

# Is European school transport safe?—The need for a “door-to-door” perspective

Anna Anund · Tania Dukic · Sian Thornthwaite ·  
Torbjörn Falkmer

Received: 29 April 2010 / Accepted: 19 April 2011 / Published online: 3 June 2011  
© The Author(s) 2011. This article is published with open access at SpringerLink.com

## Abstract

**Purpose** To identify and establish the number and aetiology behind children being killed or injured during school transport from a door-to-door perspective by using experience from Sweden and the UK.

**Methods** Available crash data were analysed.

**Results** In total, 361 children in Sweden during 1994–2001, i.e. 24% of the 1,515 identified children aged 6–16 who were injured or killed were identified in 256 school transport events. The predominant reason for being killed or injured when travelling on school transportation was when children were outside the bus (74%), either when

passing the bus to cross the street, running in front of the bus (21%) or behind the bus (30%). Contrary to the general belief that children older than 12 are mature enough to handle traffic, more than 50% of the fatal injuries in Sweden affected children aged 13–16. Similar results were found in the UK. The afternoon school journeys, pedestrians after alighting from the bus, and those in situations that deviated from their normal routine were found to be particularly vulnerable.

**Conclusions** The travel chain perspective/or door to door perspective offers a promising approach for understanding school transport risks and for identifying effective counter-measures; including around bus stops and on the way to/from the bus stop. Data collection needs to be revised to reflect this approach.

**Keywords** Child · Safety · School bus · Casualty/injury · School transport

---

A. Anund (✉) · T. Dukic  
Swedish National Road and Transport Research Institute, VTI,  
Olaus Magnusväg 35,  
SE-581 95 Linköping, Sweden  
e-mail: anna.anund@vti.se

S. Thornthwaite  
STC Ltd.,  
Derby, UK

T. Falkmer  
School of Occupational Therapy & Social Work, Curtin Health  
Innovation Research Institute, Curtin University of Technology,  
Perth, WA, Australia

T. Falkmer  
Rehabilitation Medicine, Faculty of Health Sciences, Linköping  
University,  
Linköping, Sweden

T. Falkmer  
School of Occupational Therapy La Trobe University Melbourne,  
Vic, Australia

T. Falkmer  
School of Health Sciences, Jönköping University,  
Jönköping, Sweden

## 1 Introduction

Going to and from school is a daily journey undertaken by millions of children within the European Union (EU) [1]. Whilst many children walk or cycle to and from school; buses, coaches and minibuses are major modes of travel for European children. However, school transport is not just about being a bus occupant [2]. All such journeys are also likely to involve other elements, such as walking to and from the bus stop, waiting at bus stops, and boarding and alighting. Parents are concerned about the safety of their child on the whole of the school journey and do not necessarily make the distinction that a school bus casualty occurred after having just alighted from the bus rather than as an occupant. This is why the school journey should be

considered from a “door to door” perspective [3]. Given this perspective, it is important to identify the most critical situations for children on their entire daily journey to and from school, in order to suggest effective countermeasures.

The EU consists at present of 27 member states with some 491 million inhabitants, each of them having their own traffic situation and methods of recording crash statistics, which makes direct comparisons of safety between countries complicated [26, 27]. In addition, comparing countries is problematic since “*comparison of fatality and injury rates must be done for homogeneous environments and road user groups and not for whole countries and all road user groups, as the distribution and composition of traffic in different environments must be taken into consideration*” [27].

As shown in the EU database EC-CARE,<sup>1</sup> [1] children aged 6–11 years old are most likely to be killed or seriously injured during afternoons, possibly when going home from school. However, crash and/or casualty statistics are usually mode specific, and even if the casualties occurred during the school transport they most often lack of data taking into account that perspective [28]. Data available differ not only regarding this, but also when it comes to the content and if the data are possible to extract, for example per year.

The system of school transport in the U.S.A differs from the EU system, as the bus itself is an icon and also a “mobile traffic STOP-sign”, requiring traffic to stop and not overtake a school bus when children are boarding or alighting. On a daily basis, more than 22 million children of various ages are transported to and from school in specially designed yellow and black school buses all over the U.S.A. [4, 5]. Going to school by the American school bus system appears to be the safest road transportation available in the U.S.A. [4, 6, 7]. A child on the way to school is eight times more liable to be injured while travelling to and from school in a vehicle other than in a school bus [8]. The fatality rate for school bus occupants is 0.2 fatalities per 100 million vehicle miles travelled (VMT) compared to 1.5 fatalities per 100 million VMT for cars [9]. However, a number of serious school bus crashes in the U.S.A. has been reported, including multiple fatalities of drivers and children [4, 10–13]. Most of them included rollover and side impacts as predominant features, i.e., in about 63% of the cases, representing approximately 40–50% of all school bus fatal injuries of passengers fully or partially ejected out of the bus. In 28% of the cases frontal impact crashes were the predominant feature of the fatalities [11]. These facts have highlighted the issue of mandatory seatbelts for school buses in the U.S.A. [11], an issue of

some controversy [14–20]. Other studies calculate injuries among children going to and from school by school bus differently, which unfortunately invalidates comparisons [21]. Based on a national indicative sample from the National Electronic Injury Surveillance System of all Injury Program, 17,000 injuries between 2001 and 2003 were reported in the U.S.A. This figure corresponds to a risk of 21.1 per 100,000 populations. Children in the age of 10–14 accounted for the highest proportion of injuries. Among children, motor vehicle crashes accounted for 42% of all injuries, followed by injuries that occurred as the child was boarding/alighting/approaching the bus (24%). The authors concluded that this is a much greater annual number than have been shown earlier. In addition, the illegal overtaking of school buses by cars remains problematic, for example, more than 10,000 vehicles were recorded illegally passing stopped school buses during one typical day in Florida [22]. Statistically, a child is three times as likely to be killed as pedestrians in the “loading zone” around the school bus when the school bus is present, than to be killed as passengers in the school bus [23].

Many of the features of the school transport system in the U.S.A. do not apply to most EU conditions. Instead, it is more common in the EU to have a mixed system of school transport [24, 25]. Some children are transported by a vehicle, e.g., a bus, a coach or a minibus provided for school children, but the vehicle does not have any special features or traffic rules applying to its presence on the road, except for EU regulations related to seat belts and the display of a school bus sign (and in some countries a requirement/or permission to use flashing lights when stationary or running lights). In addition, many children in EU are transported by the public transport system. As a consequence of this mixed system, injury statistics in the EU, with respect to transportation of school children are more difficult to obtain. Lastly, the EU statistics, as in the U.S.A, only cover school bus crashes when the school bus is present. Thus, they do not include children as pedestrians going from home to the bus stop or awaiting the school bus, nor do they cover them as pedestrians departing the bus stop to their final destination.

This lack of a holistic approach poses a problem, since it remains unknown what countermeasures could be taken effectively to reduce the number of injured children. The aim of this paper is to identify and establish the number and aetiology behind children being killed or injured during school transport from a door-to-door perspective by using experience from Sweden and the UK,

<sup>1</sup> CARE is a Community database on road accidents resulting in death or injuries. The purpose of the CARE system is to provide a powerful tool which makes it possible to identify and quantify road safety problems throughout the European Union, evaluate the efficiency of road safety measures, determine the relevance of Community actions and facilitate the exchange of experience in this field.

## 2 Method

The lack of a door-to-door perspective in crash statistics necessitates special approaches towards the data, since no

such EU-based statistics are available [29]. In the present study, police reported data from Sweden and the UK have been chosen to illustrate the situation, and to identify gaps where further data are necessary.

## 2.1 School transport background

### 2.1.1 Sweden

With a population of 9.2 million inhabitants, Sweden represents some 2% of the population in EU. The country has a school law which states that the local authority has to provide free transport for the children if the distance between the child's home and school is more than a specified distance (a typical distance being 2–4 km for primary school children [30]) and if a child has a disability (if any), as well as if other special circumstances require it. In order to decide whether or not a child has the right to achieve free school transport, most local authorities have school transport regulations [31]. However, these regulations are only valid for journeys with contracted school transport, not school transport as part of the public transport system. Local authorities can choose contractors and also prescribe how the services should be operated, e.g. solely by specially trained drivers. In Sweden, however, there is no mandatory training required for drivers of school transport [25]. The school transport regulation in Sweden states that the local management of the school is responsible for safety and also for practical and theoretical training of the children to prepare them for safe school transport. Despite this fact, the local authorities do not have any commonly used requirements concerning crash and incident reporting [31]. In Sweden, less than 1% of the vehicle fleet consists of buses [32], while more than 10% of the road vehicle transport kilometres travelled are performed by these buses [27]. However, children riding buses are not necessarily only using them for school transport. In order to estimate the number of children being injured in relation to school transport, the share of children entitled to this service needs to be estimated in relation to the overall number of children in the corresponding age cohorts. In Sweden, the annual number of births has been stable over the last two decades at a figure of some 100,000 [33, 34]. The number of children that attend school can therefore be estimated to be 1.2 million. In total, 440,000 children in Sweden were entitled to school transport in 1993 [30], a figure confirmed by a questionnaire study [25], indicating that approximately 37% of all children were entitled to this service. Of these children, approximately 250,000, i.e. 57%, attended primary school. Some 10% of them have some sort of disability [35, 36]. It is more common to be entitled to school transport in secondary school compared to primary school and also in rural areas. Despite having

more than every third Swedish child on school buses on schooldays, it is at present not possible from the national crash database of police reported crashes (STRADA, formerly known as VITS) to obtain statistics about the “true”/real number and aetiology of school transport related fatalities and serious injuries [28].

### 2.1.2 UK

The UK has a population of approximately 62 million, of which about 8 million are school age children. The legislation relating to school transportation is similar to that in Sweden, with local authorities required to provide free home to school transport to children who live beyond 2–3 miles of school, depending on their age. In addition, school transport is provided for those children who have special needs and would otherwise be unable to walk to school, or where a route is unsafe to walk. Local authorities either contract with local bus and coach/minibus or taxi operators to provide transport for children, or they use public transport.

In the UK, approximately 13% of school children qualify to receive free school transport, equivalent to 1.3 million children [37], and the National Travel Survey shows that in 2009 overall 14% of 5–16 years old children travelled to school by public transport, and a further 6% travelled on contracted buses and coaches.<sup>2</sup> This suggests that more than 1.6 million children each day travel to and from school by bus or coach. As in Sweden, secondary school pupils in the UK are more likely to receive school transport and to travel by bus than primary school pupils. Approximately 15% of children receiving transport qualify for school transport because of their special needs.

In recent years there has been a trend towards greater use of contracted vehicles to provide school transport, (in part because since the 1990s there has been progressive legislation that has required contracted vehicles to display school bus signs, and to have a seat belt for each child, which have encouraged parents' preference for dedicated school services where no member of the public can travel with children) [37].

## 2.2 Data analysis

### 2.2.1 Sweden

For the Swedish data, a two step analysis was performed, in order to capture fatalities and injuries in relation to school transport crashes recorded in the national database of police reported crashes (VITS), since there is no such available

<sup>2</sup> Department for Transport (2009) National Travel Survey Table NTS0613

adequate and compiled data. In step 1, all injury incidents that involved children aged 6–16 and taking place between 6 A.M.–4.59 P.M. during school days, involving bus or taxi, and/or pedestrians were selected. It should be noted that the vehicles included were either explicitly for school transport purposes or a vehicle being part of public transport. In step 2, all police reports or other records concerning these injury incidents were collected and analysed to confirm that these injury incidents actually were related to school transport. The exclusion criteria in the second step were as follows:

- incident involved a pedestrian and a car—explicitly not denoted in the records as taxi
- incident involved two or more cars—none being explicitly denoted in the records as taxi
- incident involved a bus—no child was injured
- incident involved children the utilised bicycles, mopeds, in-lines and other means of road transportation devices.

The criteria for the selection of incidents in step 2 meant that the following types of incidents were further studied and classified:

- I. bus/pedestrian
- II. incidents which involved any type of school transport vehicle
- III. children on their way to and from the bus stop
- IV. children at bus stops
- V. children injured while boarding or alighting from the bus
- VI. VI: children entering the road in front of or behind the bus after alighting from it.

Injury classification has been performed according to the Abbreviated Injury Scale (AIS) classification [38]. MAIS stands for Maximum AIS, i.e. the most severe injury. AIS=1 designates minor injuries, AIS=2 moderate injuries (e.g. concussion), AIS=3 serious injuries (e.g. femur fracture or spleen rupture) and AIS=4–6 designates severe, critical and maximum injuries.

To be able to further analyse the data, the children were subdivided into three groups according to the division made in primary schools, i.e. 6–9, 10–12 and 13–16. The reason for the first and the last cohorts having four age year groups each is that children start school in the autumn and hence could be either 6 or 7 when they enter the mandatory 9 years primary school.

### 2.2.2 UK

For Great Britain (i.e. the UK excluding Northern Ireland) the national accident database of police reported casualties (STATS19) is used to collect data on road accidents involving personal injury and classifies injuries as: fatal,

serious or slight. Police at the scene of a crash should also record whether the casualty occurred on the way to or from school. However, for buses, coaches or minibuses, casualties will include only those who were vehicle occupants or were boarding or alighting. They will not include those injured subsequent to leaving, or prior to boarding the vehicle, or waiting at bus stops. These will be included within the definition of pedestrian casualty. In addition, whilst bus and minibus occupant casualties and serious injuries are known to be well recorded, less serious injuries and pedestrian casualties are known to be under-reported [39].

In 2002, a more detailed study undertaken for the Scottish Executive [40] reviewed all child pedestrian casualty data for Scotland for 1999 and 2000 meeting the following criteria:

- Whether the crash occurred between 7 A.M. and 9.15 A.M. Monday–Friday, at lunch times, or between 3 P.M.–5 P.M. Monday–Thursday, or 12.15 P.M.–5 P.M. Wednesdays and Fridays
- Whether the casualty was aged 5–17 years
- Whether the casualty was a pedestrian or a boarding or alighting bus passenger

For each incident meeting these criteria the individual accident report was analysed to identify whether a bus or coach had been involved and the circumstances of the injury to ascertain the extent of the problem where buses are involved.

## 3 Results

### 3.1 Crashes, children, severity and road user categories

The Swedish data step 1 yielded in total 1,515 cases, in which a child was injured on school days during the time interval selected (6 A.M.–4.59 P.M.). From these cases, based on the inclusion and exclusion criteria in step 2, a total of 361 injured children in 256 injury events were selected. The distribution of MAIS (Table 1) shows that 15 were fatal, 96 suffered MAIS 2+ injuries and 250 MAIS 1. Injuries sustained by children as pedestrians (61%) and bus passengers (36%) dominated the road user type panorama.

When further elaborating the results from the age cohort 13–16 years of age, representing 36% of the sample, it was revealed that 46% of the injured and killed were in this age. Among the 15 fatally injured children, eight (53%) were 13–16 years of age. The corresponding figures for MAIS 2+ and MAIS 1 injuries for this age cohort were, 47% and 45%, respectively.

The UK analysis based on STATS19 data for the school journey shows that in the past 10 years the school journey

**Table 1** Number of killed and injured children 6–16 years old in school transport in 1994–2001, with respect to the distribution of MAIS-classification of injuries and fatalities, and with respect to road user categories

Road user category	Injury severity			
	Fatal	MAIS 2+	MAIS 1	All
Bus occupant	6	13	111	130
Car occupant	0	4	4	8
Cyclist	0	2	1	3
Pedestrians	9	77	133	219
Other	0	0	1	1
Total	15	96	250	361

has been getting safer. In 1997, 8,093 children aged 5–16 inclusive were reported as being injured or killed on the school journey (nearly 700 of those on buses). By 2008, this had fallen to a total of 3,888 children and 242 on buses. Overall 15% of child road casualties occurred on the school journey, but only 10% of fatalities (Table 2). However, a higher proportion of bus, coach and minibus casualties occur on the school journey—but these are predominantly slight injuries, reflecting the relatively low use of buses by children for journeys other than to and from school.

### 3.2 Classification of crashes in Sweden distributed on critical situation

In order to identify the most critical situations in Sweden, crashes with injured or killed children were classified. The classification was done into 10 different groups. The classification itself can be seen as a result based on the reality behind the crashes. The most common situation found (when children were injured or killed) was when the children were running out behind the bus in the afternoon, see Fig. 1.

Of the 150 casualties identified as pedestrians in crashes where a bus was involved in Scotland in 1999 and 2000,

four were fatally injured and 35 were seriously injured. In total, 111 were slightly injured. Children in the 11–14 years old age group accounted for almost two-thirds of these casualties where a bus was present, with the majority of casualties aged 12–13 years. Analysis of the distribution of casualties where a bus was known to be involved showed that 65% of these casualties were involved in accidents on the journey home from school and that 78% of these casualties had alighted from a bus (Table 3).

More than half appeared to have been crossing in front of the bus and more than 25% to the rear. Twenty of the 150 casualties (13%) were known to have occurred at a bus stop.

### 3.3 Casualties in the UK distributed on sex and age

In the UK overall, the data show that school journey casualties at all ages are higher for boys than for girls. For both sexes, casualties peak at the age of 11–12, which coincides with a time of significant change to travel patterns for children and the transition to secondary schools.

The more detailed analysis of the data in Scotland showed that of the 1,231 child pedestrian casualties recorded on the journey to and from school in 1999 and 2000, no vehicle was involved in the majority of cases, but 150 children were injured as pedestrians when a bus was present with 43 being hit by the bus and 107 by another vehicle but when the bus was present. This suggests that 12% of all child pedestrian school journey casualties in Scotland occurred when a bus is present.

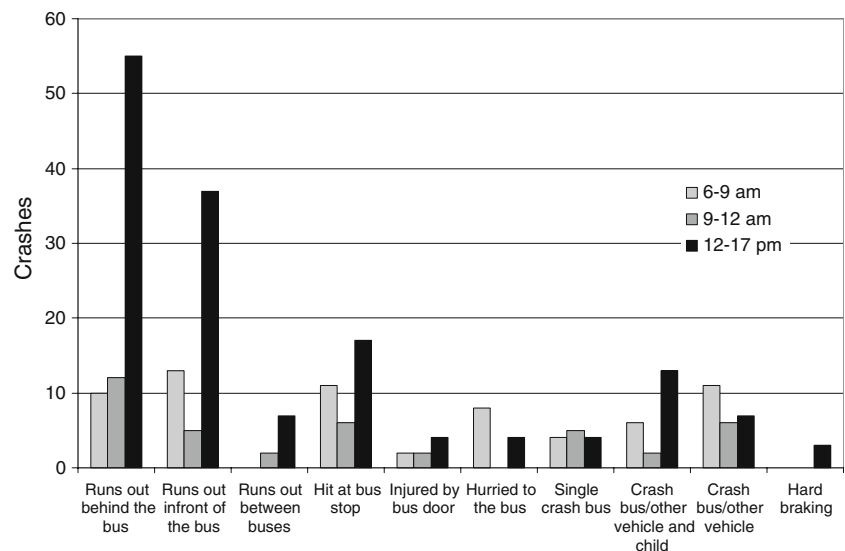
## 4 Discussion

The present study aimed to identify the number and the aetiology behind children being killed or injured on school transport by using UK and Sweden as examples. In conclusion the results have highlighted the lack of

**Table 2** School journey casualties by mode and severity, 2008, Great Britain (and as proportion of all child casualties)

Road usercategory	Injury severity			
	Fatal	MAIS 2+	MAIS 1	Total
Pedestrian	14 (20%)	397 (21%)	1968 (26%)	2379 (25%)
Cyclist	1 (6%)	53 (12%)	444 (14%)	498 (13%)
2 wheeled motor vehicle	0	6 (2%)	74 (5%)	80 (4%)
Car (including taxis)	2 (3%)	16 (3%)	616 (6%)	634 (6%)
Minibus	0	4 (67%)	41 (31%)	45 (32%)
Bus and coach	0	10 (28%)	232 (31%)	242 (25%)
Other	0	1 (4%)	9 (4%)	10 (4%)
Total	17 (10%)	487 (15%)	3384 (15%)	3888 (15%)

**Fig. 1** Reasons behind crashes with injured or killed children in relation with time of the day



consistent data and the analysis of the data that is available indicates it is difficult to have a clear view of the underlying problems and causes of school journey casualties. However, overall findings show the majority of the children on school transport who were killed were not vehicle occupants, they were in the area outside the bus on their way to or from buses, that boys seem to be over represented and that the afternoon journey is particularly vulnerable. Running out behind the bus in the afternoon was a common scenario.

The lack of data is due to different reasons and one is the problem of definition; what does ‘bus related’ mean; i.e., at what point in the travel chain does a bus journey start? Does it start when the bus passenger is entering the bus or when he or she is leaving home to go to the bus stop, and does it end when leaving the bus or when they are home again? One way to penetrate this issue is to apply the “Travel Chain Perspective” [41, 42], which means that a bus or coach trip involves all necessary steps from “door to

door”. This, in turn, implies that going to and waiting at the bus stop, as well as boarding and alighting, are integral parts of the journey and should be taken into account when focusing on casualty data collection and injury preventive measures.

This review also highlights the lack of consistency of data, and inadequate level of detail, for example recording of date, time of day, day of week as well as gender of the child, which all appear to be relevant to developing effective countermeasures. One recommendation is that there needs to be a consensus about how to report and enter such data into crash static databases, in order to monitor school transport related crashes, when they happen (year, month, day, hour) and the age and gender of the child.

The results presented in this article for child casualties are consistent with several investigations for adults [19, 26, 43] showing that boarding and, especially, alighting from the bus is the major injury related event. Moreover, children outside the school bus are exposed to a higher risk

**Table 3** Position of child relative to bus and association with bus at time of accident, Scotland 1999 & 2000

Position of child relative to bus at time of accident	Child definitely associated with bus as passenger		Child may have been associated with bus as passenger	Child unlikely to be associated with bus as passenger	All	%
	Before boarding	Having alighted				
Front	5	20	36	16	77	51%
Rear	1	7	32	–	40	27%
Unknown	4	10	9	–	23	15%
Between vehicles <sup>a</sup>	–	1	8	–	9	6%
Side	1	–	–	–	1	1%
All	11	38	85	16	150	100%

<sup>a</sup> (where at least one of vehicles a bus)

compared to those inside [44, 45]. One of the U.S.A studies of school bus crashes has shown that 85% of school bus casualties were pedestrians injured near or around the bus, and of these, many were hit by the actual bus they intended to ride or rode with [46]. Children going to and from school by bus appear from our results to be at greatest danger when going from the bus in the afternoon, on their way home. Running out behind and in front of the buses are events with the highest representatives among crashes. The average age of those children was 12 years old. Those results are in line with the results from U.S.A. [21]. Studies have shown that children do not see school transport as a part of their school day [2]. In line with this, it could be argued that children when alighting enter “play time” with things other than school in their minds—a sort of cognitive distraction. The consistency of these casualties patterns across in Sweden, the USA and the UK emphasises the need for effective road safety education, ensuring the school journey is regarded as an integral part of the school day and thus under the school’s responsibility.

Another explanation for the high numbers of casualties when running out behind (or in front of) the bus could be that children do not have the capability to perform beyond their degree of maturity. The frontal lobe is one of the latest parts in the brain that is developed [47]. The frontal lobe is the region essential in order to, for example, foresee the consequences of behaviour. It could be argued that children do not have the capability to foresee a possible critical situation when, for example, running out behind a bus. If children are unable to manage such situations this raises the need for effective risk assessment of the location of bus stops to ensure they are not in complex traffic environments which children are inherently unable to cope with.

Based on in-depth interviews with a selection of children in Sweden who were seriously injured in relation to school transport [2], it was concluded that on the day of their crashes, in almost all cases, it was a situation with deviations from their normal routines. In terms of countermeasures, this highlights the need to focus on and maybe avoid, or reassess, situations where there is change from normal routines, or when changes to routine have to occur, whether these are short term or for example transition to a new school/area. The authors recommend therefore that the planning of the trips should be arranged to make sure that there is a high degree of routine and that foreseen deviations should be considered during the planning phase, in order to avoid increasing risk. Such planning needs to be done in collaboration with other stakeholders including parents, teachers, and children themselves. In particular, this holds true in the case of children with cognitive or perceptual disabilities.

If the results from Sweden and the UK are set in relation to the data from the U.S.A., it can be seen that school bus

occupants have a good safety record in all three countries. The American data showed that there are three times as many children killed around school buses as they are killed inside a school bus. A review of school bus safety undertaken by the New Zealand Land Transport Safety Authority in 2002 found that in New Zealand, Australia, The U.S.A and Canada most school bus incidents are pedestrians alighting the bus in the afternoon [48]. The notable difference is that in the U.S.A. and Canada the majority of pedestrian casualties are caused by their own school bus, whereas in New Zealand and Australia the children injured after alighting were more likely to be injured by another vehicle. This reflects the different education practices where in the U.S.A. and Canada children are encouraged to cross the road in front of their bus, while in the UK, Australia and New Zealand the practice is to teach children to cross the road after their bus has left the bus stop.

This analysis also highlights the need to learn from other EU countries. However, solutions also need to be suitable to the local areas. Importing an American concept is not necessarily the solution, as the data from New Zealand and Australia show. Requirements such as “no overtaking” of school buses may simply relocate the casualties and the vehicle causing it, whereas more comprehensive speed management around school bus stops may be more appropriate in a European context.

Although EU wide comparisons (and comparisons with the U.S.A. and other countries) are difficult due to different injury classifications, definitions of a school child and of vehicle type, there are some consistent themes that enable conclusions to be drawn about school journey safety and some consistent problems/deficiencies with data collection that would merit discussion and further debate. A limitation is that the Swedish data were some years old. However, updated data, but based on a new crash recording routine in Sweden called STRADA, show the same pattern for those items possible to compare [49].

Buses are a safe mode of transport and it is important to keep in mind that most children are injured or killed as passengers in cars [35] in Sweden, and in the UK as pedestrians or cyclists. For example in Sweden more than half (54%) of the child fatalities and 39% of the seriously injuries sustained by children were due to car crashes [28]. Nevertheless, during the period of 1994–1999, more than 100 children in Sweden were either killed or seriously injured per annum in bus related incidents [50]. In the UK more than 14 children a year are seriously injured as bus occupants on the school journey, and the study in Scotland suggests that up to 12% of all child pedestrian casualties may be injured in bus related incidents.

## 5 Conclusions

There is an urgent need to take a travel chain perspective into account when considering school transport safety—a door to door perspective. The nature of the school journey needs to be considered as a travel chain from home to home. Data from both Sweden and UK support the need for this approach. The travel chain perspective requires a new form of research. There is a need to do ongoing analysis to monitor trends that focus on the area around school bus, and bus stops, and follow this up with child-centred research to understand more fully the circumstances of accidents involving them.

**Open Access** This article is distributed under the terms of the Creative Commons Attribution License which permits any use, distribution and reproduction in any medium, provided the original author(s) and source are credited.

## References

- TIS (2004) Road safety in School transport. Brussels
- Falkmer T, Lövgren A, Anund A, et al. (2006) Säkerhet och trygghet i samband med skolskjuts—ur barnens perspektiv. VTI Rapport. Linköping: VTI; Report No.: 548
- Carlsson G (2004) Travelling by urban public transport: exploration of usability problems in a travel chain perspective. *Scand J Occup Ther* 11:78–89
- Edwards ML (1991) A Summary of Selected Nationwide School Bus Crash Statistics. NHTSA Technical Report. Washington: NHTSA; Report No.: DOT HS 807 734
- TRB (1989) Improving school bus safety. Special report: National Research Council; Report No.: 222
- Evans L (1991) Traffic safety and the driver. Van Nostrand Reinhold, New York
- NHTSA (1985) Safety belts in school buses: U.S. Department of Transport
- Farr GN, Eng P (1985) School bus safety study-volume 1. Traffic safety standards and research, Transport Canada
- McCray L, Brewer J (2002) School Bus Safety: Crashworthiness Research: NHTSA; Report No.: Report to Congress <http://www.nrd.nhtsa.dot.gov/departments/nrd-11/SchoolBus.html>
- FMVSS (1976) Motor vehicle safety standard 222: School bus seating and crash protection. Federal Motor Vehicle Safety Standards and Regulations. Washington DC: National highway traffic safety administration, U.S. Department of Transportation
- Bladikas AK, Kabir F, Iqbal S. Lap belt effectiveness on school buses. 71st Annual meeting of TRB; 1992; Washington DC; 1992
- NTSB, Board) NTS (1999) Highway special investigation report: Bus crashworthiness issues. Washington, D.C. Report No.: PB99-917006
- NHTSA, Washington DC. Traffic safety facts 1999. School buses. 1999 [cited 2001; Available from: [www.nhtsa.dot.gov/people/ncsa/pdf/Schbus99.pdf](http://www.nhtsa.dot.gov/people/ncsa/pdf/Schbus99.pdf)
- Dusseau R, Khasnabis S, Smith T (1992) Safety and structural implications of seat belts on transit buses: Final report Phase III. Detroit, Michigan: Great Lakes Center of Truck Transportation Research; Report No.: GLCTTR 16-92=01
- Farr GN (1987) School bus seat development study: Transport Canada
- Farr GN (1989) School bus demonstration project—rearward facing seats: Transport Canada
- Keckman D. Safety of buses and coaches—problems and recent solutions. *Automotive passenger safety*. London: IMechE Seminar Publication 1996
- Khasnabis S, Dusseau R, Dombrowski T (1991) Safety implications of seat belts on transit buses. *Transp Res Rec* 1322:9–16
- Reilly E (1995) School bus safety: issues and controversy. *J Pediatr Health Care* 9:145–8
- Baltes M (1995) To belt or not to belt: should FLorida mandate installation of safety restraints in large school buses? *Transp Res Rec* 1485:97–104
- McGeehan J, Annest J, Vajani M et al (2006) School bus-related injuries among children and teenagers in the United States, 2001–2003. *Pediatrics* 118:1978–83
- Center for Urban Transportation Research (1996) Illegal passing of stopped school buses in Florida University of South Florida
- TRB (2002) The relative risks of school travel Report No.: Special report 269
- National Association for Public Education Transport (1998) School Transportation Safety in Europe; Summary of the study report
- Anund A, Sörensen G, Wretling P, et al. (2002) Trafiksäkerhet vid skolskjutsning—Slutrapport. VTI—Rapport. Linköping: VTI; Report No.: 480
- ECBOS (2001) Task 1.1. Report. Annex. Graz: Technical University Graz
- Nilsson G (1997) Methods and necessity of exposure data in relation to accident and injury statistics—development of IRTAD. Special report. Linköping: OECD/RTR & VTI
- Anund A, Larsson J, Falkmer T (2003) Skolskjutsbarns inblandning i olyckor 1994–2001. VTI Notat. Linköping: VTI; Report No.: 41–2003
- European Commission Transport Road Safety (2004) Road safety in school transport Report No.: Final Report of the EU-project Road Safety in School Transport (rsst\_final\_report\_v1.3.pdf)
- Rusk J, Börjesson M, Hilborn I (1994) Skolskjutshandboken. Sveksna Kommunförbundet, Stockholm
- Wretling P, Sörensen G, Anund A, et al. (2001) Trafiksäkerhet vid skolskjutsning—enkät till Sveriges kommuner. Notat. Linköping: VTI; Report No.: 13–2001
- OECD (1996) Training truck drivers. Road transport research. OECD, Paris
- Falkmer T (2001) Transport mobility for children and adolescents with Cerebral Palsy (CP). Linköping University, Linköping
- Falkmer T, Gregersen NP (2000) The prevalence of learner drivers with CP who are in need for highly specialised driver education. *J Traffic Med* 28:23–31
- Anund A, Falkmer T, Forsman Å, et al. (2003) Child safety in cars—Literature review. VTI report. Linköping: VTI; Report No.: 489A
- Falkmer T, Fulland J, Gregersen NP (2001) A literature review of road vehicle transportation of children with disabilities. *J Traffic Med* 29:54–62
- Thornthwaite S (2009) School Transport: Policy and Practice London: LTT
- Association for the Advancement of Automotive Medicine, ed. The Abbreviated Injury Scale 1990 revision. Des Plaines. IL: AAAM 1998
- Tunbridge P, Everest J (1988) An assessment of the under reporting of road accident casualties in relation to injury severity IRCOBI
- Scottish Executive (2002) Child accidents en route to and from school



41. Carlsson G (2002) Catching the bus in old age : methodological aspects of accessibility assessments in public transport. Lund: University
42. Iwarsson S, Jensen G, Ståhl A (2000) Travel chain enabler: development of a pilot instrument for assessment of urban public bus transportation accessibility. *Technol Disabil* 12:3–12
43. Kirk A, Grant R, Bird R. Bus and coach passenger casualties in non-collision incidents. *Traffic Safety on Three Continents*; 2001; Moscow: VTI; 2001. p. 471–84
44. Cass D, Ross F, Lam L (1996) School bus related deaths and injuries in New South Wales. *Med J Aust* 165(5):134–7
45. Towle LH. Teach school bus safety. *Parents' Magazine*. 1990:62–4.
46. TRB. Improving School bus safety. TRB, National Research Council; 1998
47. Gogtay N, Giedd J, Lusk L, et al (2005) Dynamic mapping of human cortical development during childhood through early adulthood. *PNAS*; 2005. p. 8174–9
48. Land Transport Safety Authority (2002) School bus related safety - a literature review
49. Larsson J (2008) Skador i trafikolyckor med buss 2003–2006. Särskilt barnskolresor. Linköping Report No.: VTI report 624–2008
50. VITS (2002) Vägverkets Informationssystem för TrafikSäkerhet: <http://www.vv.se>