ORIGINAL ARTICLE

Are restrained children under 15 years of age in cars as effectively protected as adults?

E Javouhey, A-C Guérin, B Gadegbeku, M Chiron, D Floret

Arch Dis Child 2006;**91**:304–308. doi: 10.1136/adc.2005.084756

See end of article for authors' affiliations

Correspondence to: Dr E Javouhey, Inrets (UMRESTTE), 25 avenue François Mitterrand, case 24, 69675 BRON Cedex, France; etienne.javouhey@inrets.fr; etienne.javouhey@chu-lyon.fr

Accepted 2 December 2005
Published Online First 11 January 2006

Aim: To compare the injury distribution between children and adults, injured as restrained car passengers.
Methods: Population based study of data from a French road trauma registry in 1996–2002. Children under 15 years old were compared with adult casualties according to the distribution of serious injuries in three distinct body regions (head, chest, and abdomen) when they were restrained car passengers. A multivariate logistic regression was performed to quantify the risk of AIS2+ injury (Abbreviated Injury Scale of 2 or more).
Results: Among the 7568 casualties who were injured as restrained car passengers in car accidents, 1033 were less than 15 years old. Overall, 35.4% of children and 25.2% of adults were unrestrained. For children and adults, the risk of fatality was significantly reduced when they were restrained, but the percentages of children with Injury Severity Score (ISS) $\geqslant$16, were not significantly different between restrained and not restrained casualties. Compared to adults, restrained children aged 5–9 were 2.7 times (OR 2.74; 95% CI 1.17 to 6.43) as likely to sustain an AIS2+ abdominal injury, and tended to be more at risk of AIS2+ head injuries, but were less at risk of AIS2+ chest injuries.
Conclusions: Children aged 5–9 years injured in road accidents as restrained car passengers were more likely to sustain an AIS2+ abdominal injury than adults. This emphasises the need to reinforce educational campaigns aimed not only at getting children into restraint systems, but also insisting on their correct use.

Children younger than 15 years old involved in a car accident are usually passengers. Their safety is the responsibility of adult drivers. Moreover, children are spending more and more time in the car, resulting in an increasing exposure to the risk of a road accident.[1] The effectiveness of seatbelts in reducing overall injury severity and fatality has been already well demonstrated, even for children of school age.[2 3] However, the premature use of seatbelts for children between 4 and 10 years as well as the use of lap belts is not recommended.[4] Since suitable child safety seats (CSS) are proven to be effective in protecting children in cars,[5–7] many countries have made their use compulsory. In France, the use of age appropriate CSS has been compulsory since 1992 for all child car passengers up until the age of 10. However, these recommendations are poorly respected.[8] Moreover, misuse of these CSS is frequent.[9] The use of CSS is insufficiently checked and little data is known concerning their correct use. Seatbelts can lead to certain specific injuries, like the seatbelt syndrome, when use of the seatbelt is premature and when it is out of position.[10 11] A better knowledge of paediatric particularities in injury patterns, as a better understanding of injury mechanisms, would allow emergency medical staff to provide the most appropriate emergency care. It could lead to a specific prevention programme targeting the safety of children in cars and promoting the improvement of car design with them in mind.[1] This study was undertaken to determine whether children under 15 years of age are as effectively protected as adults when they are restrained car passengers.

METHODS

Data collection

A road trauma registry in the Rhône region of France (population 1.5 million inhabitants; main city, Lyon) has been in use since January 1995.[12] Data collection is based on the participation of all medical units involved in the health care of crash victims in the Rhône region and its close surroundings (201 units).

To avoid losing ''dead at the scene'' cases, mortuaries and forensic institutes are also included. Any person injured in a road accident which occurred within the Rhône region is included. Casualties are defined as persons sustaining at least one injury of a severity level of 1 or more according to the 1990 revision of the Abbreviated Injury Scale (AIS).[13] The information collected by the registry consists of the casualty's characteristics, the accident's characteristics, the medical injury description, and the injured person's subsequent progress. After the data are cross checked from one source to another, they are coded by a physician. The registry is approved for ethical and scientific aspects by the French ''Comité National des Registres''.

Study design and variables definition

All car passengers casualties between 1996 and 2002 were recorded by the registry. Children under 15 years old were compared with adults, according to their injury pattern, the circumstances of the accident (date, time, location, light condition), and their restraint use (seat belt, CSS). Before 2000, the seatbelt and CSS were not distinguished. Information relative to CSS was available for only 126 children. Among these, 85 were in a CSS and sustained only 40 (including 11 AIS2+) head injuries, four (one AIS2+) chest injuries, and four (two AIS2+) abdominal injuries, making it impossible to perform such a subgroup analysis. For that reason, car passengers were considered restrained if they used a seatbelt or a CSS, and unrestrained if not. The restraint status of children and adults was determined from emergency care physicians.

For children, three subgroups of age were defined as 0–4, 5–9, and 10–14 years, because current recommendations for age appropriate restraint and/or seating position vary according to these age groups. They were compared with patients aged over 15 years (15+), called ''adults''.

Injuries were classified according to the AIS. Injuries with an AIS score of 2 or greater (AIS2+) were called ‘‘AIS2+ injuries’’. The overall injury severity was assessed using the Injury Severity Score (ISS) which is the sum of the squares of the highest code in each of the three most severely injured ISS body regions for each casualty.[14] A severe trauma was defined as an ISS of 16 and over. Only thoracic, brain, abdominal, and spinal injuries were examined, because those injuries were more likely to lead to critical conditions and/or to severe disabilities.

Statistical analysis

Incidence rates were calculated using as numerator all car passenger casualties (including 82% Rhône residents) and as denominator the resident population, estimated by the 1999 census. Bivariate associations between variables were assessed by χ^2 tests (or Fisher exact test when relevant) at the 5% threshold. In order to take the seating location and the accident severity into account, we used a multivariate logistic regression analysis to quantify the independent association of each factor with the risk of AIS2+ injury. Results of logistic regression modelling are expressed as adjusted odds ratios (OR) with corresponding 95% confidence intervals (CI). Interactions between age and seat location, gender and seat location, as well as between date and time of accident were tested using the Wald χ^2 test, and were not found to be significant. All the analyses were performed with SAS software.

RESULTS

A total of 12 700 car passenger casualties were included in the registry during the 1996–2002 study period. The corresponding annual incidence was 120 per 100 000 population. The under 15 years olds accounted for 1915 casualties (15.1%), and were compared with 10 785 adults. Data relative to the use of a restraint system were available for 8739 adults and 1599 children. Overall, 35.4% of children and 25.2% of adults injured in a road accident as car passengers were unrestrained ($p < 0.0001$). The highest rate of unrestrained car passengers was observed in the 5–9 years group (37.9% *v* 34.0% for other children, NS). However, 73% of adults injured as car passengers were located in the front seat, compared to children who were mainly rear passengers (77%). Compared to 38% of children (390), 53.4% of adults (992) injured as rear passengers were unrestrained ($p < 0.001$). On the contrary, 21.5% of children (68) injured as front passengers were unrestrained compared to 15.6% of adults (817, $p < 0.01$).

The respective odds ratios of severe trauma among survivors, and of fatality were calculated for those casualties with complete information on the restraint system (table 1). We failed to demonstrate a significant protective effect of a restraint system on overall injury severity for surviving children (table 1). However, for both categories of age, the risk of fatality was significantly reduced when a restraint system was used.

The rates of injuries in the four body regions (head, chest, abdomen, and spine) were compared between children and adults (table 2).

When they were injured in a road accident as restrained car passengers, children were more likely to experience a head or an abdominal injury than adults. On the contrary, they were less likely to sustain a chest or a spine injury. Children had also significantly less AIS2+ chest injuries than adults (1.74% *v* 5.69%), but they sustained significantly more AIS2+ abdominal injuries than adults (1.74% *v* 0.84%). Concerning head injuries, a significant difference between children and adults was only observed for AIS3+ injuries (1.84% *v* 0.87%). Whether those differences are associated with the seating location was then studied. Even though the percentages of AIS2+ head injuries were similar between children and adults injured as rear car passengers (almost 6%), children tended to be more likely AIS2+ brain injured than adults when they were injured as front car passengers (8.4% *v* 5.3%, $p = 0.03$). Since it was demonstrated that the seating location has a significant effect on the injury of car passengers, we adjusted the multivariate analysis for seating location (table 3). The location, the date (school day or not), and the time (night or daytime) of the accident were taken into account in this analysis, since those characteristics are proxy variables of the accident severity.

Compared to adults, children between 5 and 9 years were 2.7 times as likely to sustain an AIS2+ abdominal injury (table 3). Whereas AIS2+ chest injuries were more likely to be sustained by adults than children, AIS2+ head injuries tended to be more frequent in children. Females were more at risk than males to experience an AIS2+ chest injury but were less at risk than males to have an AIS2+ head injury. The rear position was associated with a lower risk of AIS2+ chest injury. For the three body regions examined, accidents that occurred on non-urban roads were associated with a higher risk of AIS2+ injury, whereas those occurring at night were associated with a higher risk of AIS2+ head injury.

In the univariate matched pair analysis, comparing 248 children to 250 adults injured in the same accidents, the odds ratios were 1.05 (95% CI 0.47 to 2.35), 0.18 (95% CI 0.05 to 0.61), and 2.22 (95% CI 0.65 to 7.63) respectively for AIS2+ head, chest, and abdominal injuries.

DISCUSSION

The first finding of our study is that children injured as car passengers were more likely to be unrestrained than adults, particularly those aged 5–9 years. Similar findings have already been described so that safety advocates call now this group the ‘‘forgotten child’’.[5 15 16] The protective effect of restraint system on fatality is confirmed in our study in adults as well as in children. However, we failed to demonstrate for children a significant protective effect of restraint system on the overall severity (ISS16+). Hoffman *et al* in 1987 also found that the ISS were not significantly different between restrained and unrestrained children.[17] Apart from a weak statistical power due to the sample size,

Table 1 Protective effect of restraint system for adult and child car passengers; odds ratios and 95% CI of severe trauma and fatality

	Survivors ISS 16+	OR	95% CI	Fatalities	OR	95% CI
Restrained children* (n = 1033)	14	1.00		2	1.00	
Unrestrained children (n = 566)	6	1.26	0.45 to 3.72	6	5.52	1.01 to 39.64
Restrained adults (n = 6535)	80	1.00		30	1.00	
Unrestrained adults (n = 2204)	54	2.04	1.42 to 2.93	27	2.69	1.55 to 4.67

*Among the 85 child car passengers restrained in a child safety seat, there was no fatality and no child with severe trauma.

Table 2 Distribution of injuries by body region among children versus adults injured as car passengers in a road accident*

	Restrained car passengers			Unrestrained car passengers		
	Children (n = 1033)	Adults (n = 6535)	p value†	Children (n = 566)	Adults (n = 2204)	p value†
Head	263 (25.46)	1069 (16.36)	<0.0001	176 (31.1)	672 (30.05)	NS
Chest	150 (14.52)	1916 (29.32)	<0.0001	36 (6.36)	359 (16.29)	<0.0001
Abdomen	93 (9.00)	390 (5.97)	<0.0001	27 (4.77)	118 (5.35)	NS
Spine	155 (15.00)	2260 (34.58)	<0.0001	57 (10.07)	554 (25.14)	<0.0001

NS, not significant.
*Data are presented as numbers and percentages in brackets. Subjects may have sustained injuries to more than one body region.
†p values were calculated based on the null hypothesis of no difference between children under 15 years versus adults.

the most likely explanation of this result is that the non-injured subjects involved in car accidents were not included in the registry. It results in an underestimation of the protective effect of seatbelts or restraints.

The comparison of the injury distribution between restrained children and adults involved in car accidents showed that children less than 15 years old were more likely to suffer a head or an abdominal injury, but less likely to be injured to the chest or the spine. However, most of these injuries were slight so we focused our multivariate analysis on injuries with an AIS severity of 2 or more. Children aged 5–9 were more at risk than adults of sustaining an AIS2+ abdominal injury. However, children under 15 were less likely to sustain chest injuries than adults. Children were not significantly more seriously injured to the head than adults in this logistic regression model, but children were more likely to experience an AIS 3+ head injury than adults in univariate analysis. Nance *et al* found a higher rate of abdominal injuries in children aged 4–8.[18] Moreover children in this age group had the lowest optimal restraint use. There were no reported abdominal injuries among the optimally restrained children—that is, using the belt-positioning booster seats. Agran *et al* previously described the same findings in 191 children less than 15 years restrained with seatbelt and in 131 children aged 4–9 years.[19] One recent study based on automobile insurance data found that, compared with children between 2 and 5 years old using CSS, children using seatbelts were 3.5 times more likely to have a significant injury and 4.2 times more likely to have significant head trauma.[15] The most likely explanation of the higher risk of serious abdominal injuries in children aged 5–9 is an inappropriate use of seatbelts. Recent studies have demonstrated that belt positioning booster seats reduced the risk of injuries in children aged 4–7 years.[5 9] Lap belts used without shoulder belts can lead to severe traumatic brain, abdominal, and spinal injuries.[8] Without a booster seat the lap belt does not fit low on the hips and is not held in place by the anterior superior iliac spines. Consequently the lap portion of the belt rides up over the soft abdomen and the shoulder portion crosses the neck or face. As children are uncomfortable in this situation, most place the shoulder belt behind them, resulting in the same situation of lap belt only, or under their arm, leading to an increased pressure on the upper part of the abdomen.

Another main finding of our study is the lower risk of serious chest injuries in restrained children compared with adults, and particularly females. It is well recognised that the chest wall of children is more compliant than adults, resulting in less rib fractures.[20] For children, the harnesses of CSS may protect them from more severe chest injuries. This could explain the lowest rate of serious chest injuries observed in restrained children less than 5 years of age who have to be seated in CSS with harnesses.

The tendency of a higher rate of AIS2+ head injuries in restrained children less than 10 years of age would be interesting to investigate. Whether is it due to the young age

Table 3 Multivariate analysis of the risk factors of AIS2+ injury to the head, chest, and abdomen in 7568 restrained car passengers injured in a road accident (adjusted odds ratios and 95% CI)

Variables (n)	AIS2+ head injury (n = 418)	AIS2+ chest injury (n = 390)	AIS2+ abdominal and/or pelvic injury (n = 73)
Age group			
0–4 years (272)	1.39 (0.83 to 2.34)	**0.24 (0.08 to 0.78)**	1.39 (0.40 to 4.84)
5–9 years (352)	1.38 (0.87 to 2.18)	**0.30 (0.12 to 0.74)**	**2.75 (1.17 to 6.46)**
10–14 years (409)	1.10 (0.71 to 1.71)	**0.48 (0.25 to 0.91)**	2.16 (0.95 to 4.89)
15 and more (6535)	1.0	1.0	1.0
Gender			
Female (4963)	**0.75 (0.61 to 0.92)**	**1.56 (1.23 to 1.99)**	1.18 (0.71 to 1.94)
Male (2605)	1.0	1.0	1.0
Seat location			
Rear (1500)	0.94 (0.71 to 1.25)	**0.70 (0.51 to 0.98)**	1.02 (0.54 to 1.95)
Unknown (1381)	0.95 (0.73 to 1.24)	0.79 (0.59 to 1.04)	1.02 (0.54 to 1.93)
Front (4687)	1.0	1.0	1.0
Road type			
Non-urban road (2283)	**1.52 (1.23 to 1.89)**	**1.62 (1.30 to 2.02)**	**2.08 (1.26 to 3.44)**
Other (1530)	0.90 (0.67 to 1.21)	0.86 (0.63 to 1.17)	0.93 (0.44 to 1.95)
Urban road (3755)	1.0	1.0	1.0
Time of accident			
Night (1878)	**1.58 (1.26 to 1.98)**	0.94 (0.73 to 1.20)	1.28 (0.75 to 2.20)
Unknown (1649)	0.98 (0.74 to 1.30)	0.80 (0.60 to 1.07)	1.01 (0.53 to 1.94)
Daytime (4041)	1.0	1.0	1.0
Date of accident			
Non-school days (5212)	0.96 (0.78 to 1.19)	0.85 (0.69 to 1.06	0.93 (0.56 to 1.53)
School days (2356)	1.0	1.0	1.0

What is already known on this topic

- Child safety seats provide a better protective effect than seatbelts alone
- Many children are still not restrained in cars and misuse of child safety seats is frequent

What this study adds

- Children injured as car passengers are more frequently unrestrained than adults
- Restrained child car passengers aged 5–9 years are 2.7 times as likely to sustain a serious abdominal injury than adults

or to the restraint system used requires further study.[21] This question is crucial because head injuries are the leading cause of long term disabilities resulting from road accidents.

Limitations

Several limitations in the interpretation of our results must be considered. The Rhône Registry is based on medical reports. The injury description may be incomplete. However, most of the seriously injured subjects are hospitalised and consequently most of them have several registry records resulting in better data accuracy. Only injured subjects are included in this registry, which may lead to an underestimation of the protective effect of seatbelts or restraint systems. Unfortunately, as we had no information on the type of restraint used, we cannot affirm that the higher risk of abdominal injuries is due to a misuse of seatbelts or a lack of booster seats. Moreover, there is no published study in France about the frequency of misuse and about the rate of booster seat use. The determination of the restrained status is based on the registry records, and information is obtained either by parents or witness reports or by emergency medical services reports. Misclassifications cannot be excluded even though there is no reason to observe more misclassifications among children than among adults.

Whether our logistic regression models, using location and time of accident as proxy variables of severity, are correctly adjusted on accident severity is questionable. However, the matched pair analysis comparing children and adults injured in the same accident confirmed the odds ratio values. Nevertheless, these criteria are insufficient to explain the higher risk of AIS2+ head injury for males, which is likely to be due to a greater crash velocity.

Conclusions

Children aged 5–9 injured in a road accident as restrained car passengers were more likely to sustain an AIS2+ abdominal injury than adults. The most likely explanation is an improper use of the restraint system. This emphasises the need to reinforce educational campaigns aimed not only at getting children into restraint systems, but also insisting on their correct use. Such campaigns should be an integral part of any changes in car design and legislation.

ACKNOWLEDGEMENTS

The authors thank all the staff of the ARVAC (Association du Registre des Victimes d'Accidents de la Circulation), its president Professor V Banssillon, B Laumon, in charge of scientific aspects of the registry, and all those who participated in collecting and recording the data of the registry: Ait Idir T, Ait Si Selmi T, Alloatti D, Andrillat M, Artru F, Asencio Y, Assossou I, Auzaneau F, Bagès-Limoges F, Bagou G, Balogh C, Banssillon G, Barnier N, Barth X, Basset M, Bec JF, Bejui J, Bel JC, Bérard E, Bérard J, Bernard JC, Berthet N, Bertrand JC, Besson L, Biot B, Biot V, Blanc C, Blanchard J, Boeuf C, Boisson D, Bonjean M, Bost J, Bouchedor C, Bouletreau P, Boyer V, Breda Y, Bret P, Brilland R, Bussery S, Cabet N, Caillot JL, Cannamela A, Caregnato B, Carre M, Catala Y, Chagnon PY, Chantran C, Chardon P, Charnay P, Chatelain P, Chattard S, Chavane H, Chazot G, Chettouane I, Chevreton N, Chevrillon E, Chevrillon S, Chiron M, Chotel P, Cochard P, Combe C, Contamin B, Coppard E, Cot T, Crettenet Z, Cristini A, Dal Gobbo B, De Angelis MP, Decourt L, Delfosse A, Demazière J, Deruty R, Desjardins G, Dohin B, Emonet A, Escarment J, Eyssette M, Fallavier L, Fanton L, Felten D, Feuglet P, Fifis N, Figura J, Fisher G, Fischer LP, Floccard B, Floret D, Fournier G, Fredenucci JF, Freidel M, Gadegbeku B, Galin L, Gaillard P, Gallon M, Garnier N, Garzanti A, Gaussorgues P, Gautheron V, Genevrier M, Gibaud F, Gillet Y, Goubsky A, Granger M, Grattard P, Gueniaud PY, Guenot C, Guignand M, Haddak M, Hamel D, Heckel T, Jacquemard C, Joffre T, Kohler R, Lablanche C, Lafont S, Lagier C, Lapierre B, Laplace MC, La Rosa C, Laurent R, Lebel M, Leblay G, Le-Xuan I, Lieutaud T, Lille R, Linné M, Lucas R, Machin B, Maello E, Malicier D, Mangola B, Marduel YN, Marie-Catherine M, Martin JL, Martinand G, Marty F, Messikh C, Meyer F, Meyrand S, Molard S, Morel-Chevillet E, Mioulet E, Minjaud F, Mollet C, Monnet J, Moreno S, Moyen B, Ndiaye A, Neidhart JP, Ngandu E, Ny S, Ould T, Paget P, Paillot JC, Paris D, Patay B, Pauget P, Peillon D, Perrin-Blondeau D, Petit P, Piton JL, Plantier M, Pornon P, Pramayon C, Quelard B, Rezig M, Rigal F, Robert D, Rode G, Romanet JP, Rongieras F, Roset C, Rousson A, Roussouli P, Roux H, Ruhl C, Salamand J, Sametzky P, Sayegh K, Sbraire N, Scappaticci N, Schiele P, Schneider M, Simonet C, Sindou M, Soldner R, Soudain M, Stagnara J, Stamm D, Suc B, Taesch MC, Tasseau F, Tell L, Thomas M, Tilhet-Coartet S, Toukou JC, Trifot M, Vallet G, Vancuyck A, Vergnes I, Verney MP, Voiglio EJ, Vourey G, Vuillard J, Westphal M, Willemen L.

Authors' affiliations

E Javouhey, A-C Guérin, B Gadegbeku, M Chiron, D Floret, UMRESTTE (Epidemiological Research and Surveillance Unit in Transport, Occupation and Environment), Joint Unit of Inrets (French National Institute for Transport and Safety Research), University Claude Bernard Lyon 1, and InVS (National Institute for Public Health Surveillance), France

Funding: the Rhône road trauma registry is funded by the French Ministries for Research, Transport (DSCR), and Health (InVS, Inserm)

Competing interest: none

REFERENCES

1 **Roberts I**, DiGuiseppi C. Children in cars. *BMJ* 1997;**314**:392.
2 **Halman SI**, Chipman M, Parkin PC, *et al*. Are seatbelt restraints as effective in school age children as in adults? A prospective crash study. *BMJ* 2002;**324**:1123.
3 **Agran PF**, Castillo DN, Winn DG, *et al*. Comparison of motor vehicle occupant injuries in restrained and unrestrained 4- to 14-year-olds. *Accid Anal Prev* 1992;**24**:349–55.
4 **Ebel BE**, Koepsell TD, Bennett EE, *et al*. Too small for a seatbelt: predictors of booster seat use by child passengers. *Pediatrics* 2003;**111**:e323–7.
5 **Durbin DR**, Elliott MR, Winston FK, *et al*. Belt-positioning booster seats and reduction in risk of injury among children in vehicle crashes. *JAMA* 2003;**289**:2835–40.
6 **Durbin DR**, Chen I, Smith R, *et al*. Effects of seating position and appropriate restraint use on the risk of injury to children in motor vehicle crashes. *Pediatrics* 2005;**115**:e305–9.
7 **Arbogast KB**, Cornejo RA, Kallan MJ, *et al*. Injuries to children in forward facing child restraints. *Annu Proc Assoc Adv Automot Med* 2002;**46**:213–30.
8 **Durbin DR**, Arbogast KB, Moll EK. Seatbelt syndrome in children: a case report and review of the literature. *Pediatr Emerg Care* 2001;**17**:474–7.
9 **Ebel BE**, Koepsell TD, Bennett EE, *et al*. Use of child booster seats in motor vehicles following a community campaign: a controlled trial. *JAMA* 2003;**289**:879–84.
10 **Garrett JW**, Braunstein PW. The seatbelt syndrome. *J Trauma* 1962;**2**:220–38.
11 **Winston FK**, Durbin DR, Kallan MJ, *et al*. The danger of premature graduation to seatbelts for young children. *Pediatrics* 2000;**105**:1179–83.
12 **Laumon B**, Martin JL. [Analysis of biases in epidemiological knowledge of road accidents in France]. *Rev Epidemiol Sante Publique* 2002;**50**:277–85.
13 **AAAM**. *The abbreviated injury scale, 1990 revision*, Des Plaines, Il, 60018 USA, 1990:74.

14 **Baker SP**, O'Neill B, Haddon W Jr, *et al*. The injury severity score: a method for describing patients with multiple injuries and evaluating emergency care. *J Trauma* 1974;**14**:187–96.
15 **Agran PF**, Anderson CL, Winn DG, *et al*. Violators of a child passenger safety law. Recent trends in child restraint practices in the United States. *Pediatrics* 2004;**114**:109–15.
16 **Johnston C**, Rivara FP, Soderberg R, *et al*. Children in car crashes: analysis of data for injury and use of restraints. *Pediatrics* 1994;**93**:960–5.
17 **Hoffman MA**, Spence LJ, Wesson DE, *et al*. The pediatric passenger: trends in seatbelt use and injury patterns. *J Trauma* 1987;**27**:974–6.
18 **Nance ML**, Lutz N, Arbogast KB, *et al*. Optimal restraint reduces the risk of abdominal injury in children involved in motor vehicle crashes. *Ann Surg* 2004;**239**:127–31.
19 **Agran P**, Winn D, Dunkle D. Injuries among 4- to 9-year-old restrained motor vehicle occupants by seat location and crash impact site. *Am J Dis Child* 1989;**143**:1317–21.
20 **Bliss D**, Silen M. Pediatric thoracic trauma. *Crit Care Med* 2002;**30**:S409–15.
21 **Muszynski CA**, Yoganandan N, Pintar FA, *et al*. Risk of pediatric head injury after motor vehicle accidents. *J Neurosurg* 2005;**102**:374–9.