ABSTRACT

Elderly motor vehicle occupants are over represented among serious occupant casualty numbers, and the most common region of the elderly occupant’s body injured in crashes is the chest. Chest injuries carry a significantly higher risk of death among elderly than younger occupants. While three point seat belts are effective in reducing the risk of death and injury in Crashes in the general population, the seat belt is often cited as a source of chest injury among elderly occupants. Little is known about the seat belt wearing characteristics of older drivers. This study aims to describe seat belt wearing patterns among drivers aged 75 years and older by examining quality of seat belt use in terms of correctness and fit.

Driver’s aged 75 years and older were interviewed and observed in their vehicles. Demographic, vehicle, and seat belt wearing data were collected during interview. Seat belt information included self-reported frequency of use and response to questions about positioning of seat belts, ease of use and comfort. Seat belt fit was assessed visually. Sash belt fit was judged ‘good’ if it passed over the mid portion of the shoulder. ‘Poor’ sash belt fit included belts positioned off the shoulder, across the tip of the shoulder or in contact with the neck. Lap belt fit was judged ‘good’ if the belt passed low over the abdomen with at least the bottom edge of the webbing in contact with the upper thigh. Participant height, weight and seated height were also recorded. A sample of 380 participants is being sought.

To date, data has been collected for 115 participants and data collection continues. Preliminary data indicates high rates of self-reported seat belt use, with only one participant reporting occasional non-use. However 22% indicate that they regularly reposition the sash portion of the seat belt. This is despite 92% reporting that wearing a seat belt is comfortable. In our sample, 44% reported having vehicles that allowed sash height adjustment, 30 were unsure if their vehicle had this feature, and only 70% who had this feature, had ever used it. Visual observation of belt fit revealed good sash and lap belt fit in 30% of participants. Sash belt fit was good in 69% of participants, with 28% positioned off or across the tip of the shoulder, and 5% in contact with the neck. The lap belt was too high in 43% of occupants. Poor lap belt positioning was significantly associated with greater body mass index (BMI), but there was no association between sash belt fit and BMI or stature.

INTRODUCTION

Fatalities among older drivers are predicted to increase by more than 280% between 1995 and 2025 due to the ageing population and expected increases in mobility. Currently drivers over the age of 70 account for over 14% of driver fatalities. Hospitalization rates for drivers aged over 75 years are approximately 60 per 100,000 population – a rate only exceeded by young drivers aged 15-25 years.

Elderly drivers have a high rate of crashes per kilometre driven but tend to drive less than younger drivers, resulting in a lower crash involvement than any other age group. Yet the elderly sustain more injury, and the injuries sustained by the are more severe than those in younger age
groups.\textsuperscript{6,9} It is estimated that injury risk is 9 times higher per mile driven in drivers 85 years and older compared to 25-69 year olds.\textsuperscript{10,12} Many older drivers die from crashes that would be survived by younger drivers.\textsuperscript{13}

Chest injuries, including rib fractures, are the most common injuries seen in elderly drivers and occupants, and rib fractures carry a much higher rate of morbidity and mortality in older people than younger people\textsuperscript{13-16}. While seat belts are acknowledged to be a highly successful countermeasure for reducing risk of death and injury, seat belts are the primary source of the chest injury seen among elderly occupants.\textsuperscript{7,8,17}

There is no doubt that physiological changes associated with aging play a role in the increased overall susceptibility to injury, and the specific increased susceptibility to chest injury. Tolerance to seat belt loading is reduced with age\textsuperscript{16,19}. This change in tolerance is associated with thoracic structural differences, such as variation in thoracic geometry\textsuperscript{19}, and spinal geometry associated with aging.\textsuperscript{20} Furthermore, overall body shape changes with age\textsuperscript{21}.

It has been established that body shape variations, like that which occur with obesity can negatively influence seat belt fit\textsuperscript{22} and it is possible body shape variations with aging may also negatively influence seat belt fit.

Poor seat belt fit may negatively impact on chest injury risk in two ways. Firstly it might alter the distribution of loads applied to the chest during a crash, and secondly it might affect user comfort leading to users inappropriately positioning the seat belt for comfort.

This paper reports preliminary observations from study investigating belt wearing patterns among drivers aged 75 years and older by examining quality of seat belt use in terms of correctness and fit.

**Method**

Driver’s aged 75 years and older were recruited as part of a randomised control trial (RCT) of a program aimed at enabling older, at risk drivers to self-limit driving but maintain mobility.\textsuperscript{23} The study aims to recruit 380 drivers aged \(>75\) years over from the outer suburbs and semi-rural areas of Sydney using advertising in local media, seniors groups and through a mail-out to members of a motoring organisation in New South Wales. As driving is to be measured objectively in the RCT, all participants are the primary driver of their own car.

During baseline assessment for the RCT a home visit by an occupational therapist was conducted. During this visit a short questionnaire to collect demographic information and details about seat belt use was completed. Questions asked include how often the participant travels unrestrained and if so to explain why they sometimes don’t use a restraint; if they find the seatbelt comfortable; if they ever reposition the seatbelt and if so, how they reposition the belt; and to report on specific issues they have had with belt fit e.g. does the belt cut into their neck, does the belt slip of their shoulder. Participants were also asked to report if the seat belt sash height is adjustable in their vehicle and if it is, have they adjusted it to improve belt fit or comfort.

Weight, standing height and seated height were also measured during the baseline visit. Standing height and weight were used to calculate the participants Body Mass Index (BMI). The participant was then asked to sit in their vehicle and engage their seat belt. A series of photographs were taken to record seat belt fit.

Seat belt fit was then assessed visually from the photographs taken during the baseline visit. Sash belt fit was judged ‘good’ if it passes over the mid portion of the shoulder. ‘Poor’ sash belt fit includes belts positioned off the shoulder, across the tip of the shoulder or in contact with the neck. Lap belt fit was judged ‘good’ if the belt passes low over the abdomen with at least the bottom edge of the webbing in contact with the upper thigh. Good overall seat belt fit required good sash belt fit and good lap belt fit.

Data from the questionnaires were coded and recorded in a custom designed database. BMI was categorised into underweight (BMI < 18.5), normal (BMI 18.5-25) and overweight (BMI >25). Standing height was used to group participants into height categories of ‘tall’ (174cm and greater) and ‘short’ (less than 174 cm tall). This breakpoint was chosen as it represents the 50\textsuperscript{th} percentile height of males aged 70 to 79 years\textsuperscript{24} As no anthropometric profiles for seated height of people in this age range (or for adults per se) were available, seated height was used as a continuous variable only.

All analysis was conducted using SPSS (IBM Corp. Released 2012. IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp). Descriptive
techniques were used to calculate frequencies and cross tabulations. Chi square was used to assess significance in the cross tabulations. Logistic regression was used to examine the association between seat belt fit and BMI and height. This study has been approved by the University of Sydney Human Research Ethics Committee.

Results

A total of 115 participants have been recruited to date. There is incomplete data for 8 participants and these have been excluded from analysis, leaving a sample of 107.

Participants range in age from 75 to 92 (mean 80 years), and currently there are 39 females and 68 males. Almost all participants (97%) report always using a seat belt, and most (92%) described the seat belt as comfortable. However 23% report sometimes repositioning the belt to improve comfort. Table 1 presents responses to a number of situations where participants were asked if they specifically encountered comfort problems. The most commonly reported were 22% reporting experiencing the belt cutting into their neck and 14% reporting the belt touching their neck when they turned. Participants were asked if they ever put the sash under their arm or behind their back and 6% reported doing this.

<table>
<thead>
<tr>
<th>Situation</th>
<th>% (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belts cuts into neck</td>
<td>22 (24)</td>
</tr>
<tr>
<td>Belt tightens over time</td>
<td>8 (8)</td>
</tr>
<tr>
<td>Belt slips off shoulder</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Belt feels loose</td>
<td>4 (4)</td>
</tr>
<tr>
<td>Belt touches neck when turning</td>
<td>14 (15)</td>
</tr>
<tr>
<td>Belt interferes with side view</td>
<td>3 (3)</td>
</tr>
<tr>
<td>Belt feels tight</td>
<td>4 (4)</td>
</tr>
<tr>
<td>None of the above</td>
<td>63 (67)</td>
</tr>
</tbody>
</table>

Almost one third (30%) of participants reported not knowing if their vehicle allowed adjustment of the sash belt height, 44% reported that their vehicle did allow this adjustment and 26% had vehicles with no height adjustment feature. Of those with potential height adjustment, 70% (?/107) had adjusted the height for better fit or comfort.

Photographs for seat belt analysis were currently available for 58 participants (26 females and 32 males). Figure 1 illustrates the observed seat belt fit. While 69% of participants demonstrated good sash belt fit, and 60% demonstrated good lap belt fit, only 36% demonstrated good overall belt fit. Poor sash belt fit and poor lap belt fit was observed in 10% of participants.

Figure1. The proportion of participants with good sash belt fit, good lap belt fit and good overall belt fit.

In this preliminary sample there was no association between whether or not participants reported that they sometimes reposition the belt for comfort and observed belt fit. Nor were there any associations between the situations experienced (see Table 1) and observed belt fit.

There was a significant association between observed belt fit and BMI. Participants in the overweight group were 4.2 times (95% CI 1.2-15.1) more likely than those in normal range to have poor lap belt fit (no participants fell within the underweight range). While there was a trend towards ‘tall’ participants having good lap belt fit (OR 3.8, 95% CI 0.9-15.5), and good overall belt fit (OR 1.7, 95% CI 0.5-5.6), this did not reach significance. There was no association between standing height and sash belt fit. When adjustment of sash belt height was controlled, the odds of having good sash belt fit was 1.1 times greater for ‘tall’ participants compared to short participants but this did not reach significance (95% CI 0.2-8.8).

There was no association between seated height and seat belt fit but seated height was only tested as a continuous variable (OR 1.02, 95% CI 0.95-1.1).
DISCUSSION & CONCLUSIONS

The key findings of this preliminary analysis is that despite high self reported restraint use, there appears to be high rates of seat belt fit problems among elderly (≥70 years) drivers. Furthermore this does not appear to be associated with discomfort, although almost one quarter of participants in this study report sometimes repositioning the belt to improve comfort.

A strength of this study is that observations about seat belt fit were made in the elderly drivers’ own vehicles, but caution should be exercised in reviewing these results as this community sample may not be representative of all drivers in this age range. The fact that drivers were also asked to fit their seat belts while being observed is also a potential source of bias as participants may have altered the way they naturally wear their belts. Importantly the results presented here represent a preliminary analysis only and may vary somewhat when the final full sample is included.

These preliminary survey responses suggest that almost all older drivers in this setting regularly use seat belts. While 22% report sometimes repositioning the belt only 6% describe positioning the sash part of the belt behind their back or under their arm.

Despite the good seat belt wearing behavior observed in this study, the high rate of poor seat belt fit warrants further investigation. It is possible poor seat belt fit might contribute to the increased risk of injury, and increased severity of injury observed in older occupants. Interestingly, two-thirds of our sample were ‘overweight’ according to their BMI using a breakpoint for overweight of BMI of 25. Obesity has been reported as increasing the severity of injury in crashes and also modifies kinematic response and loading patterns.27 There appears to have been no study of the interaction between obesity and the vulnerability to crash injury associated with aging but our observations suggest this might be a useful area of further study.

We observed significantly more poor lap belt positioning among the elderly drivers in the overweight category and this supports the findings by Reed et al.23 Reed reported that obesity adversely affected seat belt positioning by effectively introducing slack into the seat belt system and routing the belt further away from the skeleton.

They found with obesity, the lap belt is positioned further forward, and higher, relative to the anterior iliac spines than in normal weight people, a finding similar to what we observed here. However Reed also noted differences in sash position, with obesity associated with a more-inboard sash belt routing. We did not find any association between BMI and sash belt fit but this difference may be attributed to the scoring system we used. We did not measure or assess sash belt angle, but scored seat belt fit on the gross position of the belt relative the tip of the shoulder and the neck.

Similarly we did not find any association between standing height or seated height with sash belt fit. We were unable to categorised this variable due to the absence of good normative anthropometric data, and therefore the lack of an appropriate breakpoint for categorising this variable. This will be further explored in the final analysis when data for the full sample of 380 elderly drivers is available.

Another important issue for future consideration is the reported poor relationship between BMI and body shape in the elderly22 In a large UK sizing study using 3D body scanning Wells et al. found BMI to be insensitive to age-associated changes in the distribution of body weight. Their observations suggest that there is a shift in fat toward the upper body with age and, within the upper body, to a preferential distribution around the waist rather than the arm and bust, may have significant impact on seat belt fit with increasing age of the occupant. It might be sensible to include measures of occupant shape, such as chest and waist girth, in addition to BMI in future studies examining the effect of obesity and/or age and seat belt fit.

Besides the convenience-based community sample, self report and observation of fit limitations described earlier, another limitation in this study was in the measurement of comfort. Here we simply asked participants ‘Overall, with the seat belt on do you feel comfortable?’. This may have been too general, and did not provide the opportunity to quantify discomfort. The use of a validated tool like the ASDQ28 is recommended for future similar studies.

In conclusion, this preliminary analysis has demonstrated that elderly drivers aged 75 years and older may be experiencing significant seat belt fit problems, and this issue is worthy of further study.
ACKNOWLEDGEMENTS

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