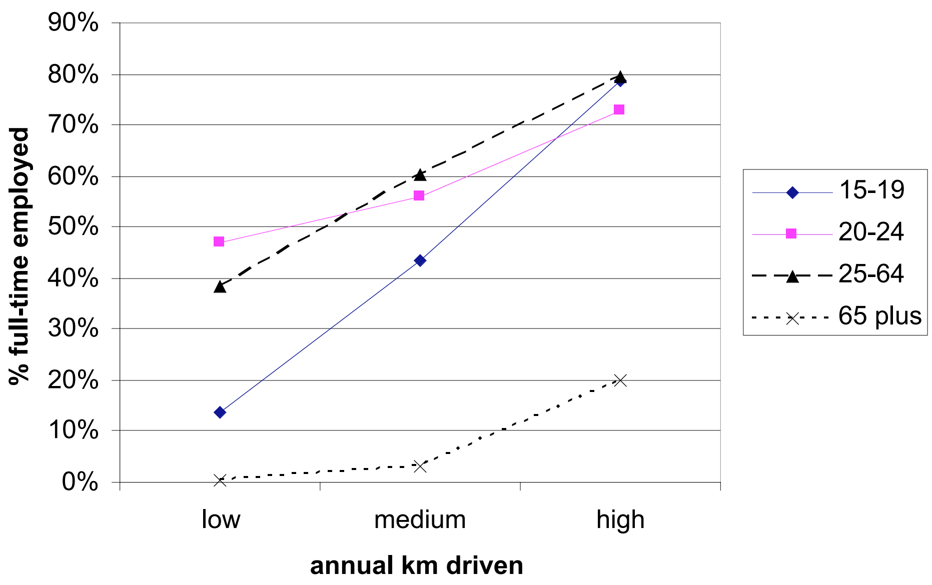


Table 1: Summary of characteristics of low km drivers vs. high km drivers for age groups 15-19, 25-64 and 65 plus.

	15-19-year-olds		25-64-year-olds		Aged 65 plus	
	Low km	High km	Low km	High km	Low km	High km
Average trip length (km)	5.7	7.7	5.6	11.8	3.9	11.5
Driving pattern risk	1.94	1.91	0.40	0.34	0.63	0.43
% driving urban roads in daytime	49%	36%	46%	29%	62%	24%
% of specified age group	59%	5%	10%	21%	30%	5%
% employed full-time	14%	79%	38%	80%	0%	20%
% with full licence	23%	82%	92%	100%	99%	100%
% low income (<=$NZ 15,000)*	96%	33%	57%	14%	83%	55%

* in dollar values as in 1997/98

Figure 8: Proportion of trips driven by trip purpose for *teenage* driver groups with low annual km (on the left) and high annual km (on the right).

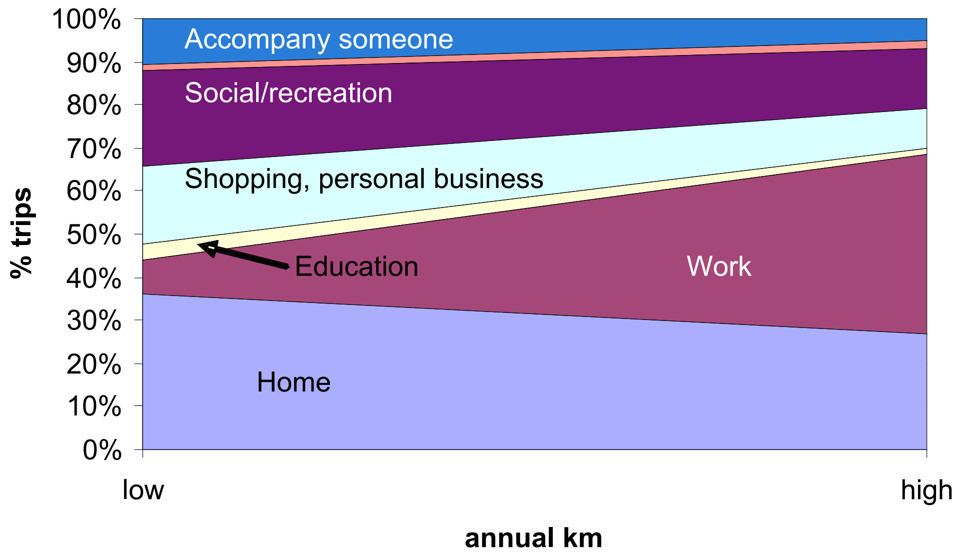
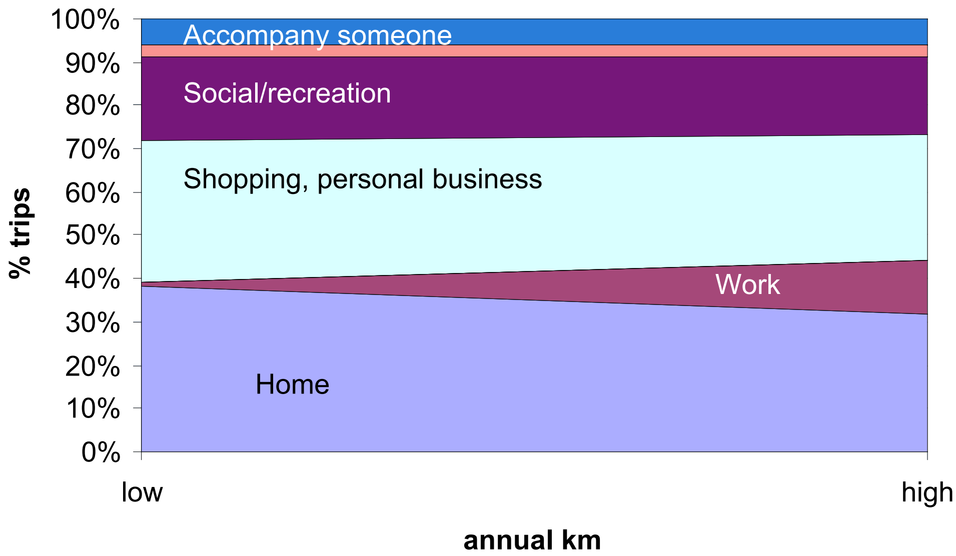


Figure 8 shows that teenage drivers who had low annual km drove a higher proportion of their annual trips for education, for recreation, for social, for shopping and personal business than did teenage drivers with high annual km, who drove more for work reasons. The low km teenage drivers tended to make trips that were based around their home (as indicated by the higher proportion of trips with purpose ¨Home¨- i.e., to return home). There were similar differences between high and low km drivers amongst drivers aged 20-64 (not shown).

Figure 9: Proportion of trips driven by trip purpose for *older* (aged 65 plus) driver groups with low annual km (on the left) and high annual km (on the right).

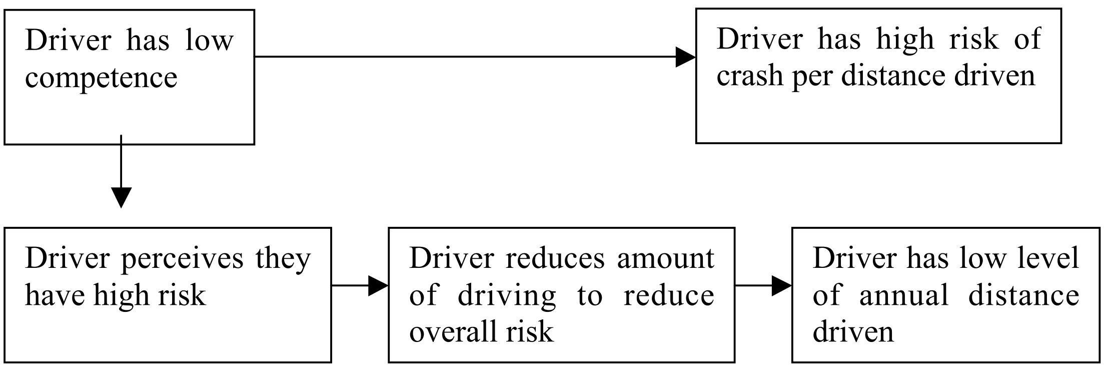


However, the distributions of driving trips by trip purposes of high and low km older drivers were not so clearly differentiated. Figure 9 shows that the major difference between high and low km older drivers was the proportion of driving trips for work reasons, which was virtually zero for low km drivers, but almost 10% of high km older drivers' driving distance. As summarised in Table 1, above, virtually no older drivers who drove low annual kms were employed full-time.

DISCUSSION

Several studies have made use of average annual distance driven as an explanatory variable in the modelling of risk, including Maycock et al. (1991) and Massie et al. (1997). Hakamies-Blomqvist et al. (2002) have also analysed risk per distance driven stratified by annual mileage classes, showing that within these classes, there did not appear to be higher risk for older drivers. The argument for accounting for annual mileage is that drivers travelling smaller distances tend to cover this distance on higher risk (per distance driven) roads, and conversely, high mileage drivers tend to cover more of their driving distance on lower risk roads, such as motorways (Janke 1991). However, in order to be able to compare crash liability of different driver groups, the inherent risk of the units of exposure should be similar for the groups being compared (Brühning and Völker 1982). Comparing drivers within similar annual mileage classes seems to provide an approximate way of comparing like exposure with like. This approach may be flawed if there is a causal path operating in which the driver recognises that they are less able to drive as competently as before, so they reduce the amount of driving to compensate for this perceived higher risk. This is represented diagrammatically in Figure 10.

Figure 10: Diagram of possible causal sequence whereby driver competence influences both risk (crash involvement per distance driven) and annual distance driven.



Clearly, it is not valid to stratify on the amount of driving in order to estimate risk per km driven given this model (Figure 10) in which the high risk drivers elect to be low annual km drivers to keep their personal risk (risk of crash involvement per licensed driver) at an acceptable level. There is considerable evidence that older drivers do deliberately reduce their driving in risky circumstances (e.g., see Hakamies-Blomqvist 1998). This is supported by evidence that older drivers with functional impairments are more likely to report that they drive infrequently (Lyman et al 2001). To our knowledge, there is no evidence that younger drivers modify their driving to avoid risky exposure.

Figure 10 represents a situation in which the amount of driving is influenced by (perceived) risk. Modelling risk using annual km driven as an explanatory variable would therefore present interpretational difficulties. However, it is likely that the mechanism represented by Figure 10 applies mainly to older drivers, as indicated by the previous paragraph, especially as younger drivers' low km driving patterns appear to be no more dangerous than their high km driving patterns (see Figure 3). There is, however, a dissonance between the conclusions of Hakamies-Blomqvist et al. (2002) and a hypothesis that mainly older drivers apply the logic of Figure 10. If mainly older drivers self-select into the low annual km group as a response to perceptions of elevated risk per distance driving, then analysis of risk within annual km classes would still show an age effect where older driver risk was elevated relative to the risks of age groups not self-selecting into the low annual km class. This was not the case in their research. It should be noted, however, that they found no significant difference between risks of older drivers and young middle-aged drivers (defined as aged 26-40) even before they undertook analysis within annual km classes (ibid), so it is hardly surprising that there was no evidence of higher risks within annual km classes! Their results cannot therefore be seen as conflicting with Figure 10 in the case of older drivers who drive low annual kms.

From the point of view of licensing policy, the above discussion has little relevance because risk per distance driven, even if perfectly estimated, is not pertinent. As discussed in the Introduction, if the crash rate of a given driver group over the licensing period is not excessively elevated, then there is no justification to apply special regulation. Hence, a driver with high risk per km travelled who follows the rationale of Figure 10 and reduces their exposure to the extent that their expected number of crash involvements is acceptable (in comparison with other driver groups), then their risk as represented by risk of crash involvement over the licensing period will also not be elevated (see Figure 1). Figure 1, which can usually be derived easily from standard official databases, presents the most germane criterion for directing licensing policy.

According to the literature on driving patterns and risk discussed in the introduction (Janke 1991; Keall and Frith 2003; Keall and Frith 2004c; Keall et al 2005), "low mileage bias" can be addressed by disaggregating exposure into units of approximately uniform risk. When such analysis is not possible, risk estimated by total numbers of crashes per total distance driven aggregated over all combinations of driving exposure is potentially subject to some degree of low mileage bias, but mainly for older drivers, according to the analysis presented here. In New Zealand, older drivers as a group tend to have driving patterns that reduce their overall risk per distance travelled (Keall and Frith 2004c), so low mileage bias will not lead to overestimated risk for this group, although it may be a factor for higher age ranges than studied here. The most important factor leading to overestimated risk for older drivers is their fragility and the fragility of their passengers, discussed in Keall and Frith (2004a). In more serious crashes, fragility is likely to play a larger role, leading to different age-based risk estimates. The current paper has evaluated injury crash risk without considering different levels of severity. A further limitation of the analysis presented here is that the older driver group was studied over a fairly wide age range (65 plus) in order to derive reliable estimates of driving patterns. It would have been desirable, had there been sufficient sample, to have looked at driving patterns of drivers aged 80 plus who, according to Figure 2, have a much larger proportion of low km drivers, and are hence more likely to be affected by low mileage bias in aggregate risk estimates. This is potentially the subject of future research.

SUMMARY OF RESULTS

Low km drivers are much less likely to be full-time employed than high km drivers and tend to have low incomes. Their driving trips tend to be shorter, with greater focus on the area in the vicinity of their homes. For young drivers only (who are subject to a graduated driving scheme in New Zealand), just a small percentage of low km drivers have full licences. Using good quality travel data, it is possible to identify particular types of roads used by drivers, meaning that driving risk can be disaggregated into high and low risk exposure so that bias in risk estimation can be minimised. Nevertheless, it is questionable whether it is valid to compare risks of drivers per km driven when drivers may respond to perceptions of their own elevated risk by changing the nature of their exposure (driving less and/or driving under less risky conditions). As recommended by various authors, risk per licensed driver gives a fairer measure from the point of view of driver licensing authorities. Generally, low km drivers tend to make shorter trips that are focused on urban speed limit roads. This focus on risky (in terms of crash involvement per distance driven) urban speed limit roads is greatest for older drivers who drive low annual km, resulting in riskier driving patterns. For young drivers, however, low km driving patterns appear to have similar risks to their high km driving patterns.

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