

WHERE DO CHILDREN SIT IN AUSTRALIAN PASSENGER VEHICLES? RESULTS  
OF AN OBSERVATIONAL STUDY

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**Erratum:**

Page 1, second paragraph of the Introduction, second last sentence (starting “Currently all states...”) contains an error. This sentence should read “Currently all states and territories require infants less than 12 months old to be restrained in an approved child restraint (RTA, 2005).”

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### ABSTRACT

International research suggests that a large proportion of children travel in the front seat of passenger vehicles even though this places them at increased risk of serious injury or death. There are no comparable figures for Australia. This study was conducted to estimate the proportion of Australian children seated in the front seat of passenger vehicles and to explore restraint use. Trained observers noted the seating positions of children, their ages and the types of restraints used for 1295 passenger vehicles carrying child passengers (aged 12 years and under) in Brisbane during March/April 2005. Results suggest that approximately 60% of passenger vehicles carrying children had at least 1 child seated in the front seat. Age was associated with greater likelihood of front seating with most child front seat passengers being aged 7-12 years. While over 90% of child passengers were restrained, around 25% wore restraints that were not optimal for their ages. These figures indicate a clear opportunity for interventions aimed at raising awareness of the risk involved in allowing children to occupy the front seat as well as encouraging parents and drivers to seat them in the rear seat whenever possible. There is also a need to explore parental knowledge of age-appropriate restraints and to encourage more widespread use.

### INTRODUCTION

In Australia, road trauma is a major factor in death and serious injury for children aged less than 14 years old, and the leading cause of death in those aged 5-9 years (Watson, Ozanne-Smith & Lough, 2000), mirroring the USA (NHTSA, 2002; Ramsey, Simpson & Rivara, 2000) and other high income nations (Krug, 1999). Over the five year period from mid 1999 to mid 2004 children under 16 years old comprised around 20% of the fatalities and 30% of the injuries to passengers in motor vehicle crashes, representing around 400 deaths and 4700 serious injuries to Australian children (ATSB, 2004, 2005). Such a level of mortality and morbidity represents a significant loss of productive years and quality of life to the Australian community and hence is of major concern.

Australia has long recognised the effectiveness of appropriate passenger restraints in preventing injury and death in motor vehicle crashes and appears to have been the first country with legislation requiring seat belt use for passengers aged 8 years or more, which came into effect in Victoria in 1970 (NRMA, 1988). Other states and territories quickly followed suit. Legislation pertaining to the restraint of children aged between 12 months and 8 years was set in place during the 1970s to early 1980s (NRMA, 1988). Previously there have been variations between the jurisdictions in the details of this legislation. The national adoption of the Australian Road Rules in late 1999 to early 2000 has meant a more uniform approach. Currently all states and territories require the restraint of infants under 9kg in

weight (approximately 6 months old) to be restrained in an approved rear-facing restraint (RTA, 2005). All other passengers travelling in motor vehicles in Australia are required to be appropriately restrained in either child-specific restraints or seat belts.

While legislation has kept pace with growing knowledge regarding restraint use, findings in relation to the relative risks of different seating positions have not been so readily recognised. As early as 1977, US researchers Williams and Zador (1977) reported the reduction of injury risk for children seated in the rear seat as compared to the front seat of passenger vehicles. In this same study, the researchers noted the greater protection offered to children by using restraints, even if the only ones available were adult seat belts. More recently, several other North American studies have elaborated on these earlier findings using figures relating to more modern vehicles and restraint technology. Analyses of the US Fatality Analysis Reporting System data has demonstrated that sitting in the back seat of a vehicle reduces the risk of death by approximately 35% for restrained children compared to sitting in the front seat (Braver, Whitfield & Ferguson, 1998; Glass, Segui-Gomez & Graham, 2000). Even if no seat belt or restraint is worn, sitting in the back seat of a vehicle reduces the risk of death in fatal crashes, though not so dramatically (Glass et al, 2000; NHTSA, 2005; Williams & Zador, 1977).

Rear seating of children may also reduce the risk of serious injury in crashes (Corneli, Cook & Dean, 2000; Durbin, Chen, Smith, Elliott & Winston, 2005; Smith & Cummings, 2004). In a recent cross-sectional study, Durbin and colleagues (2005) demonstrated that rear seating by itself significantly reduced the risk of injury to children and that this benefit was enhanced when children were appropriately restrained.

Though motoring associations and transport authorities encourage parents and caregivers to seat their children in the back seats of motor vehicles, where available, this is not mandated in Australia. Early legislation required that children sit in the rear seat if no restraint was available in the front seat, but with the requirement for all vehicles to be fitted with front seat belts since 1970 (NRMA, 1988), this has meant that children may legally be carried in the front seat providing they wear the adult seat belt.

It is difficult to ascertain whether Australian children are at greater risk from their seating position as we have no locally-based information on exactly where children do sit when they travel in motor vehicles. Moreover, in fatal crash analysis, data on the seating position of passengers is usually not collected in this country. Crash data base analyses (Berg, Cook, Corneli, Vernon & Dean, 2000; Wittenberg, Goldie & Graham, 2001) as well as observational research (Ferguson, Wells & Williams, 2000; Segui-Gomez, Glass & Graham, 1998) in the US suggests that the proportion of children aged under 12 years who sit in the front seat rather than the rear may be as high as 40%. If this figure is similar for Australia, then there is a very large injury and death risk reduction to be achieved from promoting rear seat positioning for children.

The following observational study was conducted to estimate the proportion of child front seat passengers in Australia. A key issue of interest was whether children were wearing the type of restraints recommended by authorities for optimal protection according to their height and weight. In particular, we wished to examine whether the phenomenon of early graduation to seat belts of children more appropriately restrained in child harness-style seats or belt-positioning boosters seats noted in the US (eg. Ebel, Koepsell, Bennett & Rivara, 2003; Winston & Durbin, 1999; Winston, Durbin, Kallan & Moll, 2000) is duplicated here. This

form of restraint misuse has been estimated to increase the risk of injury to children by as much as three and a half times (Winston et al, 2000) and may account for a large percentage of deaths and injuries to restrained children (Durbin, Elliot & Winston, 2003; Winston & Durbin, 1999). A further interest was in whether socio-economic status, previously associated with lower levels of other car safety-related behaviours (Vaca, Anderson, Agran, Winn & Cheng, 2002; Greenberg-Seth, Hemenway, Gallagher, Ross and Lissy, 2004; Eby & Kostyniuk, 1999), influences car seating behaviours of Australian parents.

## METHOD

### Selection of sites

In order to compare socio-economic factors, two suburban areas of Brisbane were chosen for the observations. On the basis of figures from the year 2001 census (ABS, 2001), a higher socio-economic area (median weekly family income AUD \$1,200-1,500) and a lower socio-economic area (median weekly family income AUD \$700-800) were chosen. Proportions of children aged under 15 years old in the higher SES area was 14% and for the lower SES area, 19% (ABS, 2001). A number of different locations within each area were selected using criteria of moderate to high traffic volume and places where vehicles were required to slow down or to stop, thus affording observers the opportunity to see inside the vehicles. Locations close to primary (junior or elementary) schools were favoured for two reasons. Firstly, we argued that most parents send their children to a primary school close to where they live and thus we believed we would be capturing residents of these areas rather than visitors. Secondly, we expected that choosing these locations would maximise the number of children in the 5-12 years age groups who are of special interest to this study because of their ability to use adult seat belts and thus be deemed to be appropriately restrained if sitting in the front seat. Locations also included shopping centres and major controlled intersections. For each location, we chose several different observation points. To avoid counting the same vehicles twice (for instance on different days at locations close to the same school), we assumed that drivers would be likely to use the same pickup points each day and so we observed each exit or traffic direction only once.

### Observations

Observations were carried out during March and April 2005, between the hours of 2:30 pm and 4:30 pm during term time, and between 10am and 4pm during school holidays. Following Segui-Gomez et al. (1998), the primary interest here was whether drivers chose to seat a child in the front seat. Accordingly, only vehicles with child passengers were included. Observers were also instructed to count only those vehicles with no adult passengers in the front seat since the presence of adult passengers has been shown to reduce the odds of child front seating to almost nil (Segui-Gomez et al., 1998). Passenger vehicles were defined as those with a rear seat, not including public transport such as taxis, maxi cabs and buses. Utilities (utes) and pickup trucks were not counted, nor were small vans which had rear seats removed.

For the purposes of this study, a child was defined as aged 12 years or under. Children's ages were estimated on the basis of observed height based on average growth charts for children (CDC, 2000). We used height as our age proxy due to the difficulty of determining real age without stopping drivers. Since optimal seat belt fit relies on being tall enough (NHTSA, 2002, 2004) we believed this would be the most accurate gauge of whether front seated children in particular were sufficiently protected by the restraints they were wearing. Ages

were categorised according to five (for front seat passengers) or four (rear seated passengers) age groups following child restraint guidelines. Hence these categories were: 0-6 months (rear-facing infant capsules recommended); 7 months – approximately 2 years (child seat or convertible child seat); 3- 6 years (belt-positioning booster seats); 7-10 years (adult seat belts); 11-12 years (adult seat belts and front passenger airbags). For rear seat passengers, the two upper age categories were collapsed into one of 7-12 years. This was partly because while we could see whether lap/sash belts were being used by children in the rear, we could not determine if booster cushions, which alter the child's relative height, were also being used.

Trained observers worked in pairs, one observing the front seat passenger while the other observed rear seat passengers. Observers were positioned facing the traffic on the roadside or on large traffic islands between 1 and 2 metres from the vehicle. Age, restraint type (capsule, childseat/booster seat, child harness-style belt, adult seat belt) and number of child passengers were recorded on standardised sheets. Except in very obvious cases (such as children whose heads were completely above the height of the childseat/booster seat), it was not possible to ascertain whether the restraints used by child passengers were being worn correctly. It was also not possible to distinguish reliably between child car seats, normally recommended for children weighing between 8 -18 kilograms and which have an integrated 5-point harness on the Australian market, and belt-positioning booster seats (for children 12-26 kilograms) designed to be used with existing adult seat belts in this study due to the very brief observation times available and the varied appearance of each of these types of restraint on the Australian market. A further complication limiting our viewing access was the recent media concern with paedophile activity around schools: it was clear that drivers became uncomfortable with level of scrutiny required for us to make finer distinctions between car seat types. As a result all the child car seats and booster seats were classified 'childseat/booster'.

Another limitation in the observations was for the children seated in the middle rear seat where we could not tell if lap belts were being worn by children who were not seated in childseat/booster seats, nor could we tell if they sat on backless booster 'cushions'. These cases were recorded as 'unknown' restraint use.

## RESULTS

A total of 1295 vehicles were observed, with 632 of these from the higher SES area (49%) and 663 (51%) from the lower SES area. These vehicles carried a total of 2076 children, roughly evenly split between the two areas (1058 and 1018 respectively). A total of 712 (54%) vehicles carried only one child passenger. A further 422 (32.6%) vehicles had two child passengers, while 161 (12.4%) carried three or more children.

Overall the proportion of vehicles carrying a child aged 12 years or under in the front seat was 60% (785/1295) and this was the approximately the same for each of the areas (61% and 60% respectively), suggesting that socio-economic status (as approximated by residential location) does not influence the decision to seat a child in the front passenger seat.

Observed restraint use was very high, with almost 92% (1899/2076) of children using a seat belt or child-specific restraint (Table 1). Most children (95.1%) who were observed in the front seat were wearing adult seat belts (747/785). Of the remaining 38 children in the front,

5 (0.6%) were in childseat/booster seats, 11 (1.4%) were clearly not wearing a restraint and for 22 (2.8%) we could not tell (“unknown”). In the rear seat, the restraint of choice was still adult seat belts, with 53% (690/1291) of children wearing these. A further 33% (424/1291) were using childseat/booster seats, while 0.2% were infants in capsules. Overall, 57 (2.7%) children were definitely unrestrained while in a further 120 (5.8%) cases we could not determine whether they were in a restraint.

Table 1: Observed seating position and restraint use for children aged 12 years and under.

| Restraint type | Capsule<br>n (%) | Childseat/booster<br>n (%) | Child harness<br>belt<br>n (%) | Adult seat<br>belt<br>n (%) | Unknown<br>n (%) | No<br>restraint<br>n (%) | Totals     |
|----------------|------------------|----------------------------|--------------------------------|-----------------------------|------------------|--------------------------|------------|
| Seat location  |                  |                            |                                |                             |                  |                          |            |
| Front seat     | 0                | 5 (0.6)                    | 0                              | 747 (95.2)                  | 22 (2.8)         | 11 (1.4)                 | 785 (100)  |
| Rear seat      | 29 (2.2)         | 424 (32.8)                 | 4 (0.3)                        | 690 (53.5)                  | 98 (7.6)         | 46 (3.6)                 | 1291 (100) |
|                | 29               | 429                        | 4                              | 1437                        | 120              | 57                       | 2076       |

Children in the front seat tended to be older than those in the rear seat (Table 2), with 93% (728/782) of front seated children aged between 7 and 12 years old, compared to 54% (695/1281) of rear seated children who were in this age group.

Table 2: Observed seating position and age categories for children aged 12 years and under.

| Age           | 0-6 mths<br>n (%) | 7mth-2 years<br>n (%) | 3-6 years<br>n (%) | 7-12 years<br>n (%) | Totals      |
|---------------|-------------------|-----------------------|--------------------|---------------------|-------------|
| Seat location |                   |                       |                    |                     |             |
| Front         | 0                 | 2 (1.5)               | 52 (10.8)          | 728 (51.1)          | 782 (37.9)  |
| Rear          | 29 (100)          | 128 (98.5)            | 429 (89.2)         | 695 (48.9)          | 1281 (62.1) |
| Totals        | 29 (100)          | 130 (100)             | 481 (100)          | 1423 (100)          | 2063*       |

\*Data on age or seating position were missing for 13 children

### *Factors increasing the likelihood of front seating*

Age had an impact on the likelihood of being seated in the front seat (Table 2). Being younger was protective against being seated in the front, with children aged 7-12 years having approximately the same chance of being seated in the front seat as in the rear seat (RR 1.04) while 3-6 year olds and 7 months to 2 years age groups were much more likely to be seated in the rear seat than in the front (RR 0.12, RR 0.015 respectively). Infants 6 months old and younger were always secured in the rear seat. Indeed, over 50% of children aged 7-12 years were carried in the front seat as compared to children aged under 7 years where only 8.4% were carried in the front seat. This was particularly marked where only one child was in the car. The differences with respect to age were all statistically significant.

The number of children in the vehicle does not appear to have an influence on whether a child is carried in the front: 58% of vehicles with only one child had that child seated in front compared to 54% of vehicles with more than one child. Moreover, front seating of children is not related to availability of rear seats in our study. While 187 (14.4%) vehicles had two children in the rear seat, there were only 29 (2.2%) with three or more children in the rear, leaving 82% of observed vehicles with at least 1 vacant rear seat.

### *Restraint type according to age*

We were interested in what types of restraints children of different ages were using. For children in the front seat, most wore adult seat belts (95.3%) regardless of age (Table 3). As noted above, most front seat child passengers were aged between 7 and 12 years.

Table 3: Observed restraint type according to age: front seat

| Restraint type    | Capsule | Childseat/booster | Child harness belt | Adult seat belt | Unknown  | No restraint | Totals    |
|-------------------|---------|-------------------|--------------------|-----------------|----------|--------------|-----------|
| Age               |         |                   |                    |                 |          |              |           |
| 0- 6 years n (%)  | 0       | 5 (9.3)           | 0                  | 41 (75.9)       | 6 (11.1) | 2 (3.7)      | 54 (100)  |
| 7-10 years n (%)  | 0       | 0                 | 0                  | 430 (96.8)      | 8 (1.8)  | 6 (1.4)      | 444 (100) |
| 11-12 years n (%) | 0       | 0                 | 0                  | 274 (96.5)      | 7 (2.5)  | 3 (1)        | 284 (100) |
| Totals            | 0       | 5                 | 0                  | 745             | 21       | 11           | 782       |

Rear seated younger children (0-6 years) were more likely to be using an age appropriate child restraint (Table 4). For this group, as might be expected, childseat/booster seats were the most common form of restraint, with nearly two thirds (65.7%) of children aged 0 to 6 years seated in these. Adult seat belts were used by a further 119 (20.3%) of younger children. Over 80% of the children aged 7 to 12 years wore adult seat belts, while for a further 8.5% we could not tell if they were wearing lap belts or no restraint at all.

Table 4: Observed restraint type according to age: rear seat

| Restraint type   | Capsule  | Childseat/booster | Child harness belt | Adult seat belt | Unknown  | No restraint | Totals    |
|------------------|----------|-------------------|--------------------|-----------------|----------|--------------|-----------|
| Age              |          |                   |                    |                 |          |              |           |
| 0-6years n (%)   | 29 (5.0) | 385 (65.7)        | 2 (0.3)            | 119 (20.3)      | 30 (5.1) | 21 (3.6)     | 586 (100) |
| 7-12 years n (%) | 0        | 38 (5.5)          | 2 (0.3)            | 571 (82.1)      | 59 (8.5) | 25 (3.6)     | 695 (100) |
| Totals           | 29       | 423               | 4                  | 690             | 89       | 46           | 1281      |

## DISCUSSION

It was a surprise to find that Australia, which arguably has led the world in child car safety through the early implementation of legislation and stringent standards for child-specific car safety restraints (RACQ, 1999), has a much higher proportion of children sitting in the front passenger seats of cars (60%) compared to the United States (40%). However, given that rear seating is not required for children in either Australia or the US, our findings represent a 40% compliance rate with the recommendation that children be seated in the rear seat where available. One factor that is thought to have influenced child front seating proportions in the US is the effort expended to publicise the dangers of passenger airbag (PAB) deployment for children seated in the front seat. This appears to have been effective in raising parents' awareness and willingness to seat their children in the rear (Wittenberg, Nelson & Graham, 1999). Unlike the US market, where passenger airbags were mandated for new vehicles manufactured after 1990, front passenger side airbags have always been optional in vehicles sold on the Australian market and hence do not necessarily comprise a large proportion of the Australian fleet. Further, though the early 1990s US experience of PAB injuries to children received media exposure in Australia, characteristics of the airbags fitted to Australian vehicles were different. Airbags fitted to vehicles for the Australian market were designed to work with restrained occupants and hence were smaller, fired with less force and at later delays than those associated with injuries in the US (FORS, 1996). This second generation, depowered style of airbag was not perceived as likely to lead to increased injury in Australia.

The near universal use of restraints for children (92%) was most encouraging and suggests a very high awareness and acceptance among Australian drivers of the need to restrain children in cars wherever they are sitting. Moreover, there was no difference between socio-economic areas and the rate of restraint use. This finding compares favourably with studies of Canadian and US children where restraint use has increased over the past three decades from a low of

12% (Williams, 1976) to current levels estimated to be between 60 and 88% (Ferguson et al, 2000; Halman, Chipman, Parkin, & Wright, 2002; NHTSA, 2002).

As mentioned earlier, we could not tell in most cases whether children's restraints were being used correctly. Given that poor fitting and misuse of child restraints has been shown to be as high as 80% both in Australia and overseas (Decina & Knoebel, 1997; RACQ, 1999; Will & Geller, 2004) it is likely that many of those children we observed were not restrained in an optimal way. Certainly we observed four instances where the child was clearly too big for the belt-positioning booster seat being used. We would also agree with Winston and colleagues (Winston & Durbin, 1999; Winston, et al., 2000) that children should not graduate to adult seat belts until large enough to do so, which is not until they are at least 1.45m or 4ft 9" tall (NHTSA, 2002, 2004). For over 50% of children, this does not occur until around 9 years of age (CDC, 2000). Using this criterion, at least 521 (25.3%) of the children we observed, that is, those aged 10 years and under, seated in the front seat and wearing adult seat belts, plus those aged 3-6 years secured in adult seat belts in the rear seat were arguably inappropriately restrained.

One complication for Australian parents who might wish to follow recommendations to keep their children in belt-positioning booster seats until 9 or 10 years old is that the devices available to them are only suited to children weighing 26 kg or less. Many children exceed this weight at around 7-8 years of age (CDC, 2000), making adult seat belts or child harness belts (designed to be used with an adult seat belt and top tether strap in the rear seat) the only suitable restraints. As our figures show, harnesses were not a popular choice among parent-drivers in our study.

The choice to sit a child in the front was not related to availability of rear seats in our study, as 82% of observed vehicles had at least one vacant rear seat. Parental choices seem to be based on other factors which it is important to investigate. It may be that parents perceive the centre seat in the rear as less safe than the front seat because the front seat is fitted with a lap/sash belt while the middle rear seat is generally only fitted with a lap belt in Australian passenger vehicles.

Our study was clearly limited by the observational nature of the data collection. Our choice of sites may not accurately reflect a cross-section of children who are carried in passenger vehicles. Certainly we observed a very low percentage of young babies (6 months and under) and a high proportion of primary school-aged children, as might be expected close to primary schools.

We also did not collect any information on whether the behaviour of drivers was typical of their normal behaviour or whether trip types were typical of the trips they would normally make. Since others have demonstrated that crashes involving child passengers are more likely to occur under usual driving circumstances (Chen, Durbin, Elliott, Kallan & Winston, 2005) this information is important. Lastly, we could not observe how well child restraints had been fitted to vehicles or whether they were being worn appropriately. Each of these limits the generalisability of our results. However, our results do indicate a need to investigate child front seating further, especially in relation to those children too old for booster seats but too small for adult seat belts (those aged 7 to 10 years) who appear to be at increased risk of front seating and inappropriate restraint use. More provision needs to be made for these children and could be achieved by making available belt-positioning booster seats specific to their



weight (ie from 27kg to 32kg) on the Australian market or by raising parental awareness of the risk of seating them in adult belts instead of child harnesses.

Even given the limitations of this study, there appears to be a need for specific interventions to address the extent to which children are being seated in the front seats of passenger vehicles in Australia. In addition, children's protection may be enhanced by promoting better understanding and use of age-appropriate safety restraints.

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