Review of Child Car Occupant Fatalities in Sweden During Six Decades

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Abstract The development of fatal outcome was reviewed based on crash data including all fatally injured 0–14 year old car occupants in Sweden during 1956–2011 and put in relation to general improvements in vehicle and road safety and implementation of restraint systems.

The review revealed a substantial decrease in crash-related fatalities among 0–14 year old car occupants during the past three decades, representing a significant drop of 83% compared to the highest scores in the 1960s–70s. During 1992–2011, a total of 194 crash-related fatalities were registered; the majority occurred on high-speed roads. Head injury was a primary cause of death, in a total of 54% of all cases. Two fifths of the crashes involved a single car, while three fifths involved other vehicles. In total, 24% of the children were unrestrained, and 59% of those were ejected during crashes. Among the restrained children, 56% were considered to be appropriately restrained according to Swedish recommendations. Crash severity, complex crash situation, fire and drowning were factors that contributed to the fatal outcome, even though the restraint usage was considered to be optimal.

Keywords child occupants, crash restraint systems, crashes, fatalities, passenger cars.

I. INTRODUCTION

Every day, more than 1,000 children and young people under the age of 25 years are killed in road traffic accidents around the world. This age group accounts for over 30% of those killed and injured in road traffic accidents [1]. Although the distribution of road deaths by mode of road user varies with age, among 0–14 year old (yo) children in the WHO European Region, 32% involve car occupants [2]. As with adults, an overall decrease in fatalities has been reported for children [3]. That study found a 50% reduction in child car passenger fatalities for 19 European Union (EU) countries over a 10 year period. Despite an increase in traffic density Sweden recorded the lowest child fatality rate among all the studied countries which confirms that traffic safety undertakings so far have been effective. Developments in road traffic and car safety, as well as increased use of child restraint systems (CRSs) are highlighted as instrumental factors contributing to such improvements.

During the mid-to-late 1900s Sweden adopted the traditional road safety philosophy primarily focusing on reducing the number of accidents. The authorities´ main responsibility was to introduce rules and regulations to simplify the driving task for road users and thereby minimise the accident risk. However, in 1997 the Swedish parliament passed a bill on Traffic Safety presenting the Vision Zero programme. Instead of attempting to only reduce the number of accidents, the goal was altered to accommodate eliminating the risk of chronic health impairment sustained in traffic accidents as well [4]. New principles for road and street design were established to suit the updated approach to safety [5,6]. Since the introduction of the Vision Zero programme, the traffic fatality rate has continually decreased in Sweden, from 6.1 killed/100 000 inhabitants in 1997, to 4.9 in 2006, and 2.8 in 2010 [7]. Furthermore, the number of killed car occupants has decreased by more than 50%, from ~400 in 2000 to 167 in 2010 [7].

Safety performance in passenger cars has steadily improved for several decades and the availability and functionality of three-point seat belts have been improved over the years. The injury reducing effect of the seatbelt is high; at a 68% MAIS3+ injury reducing effect for drivers [8]. In the rear seat, wearing a seatbelt was shown to reduce fatalities by 55–75% [9]. Much effort has been made on improving vehicle crashworthiness

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which has been significant over the last few decades, including structural improvements as well as the development of interior vehicle safety systems [8, 10–11]. Electronic Stability Control (ESC) systems have gradually been implemented in cars since the millennium to reduce the risk of fatal and serious loss-of-control crashes on ice and snow [12–13] at an estimated effectiveness of 50% [12]. Studded or non-studded winter tyres became mandatory for the period 1 December–31 March, annually, in Sweden in 1999 and studies have shown that studded tyres have the capacity to reduce the risk of fatal crashes on ice and snow [14]. Furthermore, recent active safety measures comprise driver assistance systems, including auto brake and crash mitigation systems [15–16].

Swedish legislation was changed in 1975 and it became illegal to travel in the front seat without wearing a seatbelt. In 1986 this law was revised to include rear seat occupants >15 yo, shortly followed in 1988 to include rear seat child occupants being required by law to wear a seat belt in the rear seat as well. The Swedish Traffic Regulation in 1998 (SFS 1998:1276, Chapter 4 §10) stated that children ≤6 yo must wear an appropriate CRS when travelling in a car, and was superseded by The Swedish Traffic Regulation in 2006 (SFS 2006:1208 Chapter 4 §10) that all children of stature <135 cm must wear an appropriate CRS.

Children differ from adults in anatomy as well as body segment mass proportions and body size [17–18]; consequently children have special needs with respect to in-car protection [18–19]. The development of child restraint systems for cars began in 1964 with the development of a rearward-facing CRS introduced by Professor Bertil Aldman [20], which was initially introduced and commercially available in Sweden in 1967. The purpose of the rearward-facing CRS was to provide a restraint designed to accommodate the needs of small children by distributing the forces over a large part of the body, enabling support and protection to the spine and head in the event of a frontal impact.

Evidence of the benefits of restraining children in rearward-facing CRSs in comparison to forward-facing CRSs has been provided through crash tests, as well as real world data [18, 21–25]. By using crash test dummies representative of 3 and 6 yo children, it was found that neck tension force was substantially reduced when rearward-facing (50 kg) compared to forward-facing (300–320 kg) [21]. That the risk of children (0–14 yo) being injured was statistically significantly lower for children in rearward-facing CRSs (1.3%) as compared to forward-facing CRSs (6.9%) was shown in real world data collected by the Folksam Insurance Company in Sweden [18]. A study based on data from Volvo Cars accident database in Sweden calculated an 80–90% effectiveness of rearward-facing CRSs, compared to 30–60% for belt-positioning boosters [23]. Another study reviewing the same database revealed that children aged 2-4, when restrained in forward-facing CRSs, were estimated to be at approximately double the risk of sustaining MAIS2+ injuries than when restrained in rearward-facing CRSs [24]. In all the above studies, the forward-facing CRSs were primarily of belt-positioning booster types, since forward-facing CRSs with an integrated child harness have not been endorsed in Sweden and are thus very rare. In a study of children aged 0–23 months involved in crashes in 1988-2003 in the USA, it was found that children fastened in forward-facing integrated child harness-type CRSs were significantly more likely to be seriously injured in all crash types than children restrained in rearward-facing CRSs [25]. Categorised by crash type, odds ratios of 1.23 in frontal impacts and 5.53 in side impacts were seen. Based on this evidence the use of rearward-facing CRSs was recommended for as long as possible, preferably until the child was 3–4 years of age [18–19, 22–24, 26–27].

In the late 1970s, the booster cushion was introduced in order to improve the seatbelt geometry in the pelvis and neck/shoulder region [28]. The booster elevates the child, so that the lap part of the adult seatbelt can be positioned over the thighs, which reduces the risk of the lap belt loading the abdomen. There are mainly three different types of belt-positioning boosters used in Sweden; booster cushions, booster seats (including backrest) and vehicle integrated booster cushions. The integrated booster cushions were developed in order to simplify usage and to minimise misuse [29], and have been shown to be very effective in this respect [30–31].

In Sweden, the recommendation promoted by all safety advocates, i.e. authorities, car and child seat manufacturers, and consumer organisations, has been clear and unanimous in endorsing rearward-facing CRSs up to 3–4 years of age (at least) and belt-positioning boosters up to 10–12 years of age. In addition, it is clearly recommended that children shorter than 140 cm should not be seated in the front seat in cars equipped with an active passenger airbag. However, most cars sold in Sweden offer the option of deactivating the airbag to allow children to be seated in the front seat.

In the early 1980s a significant increase in child restraint usage was recorded among children in Sweden [24] (Figure 1). This increase may be explained by several contributing factors. For example, national campaigns were run at the start of the 1980s in order to spread awareness about the importance of using child safety

equipment when travelling in cars. Some years later, additional campaigns for the use of seatbelts in the rear seat were carried out. Additionally, an infant seat rental programme, introduced in 1984, also contributed to the overall increase in the usage of child restraints.

Analysing crash-related child fatalities provides valuable knowledge on influencing factors and forms a basis for further safety developments. An in-depth study on all crash-related fatalities involving 0–14 yo car occupants in Sweden during 1992–mid 1997 found that more than 80% of the fatal injuries occurred to the head and neck region [32]. The author's prediction was that 32% of those children would have had a fair chance of survival had they been restrained in accordance with Swedish recommendations. In a study of restrained 0–5 yo car occupants fatally injured in vehicle crashes in the USA in 2000, it was reported that half of the crashes were considered unsurvivable for the child and that 12% of fatalities were deemed to be the result of gross misuse of the child restraint [33]. Further, 40% of all of the crashes were side impacts and, in all fatal side impact crashes, intrusion was found at the child's seated position. In a study of the influence of seat position on crash-related fatality risk for 0–7 yo child occupants in the USA, a higher fatality risk was found in the front seat compared to the second and third row [34]. Furthermore, a greater fatality risk was reported for rollovers compared to side impacts, but considering total numbers, frontal impacts had the highest frequency of fatalities. In a study of car passenger fatalities in Europe, it was concluded that the current level of protection did not seem sufficient in side impacts, and the importance of preventing children from being ejected in rollovers was highlighted [3]. Further, they identified a peak for the youngest, potentially indicating forward-facing CRSs too early in most of the countries studied. This issue was studied in more detail in a comparison study of German child passenger fatality statistics and Swedish child passenger fatality statistics [35] (Figure 2). They found that the high number of fatally injured 1 yo children in Germany was not evident in Sweden. It is likely that this peak is influenced by changing too early from rearward facing to forward facing CRSs in Germany, while this move takes place much later in Sweden, i.e. at an age of 2 to 4 years.

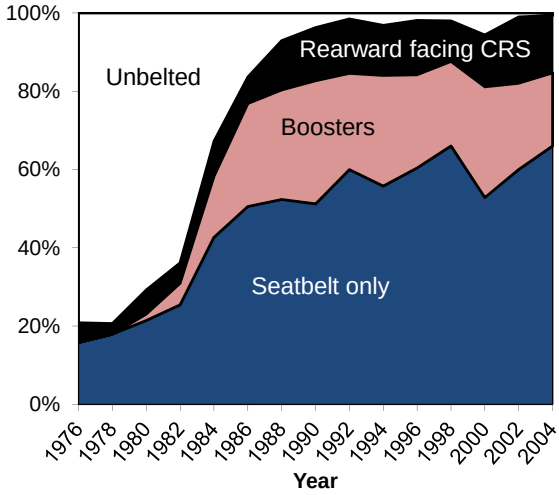

Fig. 1. Restraint usage among 0–15 year old children in Volvo cars in Sweden 1977–2004 (based on [24])

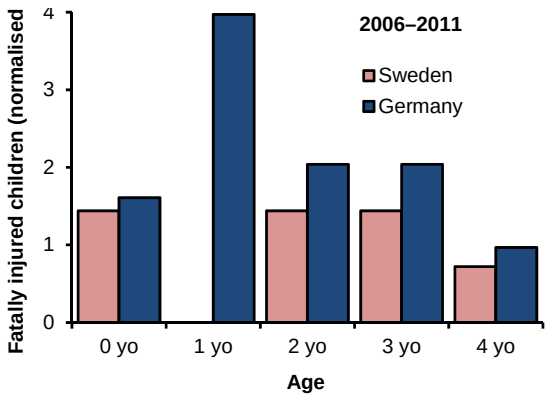

Fig. 2. Normalised number of fatally injured 0–4 years old car occupants in Sweden and Germany during 2006–2011.

Analysis of crash-related child fatalities provides valuable knowledge on influencing factors and forms a basis for further safety developments. Hence, a review of data from all fatal crashes between 1956 and 2011 in Sweden involving 0–14 yo car occupants was undertaken, identifying influencing factors and putting the fatalities in perspective in relation to general improvements in vehicle and road safety, and implementation of restraint systems.

II. METHODS

All crash-related fatalities among 0–14 yo vehicle (passenger car, minibus, van) occupants during 1956–2011 are included in this study. Four data sources provided information of every child fatality in Sweden during the time period 1956 to 2011 (Table A.II). For comparative purposes the corresponding data for the Swedish population were extracted as well, and for crashes occurring during 1992–2011 the available data allowed a more detailed analysis.

General Statistics

General statistics regarding crash-related fatalities among 0–14 yo car occupants during 1956–1991 were extracted from two sources: Statistics Sweden (SCB) and The Swedish Transport Administration (STA). The

corresponding data for the Swedish population regarding crash-related fatalities among car occupants during 1956–1991 were provided by The Swedish Transport Agency (STrA).

The main task of the SCB is to supply general statistics for decision making, debate and research. For this study, SCB delivered overview data for the period 1956–1971 on the number of fatally injured car occupants for the age groups 0–6 yo and 7–14 yo (N=323). Further, SCB provided data on the number of child inhabitants (0–14 yo) in Sweden, as well as data on the Swedish population, for the period of 1956–2011 (Table A.I).

STA is responsible for the construction, operation and maintenance of all state-owned roads and railways in Sweden. They also develop long-term plans for the transport system on roads, rail, sea and air transport. For this study the STA provided overview data, separated by age, of the number of fatally injured 0–14 yo car occupants during 1972–1991 (N=447).

STrA is responsible for drawing up regulations regarding rail, air, sea and road transports, and to ensure that authorities, companies, organisations and citizens abide by them. For this study, STrA provided data on the total numbers of fatally injured car occupants in Sweden, irrespective of age, for the period of 1956–2011 (Table A.II).

In-Depth Cases 1992–1997

The Swedish National Road and Transport Research Institute (VTI) is an independent government agency under the Swedish Government. On behalf of the STA, VTI performed in-depth investigations of all crash-related fatalities involving 0–14 yo passenger car occupants in Sweden between 1 January 1992 – 30 June 1997; in total 70 crashes and 79 fatally injured children. Each case included police and rescue team reports, autopsy protocols, photos from newspapers and the police**.** A brief description of each crash and an overview/analysis of relevant parameters, such as restraint usage, cause of death, ejections, crash directions, and other vehicles involved were summarised in a report [32]. The aim of that study was to investigate the technical crash performance of CRSs, focusing on usage and installation as well as unexpected failures. From that data source, child occupants fatally injured during 1992–1996 (N=74) were included. One case was excluded from the complete dataset due to one child being older than 14 yo [32].

In-Depth Cases 1997–2011

Since 1997 all fatal traffic-related crashes in Sweden have been collected, analysed and stored at the STA. This database contains records of technical as well as medical information about each crash, such as police and rescue team reports, vehicle specific information, on-site comprehensive information of road and surrounding conditions, pictures of vehicles involved and of the crash scene, road surface conditions, lighting and visibility, injury details and autopsy protocols. For this study, this data source provided detailed information related to car crashes involving fatally injured 0–14 yo car occupants during 1997–2011 (N=120). Two cases of the total sample were excluded in which an already existing disease may have contributed to the death of the child.

III. RESULTS

Overview of the Fatalities During 1956–2011

The number of fatally injured 0–14 yo children gradually increased from 1956 until 1962 when it reached a plateau at an average of 26 children per year, lasting for almost 20 years (Table A.II). The number of fatalities then started to decrease in three rather distinct steps: the first step occurred in 1982 down to on average 17 children per year, the second in 1996 down to on average 11 children per year, and the third in 2005 down to on average 4 children per year. In the most recent years the numbers of fatally-injured children are 83% less in comparison to the highest numbers between the early 1960s to the early 1980s. Figure 3 shows fatalities among the 0–14 yo (Table A.II) normalised with regard to the number of Swedish citizens aged 0–14 years (Table A.I), multiplied by 1.000.000 and compared to the corresponding distribution for all fatally-injured car occupants in Sweden. The trends for both categories

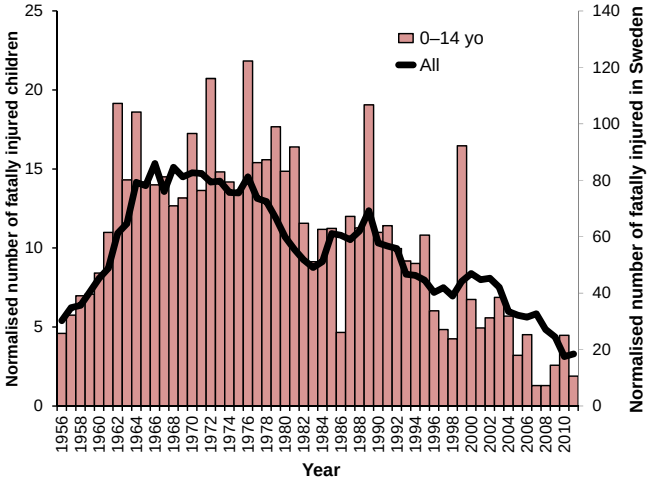

Fig. 3. The normalised number of fatally injured vehicle occupants among 0–14 year olds (primary axis, dark grey bars) and all fatally injured car occupants in Sweden (secondary axis, solid black line) during the years 1956–2011.

were similar until the mid-1970s when the total number of fatalities started to decrease in Sweden. However, for children aged 0–14 yo the number of fatalities remained at approximately the same level until the large drop, mentioned above, in 1982. The distributions were then well aligned until the mid-1990s following a trend of relatively lower numbers for the children. Even when normalised for the population size, the clear trend of substantial reduction of the number of fatalities was apparent. As compared to all car occupants the total reduction in fatalities was somewhat greater among children, 78% and 83%, respectively.

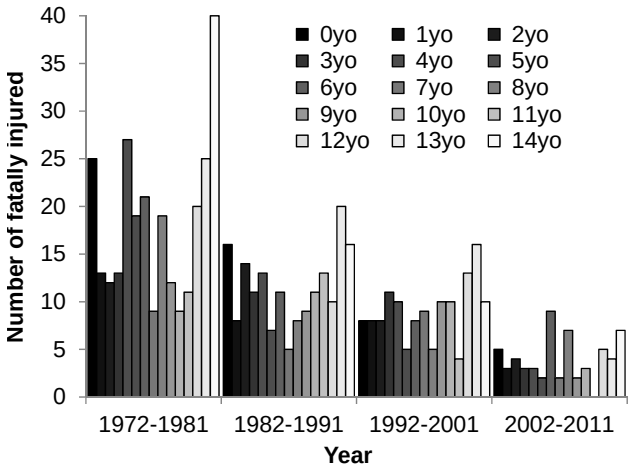

Fig. 4. The number of fatally injured 0–14 year old car occupants during the years 1972–1981, 1982–1991, 1992–2001, and 2002–2011.

After 1972, age details were also made available. A summary of the cases by age over four decades are presented in Figure 4. Overall and for each age group a trend of decreasing numbers over the years is shown. A similar trend of decreasing numbers comparing the different decades are seen for all ages. In total 275 children were fatally injured during 1972–1981, while in 1982–1991 and 1992–2001, the figures were 172 and 135, respectively, followed by 59 in total for the last decade, 2002–2011.

Analysis of Influencing Factors

The data available for crashes occurring between 1992 and 2011 allowed for a more detailed analysis. In total, 157 crashes involving 194 fatally injured children (109 boys, 85 girls) occurred during this period.

Crash influencing factors

The majority of the crashes involving child fatalities occurred on high-speed roads (19% 60–70 km/h; 52% 80–90 km/h; 16% 100–110 km/h), while a minor part occurred on either low-speed roads (6% 30–50 km/h) or were unknown (7%). The age of the cars in which the children were travelling was on average 10.2 years (SD 4.6 years). In total, 4% of the cars entered water, 29% were involved in a turn/rollover, and the remaining crashes were categorised as frontal (33%), side (27%), multiple impact directions (4%), rear (1%) and other (1%).

Two-fifths of the crashes were single car crashes, i.e. no other vehicle involved, while three-fifths involved other vehicles (cars 27%, heavy trucks 18%, buses 6%, and multiple crashes 3%) or trains (5%) (Figure 5).

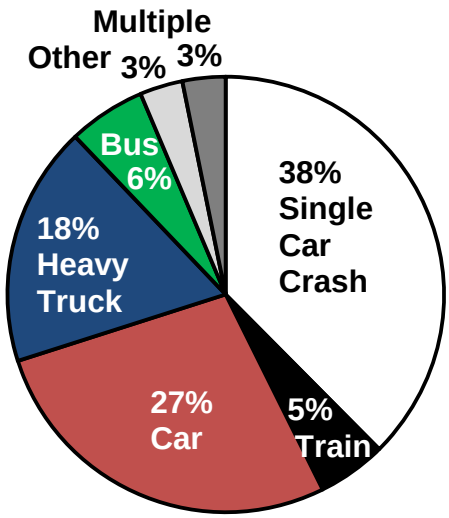

Fig. 5. The crash events resulting in fatal injuries among 0–14 years old occupants during 1992–2011.

The occurrence of single car crashes was more or less evenly distributed over the day and night with a minor dip in the early morning, and they occurred more than twice as frequently during weekends (Friday–Sunday) compared to weekdays (Monday–Thursday). Crashes involving other vehicles mainly occurred during the daytime peaking at 1 pm, and they happened most frequently on Fridays. During 1992–2006, fatal crashes were relatively more frequent during the winter season; however, during 2007–2011 these numbers decreased substantially. In recent years, crashes in spring time have increased in relative importance as compared to preceding periods.

Crashes involving one other vehicle (N=85) were dominated by frontal impacts (56%) and side impacts (40%), while rear-end impacts were less common (2%) (Table I). However, only a minor relative difference was found for frontal (N=14) and side (N=13) impacts during the second decade (2002–2011), whereas during the first decade (1992–2001) the frontal impacts were more common than impacts from the side (N=34 compared to N=21). Thus, frontal impacts have decreased more (-59%) than side impacts (-38%) during the last two decades. Side impacts from the right (25 cases) were more common than side impacts from the left (8 cases). Crashes involving one other vehicle were most frequently (68%) induced by the car that the child was travelling in, and 59% of those cases were related to skidding/loss of control. When separating the data in different impact

directions, no major differences were found for the frontal (25 and 22 crashes, respectively) and rear-end impact directions (1 and 1 crashes, respectively); however, for the side impact directions 32 out of 34 crashes were induced by the car carrying the fatally-injured child occupant (Table I). Of these 32 side impacts, 78% were caused by skidding/loss of control, 16% occurred in crossroads and 3% were related to left turns. Correspondingly for the 25 frontal impacts, 32% were caused by skidding/loss of control. The vast majority of these crashes (89%) occurred in impacts with vehicles driving in the opposite direction, while the remaining part occurred with vehicles either crossing roads (8%) or with vehicles driving in the same direction (2%). Crashes involving one other vehicle resulted in a turn/rollover in 15% of the cases and fire in 8% of the cases (Table I). In comparison, the car caught fire in 40% of the multiple crashes.

TABLE I
GENERAL STATISTICS FOR CRASHES INVOLVING ONE OTHER VEHICLE (MULTIPLE CRASHES EXCLUDED).

Number of crashes	Initial Impact Direction of the Vehicle carrying the Child Occupant												Total	
	Frontal		Side						Rear-end		Unknown			
			Left		Right		Unknown							
Other vehicle involved														
- Car	22	(1 roll) (1 fire)	4	(1 roll)	15	(3 roll) (1 fire)	-		2	(1 roll) (1 fire)	-		43	(5 roll) (3 fire)
- Tractor + trolley	-		-		1	(1 roll)	-		-		-		1	(1 roll)
- Heavy truck	18	(2 roll) (2 fire)	3	(1 roll)	5	(1 fire)	1		-		1		28	(3 roll) (3 fire)
- Light truck	2	(1 roll)	-		1	(1 roll)	-		-		-		3	(2 roll)
- Bus	6	(2 roll)	1		2		-		-		-		9	(2 roll)
- Mini bus	-		-		1	(1 fire)	-		-		-		1	(1 fire)
Travelling direction of the other vehicle involved														
- Opposite	47	(5 roll) (3 fire)	5	(1 roll)	21	(3 roll) (3 fire)	1		1		1		76	(9 roll) (6 fire)
- Crossing roads	-		3	(1 roll)	4	(1 roll)	-		-		-		7	(2 roll)
- Same	1	(1 roll)	-		-		-		1	(1 roll) (1 fire)	-		2	(2 roll) (1 fire)
Vehicle initiating the crash														
- Child's car	25[1)]	(4 roll) (1 fire)	7	(2 roll)	24	(3 roll) (3 fire)	1		1		-		58	(9 roll) (4 fire)
- The other vehicle	22	(2 roll) (2 fire)	1		1	(1 roll)	-		1	(1 roll) (1 fire)	1		26	(4 roll) (3 fire)
- Unknown	1		-		-		-		-		-		1	
Total	48	(6 roll) (3 fire)	8	(2 roll)	25	(4 roll) (3 fire)	1		2	(1 roll) (1 fire)	1		85	(13 roll) (7 fire)

1) In one of these cases it was probably the car that the child was travelling in that initiated the crash.

The single car crashes (N=59) often involved impacts with more than one object, resulting in turn/rollovers in 64% of these cases. The most common impact objects were trees (22%) followed by poles (12%), guardrails (12%), embankment soil (12%) and moose (7%). The vehicle caught fire in 12% of the cases and in 12% the vehicle entered water (lakes, water-filled ditches or rivers) which resulted in drowning. Nearly half of the single car crashes were associated with skidding and they ended up in the ditch or in the vicinity of the road in 93% of the cases. In nine cases (15%) the driver did not have a driver's licence, of which seven (12%) were below 18 years old (all of them males). Furthermore, six of the drivers (10%) were under the influence of drugs or alcohol.

Child related factors

When considering the fatally-injured children, the distribution with respect to type of crash occurring between 1992–2011 is shown in Figure 6, divided into five age groups; 0 yo, 1-3 yo, 4-6 yo, 7-10 yo and 11-14 yo. Infants had a relatively higher incidence in single car crashes (62%). However, as the age increased the proportions changed and crashes involving other vehicles became more frequent. Among the 1–3 yo, 38% were killed in single car crashes, while 62% were killed in impacts with other vehicles. For the 4–6 yo, the corresponding numbers were 22% and 76%, respectively. Among the older children (13–14 yo) involved in single car crashes,

53% were occupants in cars driven illegally by somebody not holding a driver's licence (88% of them were under-aged). This type of crash has become more common in recent years. Crashes with trains became gradually more common among older children; among the 11–14 yo, 10% were killed in crashes with trains.

The majority (62%) of the fatally-injured children was positioned in the rear seat, while the remainder were positioned either in the front passenger seat (34%) or in the driver seat (2%); in 3% of the cases the position was unknown. Of those who were positioned in the rear seat, 56% were seated in the peripheral positions (20% on the left side and 15% on the right side), 8% in the mid-position, whereas 34% were unknown.

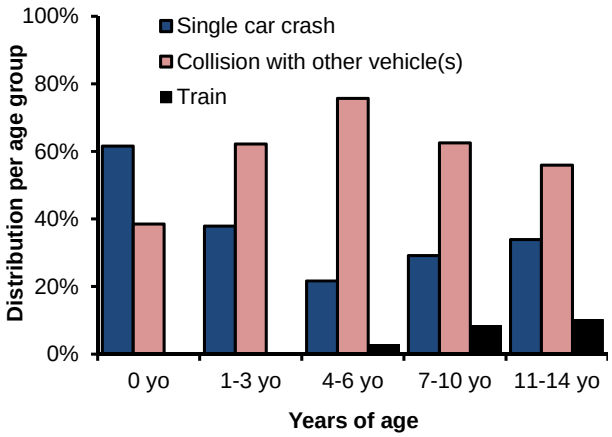

Fig. 6. The proportions of single car crashes, crashes with other vehicles or trains for different age groups.

Table II summarises the details for children fatally injured in single car crashes and in crashes with one other vehicle involved, i.e. except multiple crashes and including details on impact situation, counterpart and potential subsequent event (fire, water, ejection), and restraint usage details for the five different age groups.

Approximately one quarter of the fatally-injured children (24%) were unrestrained; the greatest number was found among the infants of which 9 out of 13 (69%) were unrestrained. In total, 59% of the unrestrained children were ejected during the crash. In single car crashes, as many as 77% of the unrestrained children were ejected, most often in relation to turn/rollovers (22 out of 26 cases), while 15% were ejected in crashes involving other vehicles. Additionally, 4 out of 131 (3%) restrained children were ejected. Influencing factors were major deformation to the car structures which made it possible to slip out of the seatbelt during the crash.

Among the 131 restrained children 74 (56%) were restrained according to recommendation for optimal protection for their size and age. This was defined as rearward-facing CRSs for the age groups 0 yo and 1–3 yo (at least), booster/forward-facing CRSs in combination with a seatbelt for the age groups 4–6 yo and 7–10 yo (at least), and a three-point seatbelt for the age group 11–14 yo. Thus, 74 children were killed despite being restrained according to the optimal protection recommendations. These cases predominantly included high severity accidents with major local intrusions, as well as fatalities due to fire (9 cases) or drowning (4 cases). Further, the restraint system failed in 3 of these cases which may have contributed to the death of those children; in 2 cases due to seatbelt detachment and in 1 case due to CRS detachment.

Rearward-facing CRSs were used by 15 of the fatally injured children; three 0 yo and twelve 1–3 yo. Two of these children died because of fire and one due to drowning. The deaths of the other twelve children were caused by other crash-related factors. In five cases the crashes were associated with major (local) roof intrusions caused by either turn/rollovers (4 cases) or collisions with moose (1 case). Crashes with heavy vehicles were registered in six cases; four frontal and two side impacts (one nearside and one farside). In one case the car was exposed to a nearside side impact by another car. In all these cases, significant intrusion located at the position of the child occurred, except for one of the frontal impacts with a truck where a CRS detachment was registered.

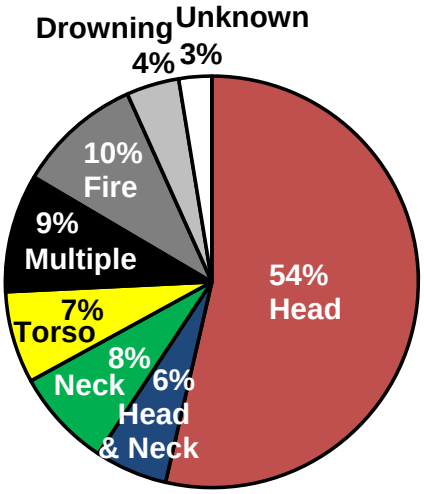

Fig. 7. Cause of death among 0–14 years old occupants during 1992–2011.

Head injuries were the primary cause of death (54%), followed by injuries to the head and neck (6%), neck (8%); torso (7%), while 9% were categorised as multiple injuries (Figure 7). In 14 cases (7% in the total sample of 194 fatalities) the head injuries also included a skull base fracture. In 10% of the total sample the death was due to fire, whereas in 4% drowning was the cause of death. When looking at the fate of the restrained children in this study, head injury was the primary cause of death in half of the cases.

TABLE II
SUMMARY OF RESTRAINT USAGE AND TYPE OF CRASH FOR THE DIFFERENT AGE GROUPS.

	Restraint usage	Crashes with other vehicles												Single car crashes										Train
		Total	Car	Light truck/minibus	Heavy vehicle	Frontal	Side	Rear	Crushed by vehicle	Multiple crash	Roll/turn over	Fire	Ejection	Total	Tree/pole	Water	Guardrail	Embankment soil	Moose	Solid wall	Other	Roll/turn over	Fire	Ejection	Total
0 yo	Rearward facing CRS	1	-	-	1	1	-	-	-	-	-	-	-	2	1	-	-	-	-	1	-	1	1	-	-
	Pram insert[1)]	3	2	-	1	2	1	-	-	-	2	1	1	-	-	-	-	-	-	-	-	-	-	-	-
	Unrestrained	1	1	-	-	1	-	-	-	-	-	-	-	6	2	-	-	1	-	2	-	5	-	4	-
	Sum	5	3	-	2	4	1	-	-	-	2	1	1	8	3	-	-	1	-	3	-	6	1	4	-
1-3 yo	Rearward facing CRS[2)]	7	2	-	5	4	3	-	-	-	-	1	-	5	1	1	1	1	1	-	-	3	1	-	-
	Forward facing CRS + seatbelt[3)]	1	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Booster + seatbelt[3)4)]	7	3	1	2	4	2	-	-	1	1	-	-	7	4	1	1	-	-	-	1	3	1	-	-
	Restrained (CRS unknown)	3	-	-	3	3	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
	Unrestrained	5	1	-	4	4	1	-	-	-	1	2	1	2	-	-	1	1	-	-	-	1	-	2	-
	Sum	23	7	1	14	16	6	-	-	1	3	4	1	14	5	2	3	2	1	-	1	7	2	2	-
4-6 yo	Forward facing CRS[3)]	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-
	Booster + seatbelt[5)]	10	6	-	3	4	4	1	-	1	-	-	2	3	-	1	-	1	1	-	1	2	-	-	-
	Seatbelt (5-point)[6)]	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-
	Seatbelt (3-point)[6)]	6	2	-	4	6	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
	Seatbelt (2-point)[6)]	2	2	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Unrestrained	6	3	-	3	3	3	-	-	-	1	1	4	2	1	-	-	-	-	-	-	2	-	2	-
	Unknown	4	-	2	1	-	3	-	-	1	-	2	1	1	1	-	-	-	-	-	-	-	-	-	1
	Sum	28	13	2	11	15	10	1	-	2	2	4	7	8	3	1	-	1	1	1	1	4	-	2	1
7-10 yo	Booster + seatbelt[7)]	4	1	-	3	1	3	-	-	-	1	-	-	2	1	-	-	-	-	-	-	1	-	-	-
	Seatbelt (3-point)[6)8)]	18	11	1	4	11	5	-	-	2	2	3	-	6	1	1	-	-	2	-	1	3	1	1	2
	Seatbelt (2-point)[6)]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
	Unrestrained	4	-	1	3	3		-	1	-	-	-	1	4	-	-	1	2	-	-	-	4	-	4	-
	Unknown	4	1	-	1	1	-	2	-	1	1	3	-	2	-	1	1	1	-	-	1	1	-	-	1
	Sum	30	13	2	11	16	8	2	1	3	4	6	1	14	2	2	2	3	2	-	2	9	1	5	4
11-14 yo	Seatbelt (3-point)[6)]	26	11	-	14	11	14	-	-	1	5	6	1	8	3	2	1	-	1	-	-	5	2	-	5
	Seatbelt (2-point)[6)]	2	-	-	2	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Unrestrained	2	1	-	1	1	1	-	-	-	-	-	-	12	6	1	1	-	-	-	-	9	3	8	-
	Unknown	3	2	-	1	-	3	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1
	Sum	33	14	-	18	12	20	-	-	1	5	7	1	20	9	3	2	-	1	-	-	14	5	8	6
Total		119	50	5	56	63	45	3	1	7	16	22	11	64	22	8	7	7	5	4	4	40	9	21	11
Percentage [%]		100	42	4	47	53	38	3	1	6	13	18	9	100	34	13	11	11	8	6	6	63	14	33	100

1) Pram insert in combination with safety net in one case.
2) CRS failure in one case (frontal impact with heavy vehicle).
3) The integrated vehicle 3-point seatbelt.
4) Misuse of the seatbelt in one case (single car crash, rollover).
5) Seatbelt failure in one case (frontal impact with car).
6) The vehicle's seatbelt.
7) Seatbelt failure in one case (single car crash, rollover).
8) Seatbelt misuse in two cases (impact from the side by another car).

IV. DISCUSSION

This study provides a comprehensive review of the child car occupant fatality development over a 55-year time period (1956–2011) in Sweden. From the peak level reached during the early 1960s to the early 1980s the number of fatally-injured car occupants has decreased on average by 78% among the Swedish population, while the corresponding reduction was even greater, 83%, among the sub-group 0–14 yo children (Figure 3).

The substantial reduction in fatalities can mainly be explained by increased usage of restraint systems, implementation of new safety systems and enhancement of crashworthiness in vehicles, as well as improvements of a more general nature in the road transport system in accordance to the Vision Zero

programme. In the early 1980s, a significant increase of CRS usage was seen in Sweden (Figure 1), which correlates with the stepwise decrease in crash-related fatalities among children in 1982 (Figure 3). In 1986/1988 for adults/children, wearing a seatbelt became mandatory in the rear seat, which corresponds to a further reduction of fatalities starting in the late 1980s. The overall drop in numbers during the 1980s and 1990s can thus principally be explained by an overall increase of restraint usage in Sweden in combination with the general improvement of vehicle safety. During the 2000s, belt use amongst children in the rear seat has further increased from a level of just below 90% to 97%, and is today at the same level as for adults in the front seat [6]. Moreover, enhancements of crashworthiness of vehicles, widespread implementation of ESCs, median barriers and speed cameras, as well as revised speed limits are interventions worth mentioning. The reduction of fatalities during the last decade can therefore potentially be explained to a large extent by safety improvements of a more general nature in the road transport system. New cars and improvements to the larger road network have contributed to a decrease in the total number of severe head-on crashes since the 2000s by more than 50% [6]. As these crashes are typical in child car occupant fatalities (Figure 5, Table 1) it is likely that these fatalities were also reduced to a similar extent.

Data extracted from the in-depth cases 1992–2011 revealed that frontal and side impacts were the most common crash situations (56% and 40%, respectively) in fatal crashes involving one other vehicle (Table I). Side impacts from the right (25 cases) were more common than side impacts from the left (8 cases). One reason for this might be due to distribution of the position of a child in a car. According to an observational survey in Sweden ~70% of the 0–4 yo were positioned on the right side of the vehicle while only ~24% were positioned on the left side [36]. For the 5–10 yo the corresponding numbers were ~57% on the right side and ~40% on the left side. In a similar earlier study it was found that ~89% of the 0 yo, ~79% of the 0–3 yo, and ~57% of the 4–10 yo were positioned on the right side [37]. Thus, since a majority of the children in Sweden are positioned on the right side, a higher incidence of fatalities may be expected in side impacts from the right, i.e. nearside relative to the child. Another reason for the higher incidence of side impacts from the right in the present study may be frequency of crash situations, further studies are recommended to address this. It would also be of interest to study differences in patterns of crashes involving children and adults.

Crashes involving one other vehicle were most often (68%) induced by the car that the fatally injured child was travelling in. When separating the data in different impact directions no major differences were found for the frontal and rear impact directions, whereas for the side impact directions 32 out of 34 crashes were induced by the car carrying the fatally-injured child occupant (Table I). The majority of these 32 crashes (78%) were associated with skidding/loss of control, which may have resulted in the child being out-of-position at the moment of impact. In manoeuvre studies on steering [38] and braking [39] events, it was shown that an evasive manoeuvre is an unstable restraint situation for belted children in the rear seat and ensuring appropriate initial shoulder belt position is an important factor influencing the kinematic response of the child.

Single car crashes often involved impacts with more than one object, most commonly with trees and/or poles (32%) followed by guardrail, embankment soil and moose. In 12% of the single car crashes the vehicle entered water (lakes, water-filled ditches or rivers) which resulted in drowning. No such case was registered in crashes involving other vehicles. Turn/rollovers also occurred more frequently in single car crashes (66%) compared to crashes involving other vehicles (15%), whereas a similar proportion of the cars caught fire in single car crashes (12%) and in crashes involving other vehicles (11%).

When considering fatally-injured children, an over-representation of 0 yo was found in single car crashes (Figure 6). As the children´s age increased, crashes with other vehicles and trains became relatively more common. As much as 75% of the fatally-injured 0 yo were unrestrained in single car crashes, of which 67% were ejected (Table II). Furthermore, the majority of the single car crashes involving 0 yo (83%) resulted in turn/rollovers. Overall, a relatively higher proportion (69%) of the 0 yo was unrestrained, in comparison to 24% in the total material. For comparison, in the US it has been reported that approximately 40% of fatally-injured children were unrestrained [33,40]. However, studies have found that the vast majority (84–99%) of the 0 yo in Sweden are restrained in rearward-facing CRSs while travelling in cars; only a minor part of them are positioned in forward facing CRSs (0–7%), car bed restraints/pram insert with a safety net (0–5%), no CRS using the vehicle's seatbelt (0–7%), or are unrestrained (0–7%) [36,37,41]. There is thus a significant discrepancy between the proportion of 0 yo travelling unrestrained in cars (0–7%) and being fatally injured while unrestrained (69%). These numbers may give an indication of the increased risks associated with infants being unrestrained while travelling by car.

More than half (59%) of the unrestrained children in this study were ejected during the crash. These situations were typically related to single car crashes and rollovers. The share of unrestrained children being ejected in the present study is substantially greater compared to the corresponding share of unrestrained adults being ejected (37%) according to a previous study based on in-depth investigations of all crash-related fatalities in the Stockholm area during 2005-2009 [42]. One plausible explanation for this difference would be that adults, to a higher degree than children, are prevented from being ejected due to being of a larger size. However, in another study regarding ejections of unrestrained vehicle occupants no statistical significant correlation was found between risks of being ejected and body size [43].

Among the 131 restrained children in the present study, 74 (56%) were considered to be appropriately restrained according to Swedish recommendations, i.e. rearward facing CRSs for the age groups 0 yo and 1–3 yo (at least), belt-positioning boosters (cushion or seat) in combination with seatbelts for the age groups 4–6 yo and 7–10 yo (at least), and three-point seatbelt for the age group 11–14 yo. Crash severity, major local intrusions, complex crash situation, fire and drowning were factors that contributed to the fatal outcome even though the restraint usage was optimal. One third of the cases were associated with crashes involving heavy vehicles and in five cases the car was impacted by a train. Moreover, nine cases were due to fire, and four cases due to drowning. In three cases the restraint system failed which may have contributed to the death of the children.

Head injuries were among the primary cause of death which correlates with prior studies [18, 32–33]. In 14 cases (7% in the total sample) the head injuries also included a skull base fracture. Although involving only the head, the mechanisms of these injuries can appear similar to those of head and neck injury combinations, and would be interesting to study further. Among the restrained children in this study, head injuries were the primary cause of death in half of the cases.

In total, 15 of the fatally injured children were restrained in rearward-facing CRSs during 1992–2011. Two of these children died because of fire and one of them drowned. The other twelve cases were associated with major intrusions: five cases to the roof (four of them due to turn/rollovers), four cases due to frontal impacts with heavy vehicles, and three cases due to side impacts (two nearside, one farside) of high severity. In one of the frontal impacts a CRS detachment may have contributed to the death of the child. It should be noted that no case has been reported in rear-end impacts.

Among 1–3 yo children in Sweden, the average rearward-facing CRS usage has been reported to be 64%–79% [41-43]. Yet, for the fatally injured 1–3 yo in the present study the rearward-facing CRSs (N=12) were less common than the forward-facing (N=15) (in three cases the CRS was unknown). In Sweden, as is often the case in all countries, the child seats are not always fitted correctly and the child harness is not always tightened appropriately. Acknowledging this, it is remarkable that so few fatalities have occurred in rearward-facing seats throughout the period of the studied time. The low relative numbers and the situations in which the few cases occurred, involving complex crash situations and extensive deformation at the area of the child, confirm that rearward-facing CRSs are extraordinarily safe and robust protection systems. Compared to statistics in Germany (Figure 2), it is obvious that the tradition of rearward-facing CRSs in Sweden has been of definite benefit for the smallest children.

V. CONCLUSIONS

A review of the child car occupant fatality developments in Sweden over 55 years (1956-2011) was undertaken in this study to gain an understanding of influencing factors and to get a perspective of fatalities in relation to general improvements in vehicle and road safety, and implementation of restraint systems. The conclusions reached are presented below.

- With the exception of initial increase during the first 10 years, crash-related fatalities among 0–14 yo car occupants has been diminishing ever since. Compared to the highest scores occurring in 1960s–70s a drop of 83% is seen. This is a higher number than the corresponding figure of 78% for the whole population, irrespective of age.
- The decreasing trend is similar irrespective of the age of the child.

For the child fatalities during 1992–2011 it was found that:

- The majority of the crashes involving child fatalities occurred on high-speed roads.
- Two fifths of the crashes involved one car, while three fifths involved other vehicles. An over-representation

of infants was found in single car crashes.

- A relatively higher proportion (69%) of the infants was unrestrained, in comparison to 24% among the whole group of 0–14 yos.
- In total, 59% of the unrestrained children were ejected during crashes. These situations were typically related to single car crashes and rollovers.
- Among the restrained children, 56% were considered to be appropriately restrained according to Swedish recommendations. Crash severity, complex crash situation, fire and drowning were factors that contributed to the fatal outcome, even though the restraint usage was considered to be optimal.
- Head injury was a primary cause of death, in a total of 54% of the cases.
- In 10% of cases the death was due to fire whereas in 4% death was by drowning.
- In total, only 15 of the fatally injured children were restrained in rearward-facing CRSs. Four cases occurred in frontal impacts (all involving severe crashes with a heavy vehicle), and zero cases in rear-end impacts. The low relative numbers and the situations in which the few cases occurred confirm that rearward-facing CRSs are extraordinarily safe and robust protection systems.

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VIII. Appendix

TABLE A.I

NUMBER OF CHILDREN IN SWEDEN OF DIFFERENT AGES (0–14 YEARS) AND THE SWEDISH POPULATION DURING 1956–2011.

	Age [years]															Popu-
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	lation
1956	106358	105647	103409	108023	107930	107747	112891	118528	123613	125760	129443	129907	129605	121836	111249	7341122
1957	105622	106378	105919	103665	108197	108176	107971	113075	118661	123784	125937	129599	130015	129696	121932	7392872
1958	104098	105528	106400	105953	103690	108237	108186	108018	113148	118720	123854	126010	129665	130051	129751	7436066
1959	103266	103866	105433	106256	105860	103666	108159	108124	107977	113106	118694	123814	125979	129653	130055	7471345
1960	100744	103352	103940	105421	106398	105862	103609	108144	108000	107898	112945	118584	123688	125766	129211	7497967
1961	103007	100884	103513	104008	105518	106551	105951	103653	108232	108086	108008	113034	118656	123757	125796	7542028
1962	105764	102954	100922	103533	104017	105573	106615	105949	103705	108275	108099	108056	113032	118684	123798	7581148
1963	111353	105787	103042	101038	103599	104085	105602	106625	106001	103755	108326	108122	108074	113065	118721	7627507
1964	121234	111716	106206	103382	101334	103858	104311	105810	106826	106200	103947	108497	108280	108224	113217	7695200
1965	121384	121885	112291	106774	103893	101792	104210	104590	106089	107059	106452	104164	108716	108507	108405	7772506
1966	121871	121690	122271	112669	107078	104230	102043	104449	104767	106310	107261	106621	104338	108874	108669	7843088
1967	119938	121861	121802	122143	112724	107118	104226	102068	104504	104807	106352	107400	106659	104413	108925	7892774
1968	110889	120179	121655	122113	122196	112831	107101	104487	102131	104596	104883	106466	107469	106731	104580	7931193
1969	105913	113331	121339	122752	122955	123056	113560	107682	105125	102670	105095	105352	106935	107905	107167	8004270
1970	108264	108089	114436	122294	123515	123647	123582	114125	108177	105582	103112	105629	105777	107441	108342	8081142
1971	111983	109427	108214	114451	122247	123413	123545	123445	113981	108126	105574	103182	105672	105846	107506	8115165
1972	112216	113198	109115	107819	113795	121773	122984	123092	123053	113725	107937	105418	103087	105591	105769	8129129
1973	108671	111418	113020	108918	107564	113445	121384	122548	122843	122808	113556	107824	105321	103007	105521	8144428
1974	109288	109393	111746	113179	108992	107652	113425	121255	122538	122865	122852	113573	107914	105388	103075	8176691
1975	103116	110407	109940	112190	113484	109246	107755	113570	121413	122728	123088	123057	113771	108101	105533	8208442
1976	98256	104317	111077	110352	112560	113855	109544	107916	113781	121612	122962	123273	123328	113954	108243	8236179
1977	95928	99332	104903	111495	110729	112913	114136	109732	108172	113997	121763	123163	123474	123542	114156	8267116
1978	92980	96591	99487	105066	111578	110828	112887	114134	109751	108239	114061	121777	123199	123524	123550	8284437
1979	95914	93670	96777	99636	105132	111710	110841	112830	114126	109796	108257	114062	121769	123262	123564	8303010
1980	96788	96649	93801	96861	99737	105153	111657	110732	112784	114022	109764	108265	114046	121760	123332	8317937
1981	93937	97577	96628	93824	96798	99671	105062	111477	110677	112729	113925	109691	108237	114028	121734	8323033
1982	92725	94439	97516	96599	93739	96764	99535	104870	111333	110560	112567	113842	109659	108206	113955	8327484
1983	91618	93202	94469	97506	96570	93679	96698	99400	104844	111234	110505	112545	113806	109673	108179	8330573
1984	93630	92230	93407	94569	97665	96641	93711	96761	99487	104874	111324	110575	112605	113851	109799	8342621
1985	98196	94399	92522	93635	94762	97787	96755	93732	96871	99586	104997	111420	110665	112737	113937	8358139
1986	101672	99023	94895	92873	93975	95050	98038	96934	93913	97065	99714	105196	111597	110839	112932	8381515
1987	104456	102626	99508	95302	93335	94436	95452	98311	97264	94186	97353	100011	105434	111837	111173	8414083
1988	111892	105337	103185	100029	95846	93910	94954	95948	98772	97666	94633	97685	100367	105718	112146	8458888
1989	115847	112875	106082	104068	100895	96673	94697	95693	96681	99456	98321	95237	98220	100837	106264	8527036
1990	124004	116782	113612	106755	104812	101565	97334	95376	96284	97285	99998	98818	95683	98715	101179	8590630
1991	123353	124659	117257	114129	107300	105265	102122	97874	95871	96800	97682	100491	99250	96070	99002	8644119
1992	122582	124040	124819	117645	114498	107659	105663	102453	98299	96258	97210	98006	100837	99578	96427	8692013
1993	117373	122968	124505	125432	118335	115171	108352	106322	103154	99016	96919	97837	98579	101456	100099	8745109
1994	111984	117570	123547	125819	126791	119742	116538	109692	107621	104384	100134	98046	98879	99520	102398	8816381
1995	103072	112307	117520	123572	125848	126900	119925	116689	109876	107794	104595	100320	98211	99044	99689	8837496
1996	94983	103371	112324	117397	123415	125824	126899	119987	116766	109937	107908	104740	100455	98287	99132	8844499
1997	90180	95292	103346	112328	117386	123424	125895	127066	120151	116968	110168	108129	104952	100670	98497	8847625
1998	89234	90715	95520	103455	112432	117503	123580	126092	127282	120412	117210	110457	108429	105201	100940	8854322
1999	88367	89890	91008	95773	103678	112627	117695	123777	126366	127545	120657	117454	110691	108696	105477	8861426
2000	90714	89230	90304	91457	96145	104083	112922	118053	124106	126748	127902	121073	117914	111108	109039	8882792
2001	91653	91628	89779	90776	91931	96588	104514	113331	118462	124505	127140	128415	121507	118454	111592	8909128
2002	96026	92686	92180	90321	91286	92380	97075	104919	113773	118889	124930	127644	128916	121978	118922	8940788
2003	99230	97079	93204	92614	90759	91768	92774	97498	105333	114226	119357	125291	128065	129384	122408	8975670
2004	101090	100281	97625	93543	93019	91140	92143	93109	97801	105726	114602	119689	125678	128401	129734	9011392
2005	101555	102191	100798	97971	93830	93336	91383	92409	93478	98081	106038	114924	120016	126019	128747	9047752
2006	106278	102913	103091	101579	98722	94453	94197	92016	93124	94231	98849	106883	115684	120794	126773	9113257
2007	107757	107531	103797	103898	102322	99411	95251	94919	92770	93887	95019	99665	107662	116358	121486	9182927
2008	109664	109163	108612	104756	104787	103126	100201	96067	95719	93622	94660	95827	100488	108451	117259	9256347
2009	112120	110902	110130	109473	105597	105582	103912	101013	96850	96577	94374	95475	96681	101427	109329	9340682
2010	115910	113423	111717	110654	110084	106130	106106	104492	101462	97467	97117	94994	96052	97264	102087	9415570
2011	112114	117242	114285	112444	111284	110630	106635	106647	104977	102048	98015	97739	95569	96714	97927	9482855

TABLE A.II

CAR CRASHES IN SWEDEN AND CRASH RELATED FATALITIES AMONG CAR OCCUPANTS (1) 0–14 YO AND (2) IN THE SWEDISH POPULATION

Year	No. of Crashes	Age [years]															Total	Popu-lation
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14		
1956	-*)				7							1					8	222
1957	-*)				8							2					10	258
1958	-*)				4							8					12	265
1959	-*)				5							7					12	302
1960	-*)				6							8					14	339
1961	-*)				10							8					18	368
1962	-*)				13							18					31	464
1963	-*)				7							16					23	493
1964	-*)				13							17					30	610
1965	-*)				8							15					23	607
1966	-*)				13							10					23	674
1967	-*)				7							17					24	600
1968	-*)				12							9					21	671
1969	-*)				10							12					22	650
1970	-*)				16							13					29	668
1971	-*)				9							14					23	669
Total	-*)				148							175					323	7860
1972	-*)	5	2	2	1	5	1	1	4	4	1	1	-	2	2	4	35	645
1973	-*)	1	2	1	1	1	1	2	-	1	1	2	1	3	3	5	25	649
1974	-*)	3	1	4	-	2	2	4	1	-	2	-	1	2	1	1	24	619
1975	-*)	4	2	-	1	1	2	3	1	-	1	-	-	-	2	6	23	620
1976	-*)	2	1	1	-	6	4	2	2	2	4	1	-	1	2	9	37	669
1977	-*)	3	-	-	1	1	-	2	-	1	-	3	2	4	6	3	26	608
1978	-*)	1	-	-	2	1	3	2	-	3	1	2	1	4	4	2	26	600
1979	-*)	-	1	2	2	2	5	-	1	3	1	-	5	1	2	4	29	553
1980	-*)	3	2	2	4	3	-	2	-	1	-	-	1	1	2	3	24	498
1981	-*)	3	2	-	1	5	1	3	-	4	1	-	-	2	1	3	26	462
1982	-*)	6	-	1	-	1	-	-	1	2	1	1	1	2	2	-	18	431
1983	-*)	1	-	1	3	-	1	1	1	-	1	-	-	3	1	1	14	409
1984	-*)	1	1	1	2	2	-	-	-	-	1	1	2	2	2	2	17	427
1985	-*)	-	1	-	1	-	-	4	1	1	1	1	2	2	2	1	17	511
1986	-*)	1	-	1	1	-	1	-	-	1	-	-	1	-	-	1	7	507
1987	-*)	-	-	1	-	3	1	3	1	-	-	2	2	1	3	1	18	496
1988	-*)	-	1	1	1	-	2	-	-	2	1	2	1	-	4	2	17	525
1989	-*)	1	2	3	1	5	1	2	-	1	1	1	2	-	6	3	29	590
1990	-*)	3	1	2	2	-	1	-	1	1	2	1	1	-	-	2	17	496
1991	-*)	3	2	3	-	2	-	1	-	-	1	2	1	-	-	3	18	490
Total	-*)	41	21	26	24	40	26	32	14	27	21	20	24	30	45	56	447	10805
1992	13	2	-	1	4	-	1	1	1	-	1	1	2	1	1	-	16	485
1993	14	-	3	1	1	1	-	1	1	1	-	-	-	2	2	2	15	408
1994	12	2	1	2	1	2	-	-	1	-	-	2	1	-	2	1	15	408
1995	18	2	-	1	1	3	1	-	1	1	3	2	-	2	-	1	18	394
1996	8	-	1	-	1	1	1	-	1	1	-	-	-	3	1	-	10	356
1997	8	-	2	-	-	-	1	1	1	-	1	1	-	-	1	-	8	371
1998	5	-	-	-	1	1	1	-	-	1	1	-	-	1	-	1	7	345
1999	11	1	1	2	-	-	-	4	1	1	3	2	-	3	6	3	27	392
2000	10	1	-	-	-	1	-	-	1	-	-	1	1	1	3	2	11	417
2001	7	-	-	1	2	1	-	1	1	-	1	1	-	-	-	-	8	399
2002	8	-	1	1	-	1	-	-	-	1	-	1	-	2	-	2	9	405
2003	9	-	1	1	-	-	-	2	1	2	-	1	-	1	1	1	11	378
2004	7	2	1	-	1	1	-	2	-	-	-	1	-	-	1	-	9	302
2005	5	1	-	-	-	-	-	1	-	-	-	-	-	1	1	1	5	291
2006	5	-	-	-	2	-	1	1	-	1	1	-	-	-	-	1	7	287
2007	2	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	2	300
2008	2	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	2	251
2009	3	-	-	-	-	1	-	1	-	2	-	-	-	-	-	-	4	229
2010	7	-	-	1	-	-	1	1	1	1	-	-	-	-	1	1	7	165
2011	3	1	-	-	-	-	-	-	-	-	-	-	-	1	-	1	3	175
Total	157	13	11	12	14	13	7	17	11	12	12	13	4	18	20	17	194	6758
Total (1956-2011):					445							519					964	25423

*) No data available