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Child restraint use and parental perceptions of comfort

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ABSTRACT

Objective: Suboptimal child restraint use includes incorrect and/or inappropriate restraint use, and increases the risk of injury. Comfort has been suggested as an important factor impacting on optimal use of restraints by children. This paper aims to examine the relationships between parent reported comfort and restraint misuse and age appropriate restraint choice.

Methods: This is an analysis of data from a cross sectional observation study of child restraint use in NSW. Logistic regression was used to model the relationship between parent reported comfort and restraint misuse and age appropriate restraint choice.

Results: There was no significant relationship between either parent reported comfort and restraint misuse or parent reported comfort and age appropriate restraint choice.

Conclusions: Parent perceptions of comfort of children in child restraints do not appear to be associated with incorrect child restraint use, or age appropriate restraint choice. It is possible that the actual comfort of the child may be related to incorrect use but this remains to be tested.
Further investigation of the relationship between parent perceived comfort and the actual comfort of the child, as well as the impact of child comfort on optimal child restraint use is warranted.

KEYWORDS

Child restraint, incorrect use, appropriate use, safety
INTRODUCTION

Motor vehicle crashes are a leading cause of death among children in Australia (BITRE 2012) and elsewhere in the world (Peden et al. 2002). In Australia, the number of child passengers killed is approximately 70 per year (10 year average, 2002-2011, (BITRE 2012)), and approximately 3000 are seriously injured each year (Brown and Bilston 2012) despite restraint usage rates of >99% among Australian children (Brown et al. 2010a). Similarly in the US, 1140 child passengers (aged 0-14) were killed in 2011 and a further 171,000 injured (NHTSA 2013), despite 91% of child passengers below the age of 8 using restraints across the nation (Pickrell and Ye 2013). In the US, 67% of fatally injured child passenger were using a restraint (Sauber-Schatz et al. 2014). Suboptimal child restraint use is a widespread problem that reduces crash protection and increases risk of injury (Brown and Bilston 2007; Bull et al. 1988; Jakobsson et al. 2005).

Suboptimal restraint use includes incorrect and/or inappropriate restraint use. Incorrect restraint use includes incorrect installation of a restraint as well as errors in securing a child within the restraint. Inappropriate restraint is the use of a restraint that does not match the age and size of the child; typically this is using a restraint designed for an older occupant. Incorrect use occurs as frequently as inappropriate restraint use (Brown et al. 2010a) and carries a higher risk of injury than inappropriate use (Brown and Bilston 2007; Du et al. 2008).

There is some indication that child comfort, and/or parental perception of child comfort, might play a role in choice of restraint type and/or correctness of use (Bilston et al. 2011; Pettersson and Osvalder 2005; Simpson et al. 2002). A number of studies have suggested that comfort is deemed important by the children using the restraint, with children preferring restraints that are
comfortable for them (Bohman et al. 2007; Osvalder et al. 2013; Pettersson and Osvalder 2005). Bingham et al. (2006) reported that parental perception of increased comfort also motivated parents to choose boosters for their children rather than adult belts. In contrast, others have found perceived discomfort in booster seats to be a reason parents prematurely transition their children to adult seat belts (Charlton et al. 2006; Simpson et al. 2002). Discomfort has also been suggested as a reason for incorrect use (Klinich et al. 1994; Osvalder et al. 2013). Bohman et al. (2007) found that poor restraint fit caused discomfort in children, and the avoidance of discomfort resulted in severe misuse of restraints. However, these studies have largely focussed on qualitatively exploring reasons why children use different sorts of restraints and none directly examine the relationship between reported comfort and observed restraint use.

The complexity of restraints is cited as being an important contributing factor to incorrect use (Brown and Bilston 2012; Pettersson and Osvalder 2005; Simpson et al. 2002). A dedicated child restraint system is more complex than a conventional adult seat belt as a child restraint requires installation and involves more steps to secure child than an adult seat belt (Brown et al. 2010a, 2010b). These extra steps provide much greater opportunity for error. Convertible child restraints are designed to be converted from one type of restraint to another type as the child grows (e.g. a rear facing to a forward facing restraint) and therefore are more complex than restraint systems designed to be used in only one mode. Previous research has shown convertible restraints are more often used incorrectly than single mode designs (Brown et al. 2010b).

Demographic factors associated with incorrect use centre around socioeconomic issues. Children of low income households have been found to be at greater risk of restraint misuse (Bilston et al. 2011; Brown et al. 2013; Simpson et al. 2006) and, in large families, the cost of multiple
restraints is an issue (Bingham et al. 2006; Simpson et al. 2002). Bilston et al. (2011) found the risk of misuse in rear-facing, forward-facing and booster restraints was higher among children from low income families. In Australia where English is the dominant language, children from non-English speaking backgrounds have also been reported to be at an increased risk of restraint misuse than those from English speaking families (Bilston et al. 2011; Brown et al. 2013; Edwards et al. 2006).

Similar demographic factors have been implicated in inappropriate restraint choice. Parental education level, non-English speaking backgrounds and large family size have been highlighted as risk factors for not using appropriate restraints in Australia (Bilston et al. 2008; Brown et al. 2013; Edwards et al. 2006). In the US, children of Hispanic and African American backgrounds were found to be less likely to be using a child restraint, with the differences in restraint usage rates widening as children get older (NHTSA 2013). This is consistent with the socioeconomic predictors of suboptimal restraint use seen in Australian families.

To qualitatively study the association between comfort and suboptimal restraint practices, these known restraint design and family demographic factors need to be taken into account. This study therefore aims to investigate the relationships between parental report of child restraint system comfort and observed restraint misuse and/or inappropriate restraint choice while controlling for known confounders such as restraint type and family demographics.

METHODS

This analysis uses data collected during a 2008 cross-sectional population representative observational study of child restraint practices among children aged 0-12 years across NSW, see Brown et al. (2010a) for more details. Briefly, children aged 0-12 arriving in vehicles at
randomly selected early childhood health clinics, pre-schools, day care centres and primary schools within randomly selected local government areas (LGAs) across NSW were observed in their restraints within the vehicle they were travelling in. This study was approved by the University of New South Wales' Human Research Ethics Committee.

Four strata, metropolitan, metropolitan fringe, regional and rural, were constructed from LGAs based on geographical location, socioeconomic characteristics and accessibility of services. LGAs with less than 0.5% of the NSW population were excluded for efficiency. Probability proportional to size sampling was used to distribute LGAs across strata and simple random sampling was then used to select individual LGAs from each stratum using Australian Bureau of Statistics (ABS) 2001 census-based end of year populations estimates for each LGA. There was a 37% non-participation rate.

Trained researchers made in situ observations of the child within the restraint system as the vehicle arrived at the observation site and then undertook a detailed examination of the installation of the restraint, and conducted a structured interview with the driver. The structured interview collected demographic information including education level, household income, language spoken at home and questions relating to the use of child restraints. Only one child per vehicle was selected for observation. In vehicles that contained more than one child, the child who had the most recent birthday was chosen.

All analysis was performed using SAS Version 9.4 (SAS Institute, 2013). Variables used in the analysis were either taken or derived from the structured interview or from observation. Table 1 describes the sources and coding of variables used. The variable of interest was parent reported comfort obtained by asking the parent to respond to the statement “my child finds the restraint
he/she is using today uncomfortable.” Cases missing responses to this question were excluded from the analysis and because of this population weights were not applied in this analysis. The dataset therefore represents a convenience sample, and all analyses were conducted on unweighted data.

The two outcome variables investigated were child restraint misuse and the use of age appropriate child restraints. Incorrect use was defined as any observed errors in the installation, adjustment or use of the child restraint. Examples of observed errors in use include; sash guide not used, seatbelt twisted, seatbelt worn across/under arm/behind back, seatbelt/harness slack. Examples of installation errors include: top tether loose/not used, dangerous seatbelt routing, gated buckle incorrectly/not used, incorrect seatbelt routing See Brown et al. (2010b) for more details. Appropriate restraint use was defined using definitions of age-appropriate restraint use contained in current Australian legislation, see Table 2.

The SAS SURVEYLOGISTIC procedure was used to examine the association between parent reported comfort and the two outcome measures while accounting for the complex sample design. Two models were constructed.

Model 1: Incorrect Use, examined the relationship between reported comfort problems and incorrect use of child restraints. As known demographic confounders for incorrect use, parental education level, household income and language spoken at home were forced into the model. Similarly, a variable describing whether the restraint was a convertible restraint was also forced into the model. Restraint type and age of child were not included in the model due to co-linearity between these variables and the convertible restraint variable.
Model 2: Age Appropriate Use, examined the relationship between reported comfort problems and the use of age appropriate child restraints. Education level, household income and language spoken at home were also included as covariates in this model. As rates of inappropriate use have been reported to be different in child restraints and in adult belts, restraint type defined as either a seat belt or child restraint was also forced into the model. Age of child is strongly correlated with restraint type and for this reason age was not included in this model.

Subgroup analysis was also performed to examine the differences between children aged 0-7 and children aged over 7, as there was a higher rate of convertible child restraint use among children aged 0-7 and a higher rate of seat belt use among children above age 7. The subgroup analysis was used to explore any potential difference in effect between these two groups.

Odds ratios and 95% confidence intervals were calculated for all variables included in both models.

RESULTS

Observations were available for a total of 497 children aged between 0-12 years across the state of NSW.

Restraint misuse was observed in 59% of children. Age appropriate restraint use was observed in 80% of children while optimal (appropriate and correct) restraint use was recorded in only 30% of all cases. Comfort problems were reported in 12% of cases. Child restraints were more commonly used by children under the age of 6 (Figure 1). Incorrect use was more common among younger children but was observed in children of all ages (Figure 2), and in all restraint types. Parent reported comfort problems by child age are shown in Figure 3 and by restraint type is shown in Figure 4.
Cases with missing data for any variables were excluded from the logistic regression models. The dataset used for logistic regression therefore contained records for 383 children.

Logistic regression modelling outputs are presented in Table A1. For the whole sample in Model 1: Incorrect Use, there was no significant association between parent reported comfort and incorrect restraint use. However, there was an increase in incorrect use with the convertible restraints independent of reported comfort (OR 12.46 95% CI 6.20-25.05). There were no significant associations between any other variable included in the model and incorrect use of child restraints.

In the sub-group analysis of children aged 0-7 years, there was a non-significant trend of a decreased likelihood of incorrect use of child restraints when parents reported their child as being comfortable. For children aged 7 and younger, there was a significant increase chance of misuse with the use of convertible restraints (OR 9.03 95% CI 4.41-18.489). In the older than 7 age group no significant associations were observed.

No significant association between reported comfort and the use of age appropriate restraints was observed for Model 2. There was also significant increase in age appropriate restraint use when a child restraint was used, regardless of reported comfort (OR 3.93 95% CI 2.30-6.71). In the sub-group analysis a similar significant increase in age appropriate restraint use when a child restraint was used for children ≤ 7 years (OR 14.01 95% CI 7.51 -- 26.13). However, we were unable to run an analysis for children older than 7 as there was only one case of age inappropriate restraint usage.

**DISCUSSION**
This study is the first quantitative analysis of the effect of parental reported comfort on observed incorrect and inappropriate use of child restraint systems. The key findings are that parent perceptions of comfort of children in child restraints do not appear to be associated with incorrect child restraint use, or age appropriate restraint choice. These findings may help to rule out parent concerns about child comfort as a factor in incorrect restraint use or selection.

**Comfort and Incorrect Use**

From the literature, it is expected that parent perceived *discomfort* might be associated with incorrect use. It may be that child discomfort is a factor in incorrect use but parental perception of child comfort is a poor indicator of the actual comfort of the child. Currently, there is no literature examining the relationship between parent perception of child comfort in child restraints, and the actual comfort of the child. In fact there are few studies in the literature examining comfort experienced by children in child restraint systems and the influence this might have on misuse. One study (Osvalder et al. 2013), examined the subjective comfort experienced by a small sample of children using different forms of booster seats while being driven in a vehicle. The observations made in that study suggest a potential interaction between comfort and the seated posture adopted by a child using a booster seat, but the authors did not examine a link between comfort and incorrect use. Therefore there may be a relationship between the actual comfort of children and incorrect use; however this remains untested.

Currently there have only been a few studies that have attempted to measure comfort in children. These include focus groups of children and parents together (Pettersson and Osvalder 2005; Simpson et al. 2002) as well as separately (Simpson et al. 2002), but details of these focus group discussions are scant. Children have been observed in their restraints (Andersson et al. 2010;
Forman et al. 2011; Osvalder and Bohman 2008; Osvalder et al. 2013; Pettersson and Osvalder 2005) but these studies have not objectively quantified comfort levels. It is important to develop methods to quantify comfort levels in children in order to better understand the relationship between comfort and restraint choice and misuse. While it may be possible to simply ask older children directly about their comfort or discomfort, this may be more difficult with younger children with limited language skills.

Previous research has suggested that parent perceived comfort may play a role in correctness of restraint use (Bilston et al. 2011; Pettersson and Osvalder 2005; Simpson et al. 2002), however, we did not find a statistically significant association between parent perceived comfort and observed errors in use. This might be because there is actually no association between perception of comfort and correctness of use, or it may be we did not have enough statistical power to detect this in this sample. Parental perceived comfort theoretically may be a factor in how a parent secures a child within a restraint if parents ‘adjust’ restraints to increase child comfort. In turn, this might lead to both the parent’s assurance the child was comfortable and the introduction of errors into the way the restraint was being used. This could be tested by examining the types of errors occurring when parents report their children are comfortable in restraints that are being used incorrectly. We checked whether the result would be different if we used only restraint adjustment errors e.g. sash guide not used, seatbelt twisted, seatbelt worn across/under arm/behind back, seatbelt/harness slack, or only installation errors e.g. top tether loose/not used, dangerous seatbelt routing, gated buckle incorrectly/not used, incorrect seatbelt routing as the outcome. No significant relationships were observed between parental reported comfort and
either use errors or installation errors., but again this may be due to low power in this current analysis and should be confirmed in a larger sample.

**Comfort and Appropriate Use**

The fact that we saw no association between parent reported comfort and appropriate restraint use was even more surprising than our observations about incorrect/correct use given comfort has often been reported as a barrier to appropriate restraint in qualitative and descriptive studies (Bohman et al. 2007; Charlton et al. 2006; Pettersson and Osvalder 2005; Simpson et al. 2002).

With the high levels of age appropriate restraint use within this sample it is likely that there are few comfort problems to be reported as children in the appropriate restraint should be relatively comfortable. The significant association between age appropriate restraint use and the use of child restraints is expected within this sample as the majority of the targeted age range is recommended to be using a child restraint or booster seat.

**Limitations**

There are a number of limitations that must be kept in mind when reviewing these results. This analysis uses a dataset collected to characterise restraint use among children aged 0-12 in NSW (Bilston et al. 2011; Brown et al. 2010a). While the existence of this data provides an opportunity for the first attempt to quantitatively examine associations between appropriate and correct use of restraints, and parental report of comfort, the dataset was not designed for this purpose. Therefore the sample may be underpowered to detect significant differences. The dataset also represents a convenience sample. Therefore the results cannot be generalised to the greater population. For these reasons replication of this work in other populations is suggested. This study used the current Australian legislation to define appropriate restraint, and therefore this
represents a minimum acceptable level of appropriate use and does not accurately reflect best practice guidelines. This possibly explains the high rate of appropriate restraint found in this sample. A further potential limitation is that the sensitivity and validity of methods used to measure parental perception of child comfort is unknown. Currently, to the authors’ knowledge, there is no validated method for precise measurement of parental perception of child comfort and devising such a measure would be useful for future studies.

This study shows that parental reported comfort problems in child restraint systems do not appear to be predictive of age appropriate child restraint choice. Existing literature indicates the comfort of a restraint is important for the child (Osvalder and Bohman 2008; Pettersson and Osvalder 2005; Simpson et al. 2002) and the parent (Bilston et al. 2011; Osvalder and Bohman 2008; Simpson et al. 2002). The way actual child comfort is measured needs to be refined in order to better understand the effects of comfort in child restraints and, the development of a quantitative measure should be a high priority. Furthermore, there is a need to closely examine the comfort of parents in installing and adjusting child restraints as their comfort and confidence is equally important.

ACKNOWLEDGEMENTS

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REFERENCES


Charlton JL, Wales NS, Authority MA. *Factors that Influence Children’s Booster Seat Use*. Monash University Accident Research Centre; 2006.


Table 1: Sources and coding for variable used in analysis

<table>
<thead>
<tr>
<th>Variable</th>
<th>Source</th>
<th>Coding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comfort Problem</td>
<td>Survey - Is comfort reported to be a problem</td>
<td>0 = No&lt;br&gt;1 = Yes</td>
</tr>
<tr>
<td>Appropriate Age</td>
<td>Observation + Survey - Is the restraint appropriate to the age of the child. Rearward facing restraints can be used up to age 1, forward facing restraints from 6 months until age 7, boosters from age 4 upwards</td>
<td>1 = Yes&lt;br&gt;2 = No</td>
</tr>
<tr>
<td>Education</td>
<td>Survey - The highest level of education attained by the parent/guardian interviewed</td>
<td>1 = Secondary or Lower&lt;br&gt;2 = Tertiary Education</td>
</tr>
<tr>
<td>Income</td>
<td>Survey - Household income</td>
<td>1 = &lt; $50,000&lt;br&gt;2 = $50,000-100,000&lt;br&gt;3 = &gt;$100,000</td>
</tr>
<tr>
<td>Language At Home</td>
<td>Survey - Language spoken at home</td>
<td>1 = English&lt;br&gt;2 = Other</td>
</tr>
<tr>
<td>Misuse</td>
<td>Observation - was child restraint misuse observed</td>
<td>0 = No&lt;br&gt;1 = Yes</td>
</tr>
<tr>
<td>Convertible</td>
<td>Observation - was a convertible restraint used</td>
<td>0 = No&lt;br&gt;1 = Yes</td>
</tr>
<tr>
<td>Restraint Type</td>
<td>Observation - type of restraint in use</td>
<td>0 = Seatbelt&lt;br&gt;1 = Restraint</td>
</tr>
</tbody>
</table>
Table 2: Definition of age appropriate restraint use according to Australian legislation

<table>
<thead>
<tr>
<th>Age</th>
<th>Restraint Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-6 months</td>
<td>Capsule or Rear Facing restraint</td>
</tr>
<tr>
<td>6 months - 4 years</td>
<td>Rear or Forward Facing restraint with built-in harness</td>
</tr>
<tr>
<td>4-7 years</td>
<td>Booster seat</td>
</tr>
<tr>
<td>8-12 years</td>
<td>Seat belt</td>
</tr>
</tbody>
</table>
Figure 1: Restraint type compared to child age
Figure 2: Occurrence of misuse compared to child age
Figure 3: Reported comfort problems compared to age
Figure 4: Detailed restraint type vs Reported comfort problems