

Current situation of child occupant safety in German accidents

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Although the statistics show a decreasing rate of child injuries and fatalities in German road accidents more efforts can be made to protect children in cars e.g. by developing appropriate child restraint systems. An important part in of this work can be achieved with the help of crash tests using child dummies. However these crash tests cannot completely reflect the situation of real world crashes as factors like children moving out of the optimal position or children incorrectly fastened by their parents are difficult to predict. Therefore this study gives an overview over the current accident and injury situation of child occupants in cars in German road accidents.

German Federal Statistics

Based on the figures from the German Federal Statistics [3], Figure 1 shows the development of annual child fatalities due to traffic accidents from the year 1979 to the year 2007 comparing this to the development of fatalities of all ages in the same period. With a reduction from over 1200 fatalities in 1979 to 111 fatalities in 2007 the amount of child fatalities have not only drastically decreased over the last three decades but have also fallen at a much larger rate than all fatalities related to traffic accidents (11558 fatalities in 1979; 4949 fatalities in 2007). A great part of this improvement of child safety in traffic can be related to the situation of children in cars.

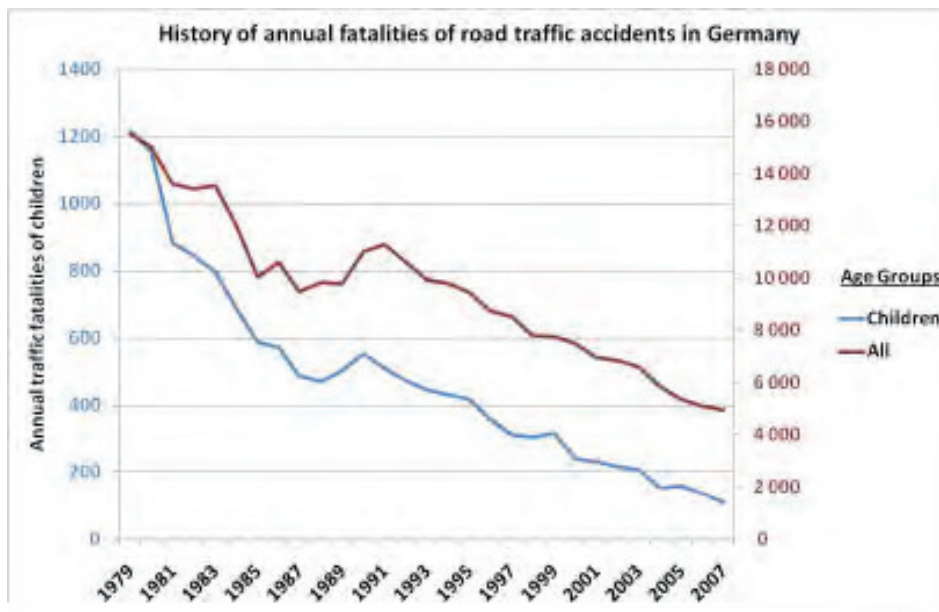


Figure 1: Traffic fatalities of children over the years compared to all fatalities.

When looking at children in cars (Figure 2), it is visible that there has also been a continuous decrease of severely injured children since the early 1990ies from over 3.400 children to 1.278 children in 2007.

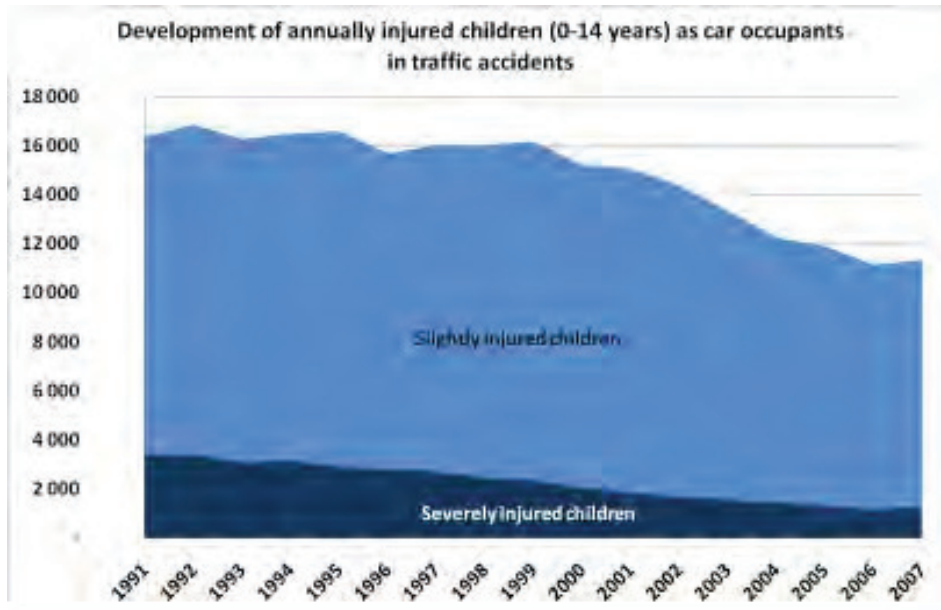


Figure 2: Development of annually inured children in cars since 1990.

The share of slightly injured children in cars however slightly rose from 1991 with 12.494 children to 2001 with 13.209 slight injured children in cars. Nonetheless after the year 2001 a significant decrease of the slightly injured children could also be noticed to 10.088 children in the year 2007.

Even though the development over the years of safety of children in cars has shown to be heading in a positive direction, there is always potential for further improvements. Therefore in this study the accident situation of real world accidents with children cars is analyzed using the data of the German In-Depth Accident Study GIDAS.

Sample of GIDAS cases for analysis

Within GIDAS extensive data on various fields of accidentology are collected on-scene from road traffic accidents with injuries in the Hannover and Dresden area. Using a well defined sample plan the collected data is highly representative to the whole German situation (Brühning et al [1], Otte et al [2]).

From the GIDAS database a sample of 10 years from July 1999 to July 2009 of accidents with children in cars is taken for analysis. This data pool includes 1410 children with less than 13 years of age as car occupants involved in traffic accidents with at least one injured accident participant. 648 of these children were known to have been restrained in a child restraint system and of 341 children the type of CRS concerning the classification into the groups from 0/0+ to group III is known. This subsample only includes cases, where no evidence was found, that the CRS or the children were incorrectly fastened. The three main types of CRS (according to the ECE 44 [4]) found in Germany are Infant carriers for babies up to 13 kg (Groups 0/0+), Child seats to fasten children weighing from 9kg to 18 kg mostly with a harness (Group I) and booster seats with an attached back rest including a seatbelt guidance or booster cushions for children weighing over 15 kg (Groups II) or over 22 kg (Group III). Table 1 shows the distribution of cases with children in CRS onto the different groups of CRS.

No. of Children		Type of CRS
32	Children in	CRS Group 0/0+
82	Children in	CRS Group I
203	Children in	CRS Group II-III / III
8	Children in	CRS Group 0-I
6	Children in	CRS Group I-III
10	Children in	Other Groups

Table 1: Distribution of cases on different groups of child restraint systems

Next to the common three groups mentioned first, some cases also include CRS types which cover multiple groups. Due to low case numbers of these cases they are not included in the analyses.

Accident Situation of cars with child occupants

Independently of the Group of CRS used, the distribution of the occurrence of different accident types [5] for accidents with children in cars is compared to all accidents with cars in Figure 3.

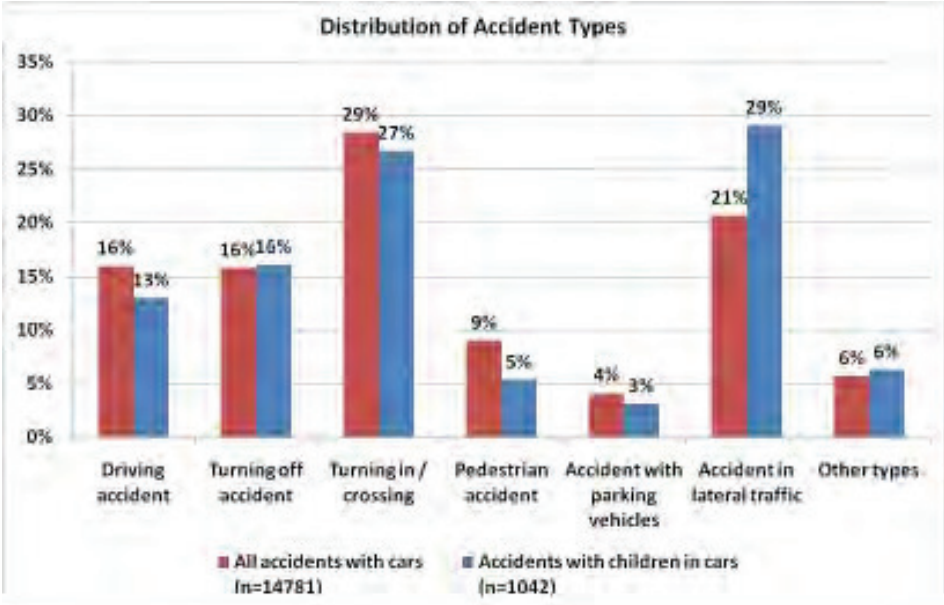


Figure 3: Distribution of accident types from accidents with children in cars compared to all accidents with cars.

While there are some visible differences of the frequencies in almost all accident types, the largest variance can be found at Pedestrian accidents (accidents with children in cars 5%; all car accidents 9%) as well as at Accidents in lateral traffic (accidents with children in cars 29%; all car accidents 21%). Accidents of cars with child occupants against pedestrians however are of little relevance for the child occupant safety. Therefore the most significant conclusion here is that accidents with children in cars show a significantly higher rate of lateral traffic accidents. This statement seems to be quite in line with the analysis displayed in Figure 4 where the type of road of accidents with children in cars is compared to all car accidents.

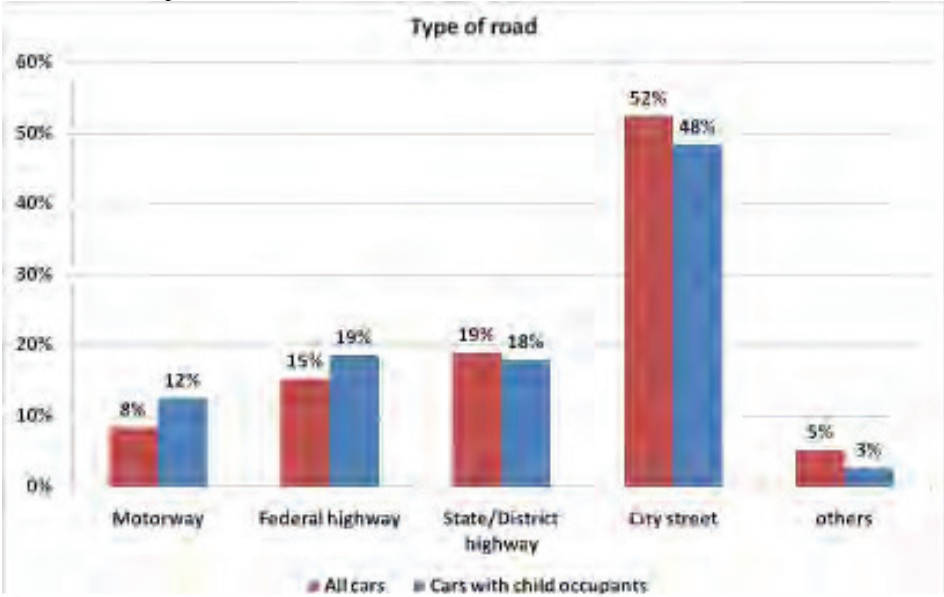


Figure 4: Type of road for accidents with cars with child occupants compared to all cars.

Both accidents with children in cars as well as all accidents with cars in about 50% of the cases happen on city streets. Unexpectedly accidents on motorways and on federal highways occur slightly more often in the group of accidents with children in cars than in the group with all car accidents: 12% of accidents with children in cars occur on motorways while only 8% of all car accidents happen on motorways. Furthermore some 19% of accidents with children in cars occur on Federal Highways while only 15% of all car accidents happen here. Accordingly accidents with children in cars happen less often on smaller roads such as state or district highways or city streets than all car accidents.

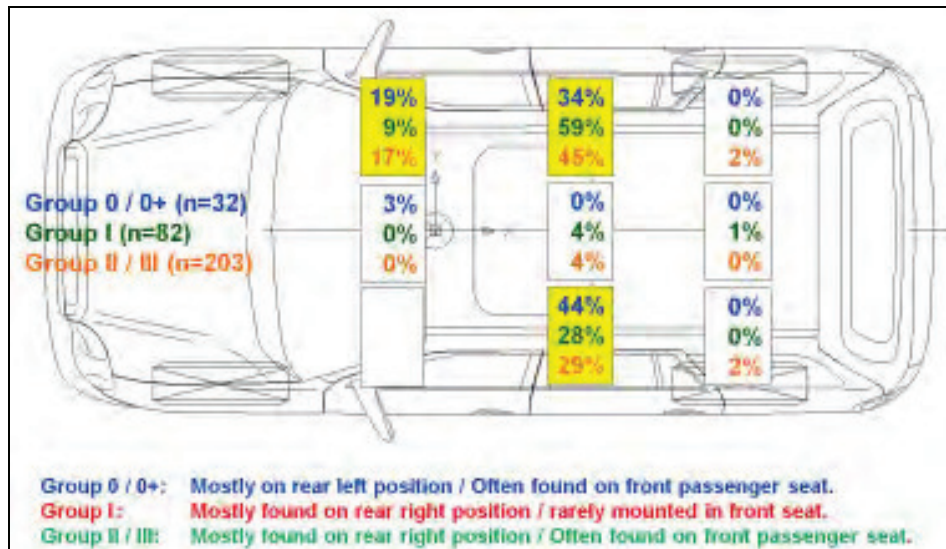


Figure 5: Distribution of child seating position in cars for different types of CRS.

Figure 5 displays the seating position of children in cars which had accidents. Here children in Group 0/0+ CRS are mostly found to be seated on the rear bench of the cars. Interestingly they are more often found to be seated behind the driver seat on the rear left position (in 44% of the cases) than behind the front passenger seat in the rear right position (in 34% of the cases). Furthermore the incidence of 22% children in Group 0/0+ CRS being seated on one of the front passenger seats (middle or right position) shows that babies are more often found to be seated in the front, next to the driver than children in other groups of CRS. Children that have come to use Group I CRS show a contrary placement to the babies in cars during accidents. Only 9% are found in the front passenger seats. Most of them are seated on the rear bench, however here they are twice as often found behind the front passenger seat in 59% cases than behind the driver's seat in only 28% of the cases. Elder children (using Group II/III CRS) again are often found on the front passenger seat (in 17% of the cases). When seated in the back seat elder children in Group II/III CRS are also significantly more often found behind the front passenger seat (45%) than behind the driver's seat (29%).

Injury outcome of children in cars at traffic accidents

The injury outcome of real world accidents is an adequate indicator of the child occupant safety situation. Figure 6 shows the shares of different injury severities (according to AIS [6]) uninjured (MAIS 0), slightly injured (MAIS 1) and more severely injured (MAIS 2+) for children in different groups of CRS.

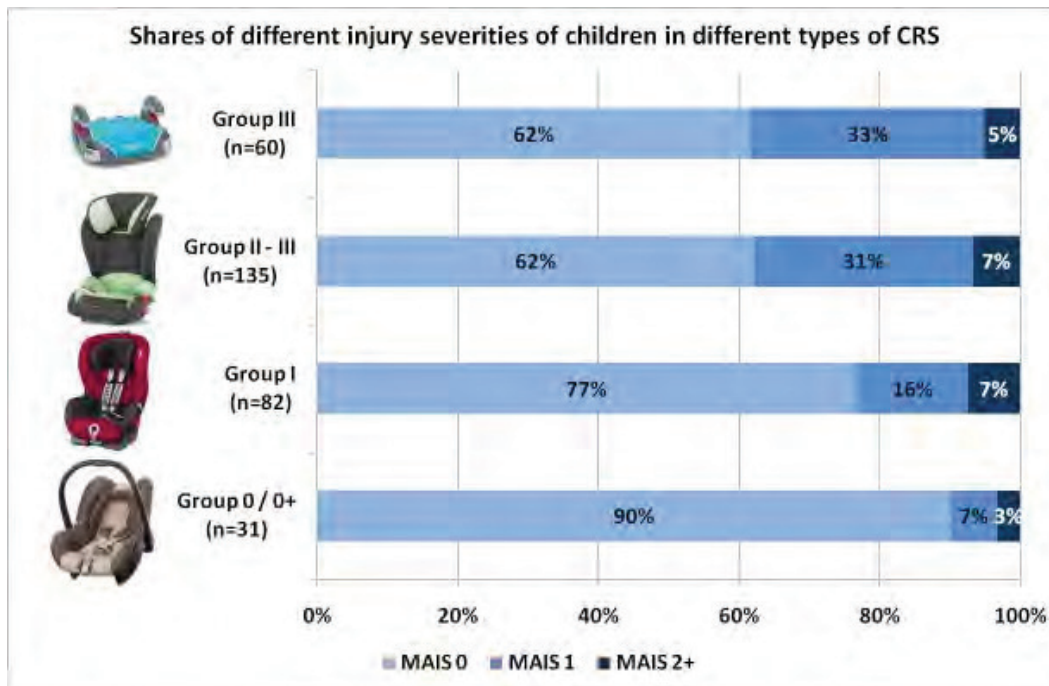


Figure 6: Injury severity of children in cars in different types of CRS

Even though there were only 31 cases of children in Group 0/0+ CRS, the tendency is clear: Younger children in their CRS are safer than older children in their CRS. 90% of the babies in Group 0/0+ CRS remained uninjured after an accident, only 6% in this group suffered minor injuries (MAIS 1) and only 3% were more severely injured. Of the children using Child restraint systems with a harness (Group I) 77% remained uninjured in traffic accidents and 23% were injured (7% had severe injuries). Older children using a CRS in combination with the cars seat belt (Groups II-III/III) show the highest injury severity in real world accidents: Only 62% remained uninjured while about one third of the children suffered slight injuries (MAIS 1) and about 6% suffered more severe injuries.

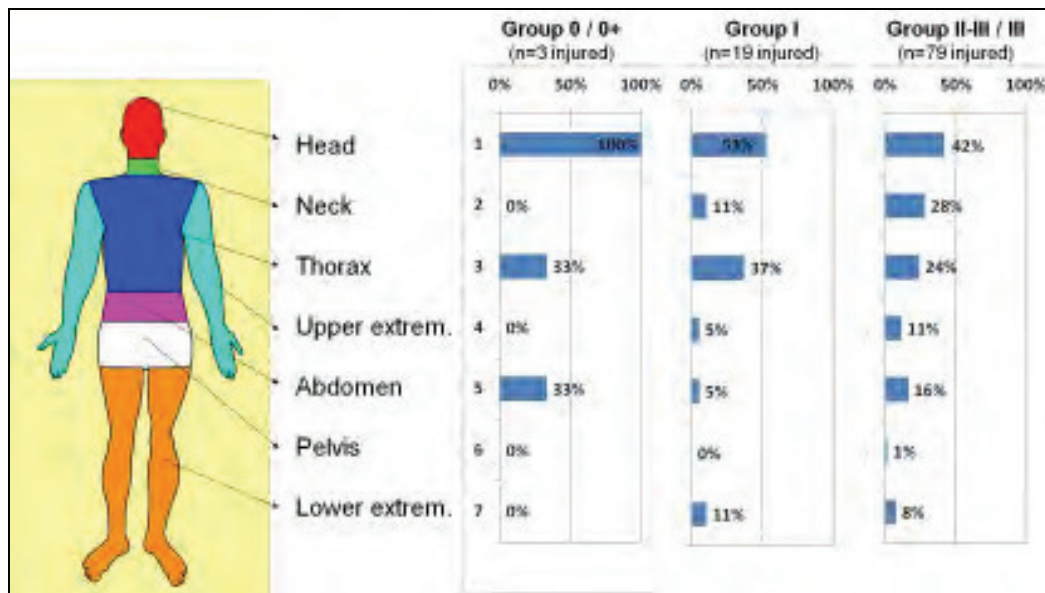


Figure 7: Most frequently injured body parts of children in different groups of CRS.

The injury location as displayed in Figure 7 is an important information to reduce the injury potential in future CRS. From the 3 injured children in Group 0/0+ CRS all children had injuries on the head, one child additionally was injured at the thorax and one was additionally injured at the abdomen. Children who were seated in a CRS of Group I also predominantly suffered injuries at the head (53%). With 37% however injuries of the thorax were also among the most frequent injuries here, while

injuries of other body parts were visibly less frequent. Older children seated in CRS of Groups II-III/III which use the seatbelt of the car also most frequently suffered head injuries (42%) and thorax injuries (24%). Interestingly here the amount of neck injuries with 28% is remarkably high and is significantly higher here than with children seated in CRS with a harness (Group I).

Thus the most frequent injuries of children in CRS are injuries of the head and injuries of the thorax, for older children injuries of the neck are also quite frequent. When looking at the injury sources of the head injuries, the most common sources were the backrest of the front or rear seats, the headrest of the front seat but also window glass of the window between B- and C-pillar. Thorax injuries were most frequently caused by the seat belt and neck injuries of children in Group II-III/III CRS were almost always found to be a result of the kinematics of the body (e.g. whiplash).

So how do children in CRS compare to adults in cars regarding safety in accidents? Children if correctly fastened are significantly safer in cars than adults! Figure 8 shows that children in their CRS are more often uninjured (68%) than the adults (52%) that were in the same cars together with the children during the accidents. Therefore the children in their CRS had lower incidences of slight injuries with MAIS 1 (children 27%; adults 41%) and also lower incidences of more severe injuries with MAIS 2+ (children 4%; adults 7%).

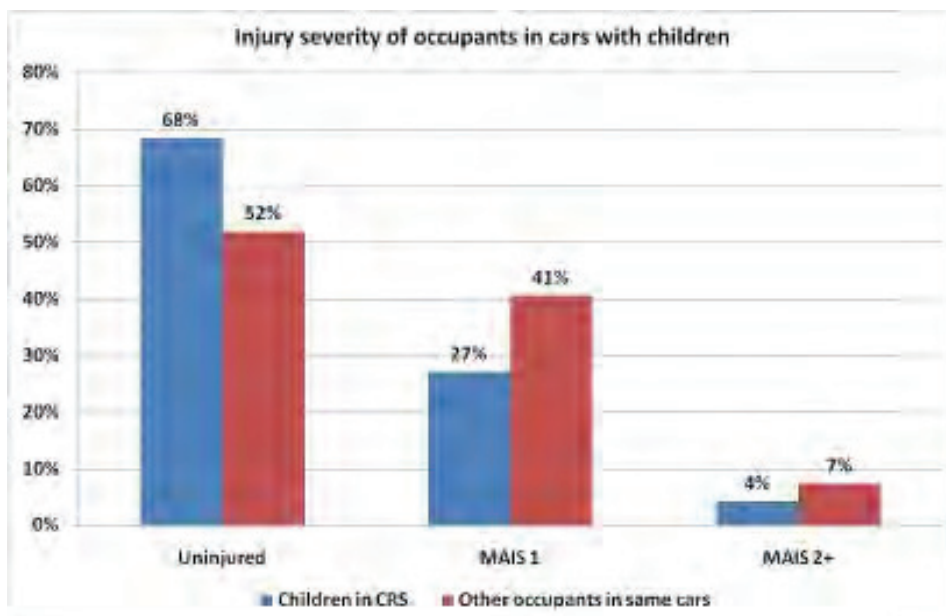


Figure 8: Injury severity of occupants in cars with children, comparing the adults with the children.

Conclusion

The effectiveness of child restraint systems is undisputed; this is confirmed by the statistics on road traffic accidents. This study also shows that children in cars were safer than the adults in the same cars during accidents and younger children in their CRS are safer than older children in their typical CRS. However this study also shows that there is potential for improving CRS based on the analysis of real world accidents. The analysis of the GIDAS accident database displays that the occurrence of head and thorax injuries as well as neck injuries for older children in CRS is exceptionally high for children as car occupants involved in an accidents. Together with more detailed information on the injury sources this field holds a great potential for the improvement of child occupant safety.

The knowledge about the type of accidents that happen with children in cars (e.g. more accidents in lateral traffic) is also an important base for further activities. Together with detailed Information on the accident circumstances and the causes of accidents with children in cars appropriate measures can be developed to prevent accidents from happening in the first place.

Acknowledgements

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