Children in buses and coaches

Philippe LESIRE using supports from LAB, CEESAR and MHH
30/10/2019
CONTEXT, ISSUES AND LIMITATIONS

TODAY’S TIMELINE

Descriptive and in-depth analysis French and German accident data

National data comparison

French data
SETRA

German data
DESTATIS

In depth:
GIDAS (D)

VOIESUR
(F)

CEESAR db

SUMMARY & CONCLUSIONS
LIMITATIONS

Events included:
F: Accident with at least one collision. 
D: Events where a passenger is injured (including driving manoeuvres)

Vehicle type:
F: Buses coded according to architecture 
D: Buses coded according to actual use

Type of potential restraint systems:
City buses, coaches and minibuses are part of the sample

Period of data collected
Sample for National data used in this study: 2008-2012 
GIDAS: 2005-2014 
VOIESUR: 2011 
CEESAR: before 2005
Severely and fatally injured children in different transport modes

Severely and fatally injured children in road traffic accidents in Germany 2008-2012

- Car (n=5744): 12,5%
- Pedestrian (n=10625): 50,7%
- Cyclist (n=7550): 23,7%
- Bus (n=287): 31,2%

Severely and fatally injured children in road traffic accidents in France 2008-2012

- Car (n=3436): 35,6%
- Pedestrian (n=4894): 50,7%
- Cyclist (n=1210): 12,5%
- Bus-coach (n=118): 1,2%

Percentage of severely and fatally injured children in buses is low for both countries.
National statistical data from DESTATIS and SETRA

Location of coach and bus accidents with injured children

- **Bus accidents with injured child occupants (0-14 years of Age) by locality of accident**
  - Germany 2008-2012
  - Inside city limits: n=2412 (87%)
  - Outside city limits (without motorway): n=330 (12%)
  - Motorway: n=42 (1%)

- **Bus accidents with injured child occupants (0-14 years of Age) by locality of accident**
  - France 2008-2012
  - Inside city limits: n=374 (36%)
  - Urban: n=125 (12%)
  - Non urban (without motorway): n=424 (53%)

Lower percentage of accidents on motorways of both countries

Completely different repartition of accident location between the 2 observed countries
Injury severity for children in buses per age groups

Injury severity of children in buses in Germany 2008-2012 for different age groups:
- Slightly injured: 91% 96% 94%
- Severely injured: 9% 4% 6%
- Killed: 0% 0% 0.1%

Injury severity of children in buses in France 2008-2012 for different age groups:
- Slightly injured: 89% 84% 69%
- Severely injured: 10% 16% 27%
- Killed: 2% 0% 3.7%

In general injury severities are low

Tendency to higher injury severities in France for children older than 4 years of age
<table>
<thead>
<tr>
<th>Inside City Limits (n=4511)</th>
<th>Outside City Limits (n=706)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Accident of Another Kind</strong></td>
<td><strong>Collision with Vehicle at Intersection</strong></td>
</tr>
<tr>
<td>47.4% (mainly driving manoeuvres, often without collision)</td>
<td>26.3% (Opposite vehicle is turning or crossing the road)</td>
</tr>
<tr>
<td><strong>Collision with Vehicle at Intersection</strong></td>
<td><strong>Collision with Oncoming Vehicle</strong></td>
</tr>
<tr>
<td>23.1% (Opposite vehicle is turning or crossing the road)</td>
<td>21.8%</td>
</tr>
<tr>
<td><strong>Collision with Vehicle Moving Laterally in the Same Direction</strong></td>
<td><strong>Accident of Another Kind</strong></td>
</tr>
<tr>
<td>9.2%</td>
<td>17.3% (mainly driving manoeuvres, often without collision)</td>
</tr>
</tbody>
</table>
Uninjured passengers are included in statistics

Most buses and coaches passengers are uninjured - if injured, they are mostly slightly injured
In-depth data: GIDAS – German in depth accident study

Accidents from 2005 - 2014
Accidents with large buses (M3 – more than 8 seats, exceeding 5t)
Accidents with injured child occupants (aged 0-14 y)

- 27 Accidents
- 51 documented injured child occupants

<table>
<thead>
<tr>
<th>Location of accident</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inside city limits</td>
<td>24</td>
<td>89%</td>
</tr>
<tr>
<td>Outside city limits</td>
<td>3</td>
<td>11%</td>
</tr>
<tr>
<td>Motorway</td>
<td>0</td>
<td>0%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of vehicle</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bus</td>
<td>1</td>
<td>4%</td>
</tr>
<tr>
<td>Large bus</td>
<td>14</td>
<td>52%</td>
</tr>
<tr>
<td>Motor vehicle</td>
<td>12</td>
<td>44%</td>
</tr>
</tbody>
</table>
In-depth data: GIDAS – German in depth accident study

GIDAS: Bus accidents

<table>
<thead>
<tr>
<th>Collision / vehicle maneuvre</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collision</td>
<td>3</td>
<td>11%</td>
</tr>
<tr>
<td>Rollover</td>
<td>1</td>
<td>4%</td>
</tr>
<tr>
<td>Braking maneuver</td>
<td>21</td>
<td>78%</td>
</tr>
<tr>
<td>Braking and steering maneuver</td>
<td>1</td>
<td>4%</td>
</tr>
<tr>
<td>Steering maneuver</td>
<td>1</td>
<td>4%</td>
</tr>
</tbody>
</table>

Most accidents are accidents without a collision (85%) or with a very light collision (4%)
**GIDAS: 51 injured child occupants were documented**

<table>
<thead>
<tr>
<th>Age groups</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-3 years</td>
<td>11</td>
<td>22%</td>
</tr>
<tr>
<td>4-11 years</td>
<td>24</td>
<td>47%</td>
</tr>
<tr>
<td>12-14 years</td>
<td>16</td>
<td>31%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Seatbelt usage</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not seated</td>
<td>20</td>
<td>50%</td>
</tr>
<tr>
<td>Seated without seatbelt</td>
<td>20</td>
<td>50%</td>
</tr>
<tr>
<td>Seated with seatbelt</td>
<td>0</td>
<td>0%</td>
</tr>
</tbody>
</table>

3 of 20 children were in the buggy or stroller which fell over due to driving maneuver.

**High incidence of injuries to non-seated children.**
Half of the injured children are not seated.
The other half is seated but not restrained.
In-depth data: GIDAS – German in depth accident study

GIDAS: Injury overview of child bus occupants

<table>
<thead>
<tr>
<th></th>
<th>Head</th>
<th>Neck</th>
<th>Thorax</th>
<th>Arms</th>
<th>Abdom</th>
<th>Pelvis</th>
<th>Legs</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIS 1</td>
<td>13</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>AIS 2</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AIS 1</td>
<td>13</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>AIS 2</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Majority of injuries were minor head injuries, mostly contusions or cuts to the face which were caused by contact with the front seat (by braking manoeuvres) or with grab poles inside the bus.
- Not seated: High incidence of injuries to the arms from falling over (contusions, abrasion wounds).
In-depth data: VOIESUR French in-depth accident database

**VOIESUR: Sample frame**

Accidents with injuries studied from police reports – year 2011

- 84 buses and coaches
- 391 occupants of all ages

**Distribution of impact buses and coaches**

- Majority of impacts are frontal and side impacts
- Very few rollovers

<table>
<thead>
<tr>
<th>Impact Type</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frontal</td>
<td>41%</td>
</tr>
<tr>
<td>Side</td>
<td>29%</td>
</tr>
<tr>
<td>Rear</td>
<td>15%</td>
</tr>
<tr>
<td>Rollover</td>
<td>9%</td>
</tr>
<tr>
<td>Other</td>
<td>4%</td>
</tr>
<tr>
<td>Unknown</td>
<td>2%</td>
</tr>
</tbody>
</table>

n=391 occupants (938 with weight)
In-depth data: VOIESUR French in-depth accident database

VOIESUR: Injury severities and body regions

- Children were mostly uninjured or with minor injuries

- If injured: High incidence of minor head injuries (over 80%)
  - Some injuries to the spine and upper limbs
In-depth data: CEESAR in-depth accident investigations

Presentation done to EEVC WG18 by P. Botto and J. Sinnaeve in August 2005

Aim: Estimated potential benefit of seatbelt use for child passengers transported in coaches
In-depth data: CEESAR in-depth accident investigations

Method and Sample

This study is based on the in-depth investigation of 20 accidents involving at least one coach within at least one passenger has been injured.

- 753 OCCUPANTS
- 663 CHILDREN
- 90 ADULTS
- 338 UNINJURED
- 223 SLIGHTLY INJURED
- 62 SEVERELY OR FATALLY INJURED
In-depth data: CEESAR in-depth accident investigations

**JOURNEY TYPE**
- Regular school transport
- School trip
- International trip
- Sport fixture

REGULAR SCHOOL TRANSPORT represents a large part of the sample

**VEHICLE TYPE**
- Standard 12m coach
- Minibus

Very large proportion of single deck coaches with 55 seats
In-depth data: CEESAR in-depth accident investigations

Impact type

- Frontal: 65%
- Tipover: 20%
- Rollover: 10%
- Rear: 5%
Age distribution of injured child victims (N=325 occupants, n=12 unknown):

The 13-15 year-old age group shows the highest number of victims.
Analysis of frontal impacts (n=13)

Trucks by far are the most common obstacle in the sample.

OVERALL INJURY DISTRIBUTION (n=222)
In-depth data: CEESAR in-depth accident investigations

Distribution of injured children according to injury mechanism in frontal impacts

- **FRONTAL IMPACT** (N=222 victims)
  - Severity index = 0.17
  - Fatalities (n=0)
  - Seriously injured (n=9)
  - Slightly injured (n=160)

- **PROJECTION** (N=169)
  - Severity index = 0.053
  - Serious injuries (n=9)
  - Slightly injured (n=160)

- **INTRUSION** (N=49)
  - Severity index = 0.53
  - Fatalities (n=4)
  - Seriously injured (n=22)
  - Slightly injured (n=23)

- **EJECTION** (N=4)
  - Severity index = 0.75
  - Fatalities (n=3)
  - Seriously injured (n=0)
  - Slightly injured (n=1)

**INTRUSION** and **COMPLETE EJECTION** cause all fatalities and most of the serious injuries in frontal impact.
In-depth data: CEESAR in-depth accident investigations

Analysis of frontal impacts

(n=222 victims)

<table>
<thead>
<tr>
<th>Body region</th>
<th>All severities Frequency</th>
<th>M AIS 3+ Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head</td>
<td>44 %</td>
<td>56 %</td>
</tr>
<tr>
<td>Lower limb</td>
<td>26 %</td>
<td>23 %</td>
</tr>
<tr>
<td>Upper limb</td>
<td>9 %</td>
<td>4 %</td>
</tr>
<tr>
<td>Spine</td>
<td>7 %</td>
<td>2 %</td>
</tr>
<tr>
<td>Thorax</td>
<td>6 %</td>
<td>4 %</td>
</tr>
<tr>
<td>Abdomen</td>
<td>5 %</td>
<td>11 %</td>
</tr>
<tr>
<td>Pelvis</td>
<td>3 %</td>
<td>0 %</td>
</tr>
</tbody>
</table>

The head and lower limb body regions are the most often injured.

38 M.AIS 3+ children: -28 with 1 body region at AIS3+ level,
-8 had 2 regions
-1 child sustained AIS 3+ injuries to 3 body regions.
In-depth data: CEESAR in-depth accident investigations

Analysis of frontal impacts: potential benefit of 2 point belt

2 pt belt would limit/avoid projection and complete ejection which are representing 78% of total number of children injured.
In-depth data: CEESAR in-depth accident investigations

Analysis of tip over and roll-overs: potential benefit of 2 point belt

101 children injured:
- Projection – 66
  (7 seriously injured, 1 fatality)

- Intrusion - 10
  (3 seriously injured, no fatality)

- Complete ejection – 24
  (7 seriously injured, 5 fatalities)

- Partial ejection – 1
  (1 seriously injured)

SEVERE INJURIES REPARTITION (M.AIS 3+)

- Head 40%:
  - Upper limbs 22%
  - Lower limbs 11%
  - Chest 12%

Potential benefit of 2 pt lap belt:

Reduce injuries due to projection and ejection (77%)

Not of any help for injuries due to intrusion (23%)
CONCLUSIONS

Summary

- Children travel safely in buses and coaches
  - Children are rarely injured in buses and coaches
  - If injured, the injury severity is rather low
- Many children are injured in buses by non-collision accidents
- Most common injuries are minor injuries to the head

Can the number of injured children be reduced?

- Provide seats for all passengers – High incidence of injuries to non-seated children
- Provide devices to secure prams and strollers
- Seat belts or rearward facing seats can further reduce injuries
  - Most impacts are frontal impacts (Children fall off their seat and/or collide with the front seat)