This report presents the results of the Danish Road Traffic Accident Investigation Board’s (AIB’s) detailed study of 27 road accidents involving pedestrians in cities. The study has been limited to urban areas, as this is where pedestrian accidents typically occur (6 out of 7 pedestrian accidents). It has been limited to include only those accidents involving pedestrians and cars or vans where serious injury or death has occurred.

The AIB has analysed the accidents and classified them into a number of subgroups or typical scenarios or types of accident, according to their common features:

- Accidents while reversing
- Accidents on the sidewalk
- Accidents taking place in the dark
- Accidents involving children
- Accidents related to crossing the road

Several accidents fit into more than one of these subgroups.

The summary goes through the typical features for each group and lists the recommendations given by AIB at the end of the document.
The rationale for this study is that pedestrian accidents often have very serious consequences in the form of injuries or even death for the pedestrians involved. Accident statistics show that in fatalities as a result of road accidents, 1 in 6 is a pedestrian. Walking is a mode of transport everyone uses. It is at the same time both healthy and sustainable, and should therefore be made as safe as possible.

The study has provided an insight into why the accidents studied have occurred, their circumstances and common features. Its aim is to make recommendations for more targeted interventions which in turn could contribute to greater efforts to prevent pedestrian accidents.

**Brief description of the methodology**

The AIB’s analysis of the individual accidents has been based on its own studies, and has been supplemented with information from police investigations, from hospitals, from the Institute of Forensic Medicine at the University of Copenhagen, and from the Danish road authorities.

All accidents and all detained vehicles have been inspected by AIB officers. Moreover, victims, witnesses and many of the other parties involved have been interviewed as well. After an analysis of the individual accidents, the AIB then completed a comprehensive analysis covering them all. The causes of the accidents described here come from this analysis.

**Results**

The AIB has chosen to classify the accidents into a number of subgroups or typical scenarios or types of accident, according to their common features:

- Accidents while reversing (5 accidents)
- Accidents on the sidewalk (6 accidents)
- Accidents taking place in the dark (10 accidents)
- Accidents involving children (9 accidents)
- Accidents related to crossing the road (16 accidents)

Several accidents fit into more than one of these subgroups.
The pedestrians and motorists
Overall, 2/3 of the pedestrians (19 out of 27) in the study were particularly vulnerable for one reason or another. These were because they were children, the elderly, under the influence of alcohol at the time, or pedestrians with invisible handicaps. Common to them all was that none of them possessed either optimal mental or physical capacity to manage themselves effectively in the traffic environment.

In 20 out of 27 accidents, the pedestrian was shown to have contributed to its cause. In some of the accidents, however, the pedestrians involved were young children, who should not have been alone in a traffic environment without adult supervision. In these cases, there was a close correlation between the pedestrian’s contribution to the accident and their lack of supervision by responsible parties.

It appears, moreover, that 6 out of the 8 pedestrians who were not particularly or obviously vulnerable, did not in any way contribute to the accident in which they were involved. These 6 pedestrians were involved in accidents in which they were hit by a car while on the sidewalk, without contributing in any way to the accident, and without any chance of avoiding the collision. They accounted for all 6 of the 7 accidents where the pedestrians could be considered as not contributing to the accident.

With regard to the motorists themselves, a fairly large proportion of young people between the ages of 18 and 24 – almost 1/3 – were involved in the accidents studied. Another common feature was that driver behaviour for a large proportion of the drivers in the accidents could, to some extent, be described as risky. Driver behaviour appeared to have contributed to many of the accidents taking place in that the drivers were not sufficiently aware of the dangers presented by the pedestrians, and the possible explanation of this was that they were either risk-averse, risk-blind or simply careless.

In all accidents but 1, motorists were shown to have contributed to the accident happening.
Accidents taking place in the dark

Of the 10 accidents which occurred in the dark, 7 took place during the weekend.

Many young people were involved in the accidents which occurred in the dark; half of these motorists were aged 25 or younger, and half of the pedestrians were between 18 and 24 years old. In addition, half of the pedestrians involved were shown to be physically or mentally impaired, primarily as a result of alcohol consumption. Typically speeding was the main cause of these accidents, i.e., in 7 out of the 10. The high speeds appear to have been either caused by driver ignorance of the risk posed by high speed, or by the driver deliberately seeking out the thrill or excitement of speeding. 4 of the speed offenders were under the influence of alcohol and/or they were attempting to flee.

As far as the pedestrians in these accidents were concerned, it was typically poor orientation or misjudgement of the distance from the vehicle that was crucial to the accident taking place. In many cases, alcohol- or medication usage appear to have influenced their assessment of distance. The drivers’ speeding in many cases probably also meant that it was difficult to judge the distance between the pedestrian and the vehicle sufficiently quickly.

In almost all these accidents, it is assumed that it was possible for the drivers to have seen the pedestrians, even though in many cases the pedestrians wore dark clothes, and were not wearing reflectors either, and the street lighting, in some cases, was not functioning, or did not comply with current Danish road standards. In all accidents involving pedestrians crossing the road, it was shown to have been possible for the pedestrians to have seen the motorist.
Accidents related to crossing the road

More than half of the accidents (16 out of 27) occurred where a pedestrian was crossing the road either at an intersection or midblock. In all crossing accidents, both drivers and pedestrians had a share in the cause of the accidents.

In many cases, either the pedestrian or the motorist did not see the other party involved in the accident. In all crossing accidents (except for 1) the driver/pedestrian did not orientate themselves sufficiently, which was the direct cause of the accident. This applies to 2/3 of both pedestrians and drivers.

For the pedestrians, the reason for the lack of orientation was due to being pre-occupied/busy, and for those of them who were children, not being able to understand the situation because of their extreme youth, or because of being distracted by other children. There were also cases where alcohol/medication affected the pedestrian orientation. For the motorists, it was mainly lack of attention which lay behind their poor orientation. For example, the drivers should have been extra careful when observing children, or elderly or intoxicated pedestrians near the road.

Misinterpretation of the other party's actions prior to the accident contributed to 5 of the 16 accidents, for example, miscalculation of motorist’s speed by the pedestrian, or misinterpretation of a child’s behaviour by a driver who had thought that the child had seen him. The drivers’ speeding contributed to 6 of the 16 accidents.

Pedestrians usually choose to use the most direct route in order to save time and to move quickly. This is probably the reason why such a large proportion of the pedestrians crossed mid-block or outside a pedestrian facility; in fact, 2/3 of crossing accidents typically occurred on the road and outside a crossing facility.
Allan (40 years old) is out walking to get some fresh air and to discuss an issue with a colleague. Jakob (19 years old) has borrowed his friend’s car today. He does not have his own car and has only had his license for a year. He is in a “party mood” and wants to “show off” - He likes excitement.
At the intersection the signal shows yellow. He speeds up a little, so he can make it before red. The turning maneuver is however too sharp for the speed, and he skids to one side. He tries to counter balance the car while braking to get the car back under control. He ends up on the sidewalk, where he hits Allan. His friend shouts "beware!". It is however too late.
Accidents when reversing

5 accidents in the study were associated with reversing, where the drivers did not take sufficient care to see everything possible around them. Typically, only the rear-view mirror and one window mirror were used, or the driver simply looked behind by turning his/her head to one side and to use one of the window mirrors. Some drivers focussed all their attention on the narrowness of the space into which they were attempting to reverse, or on the traffic around them.

A couple of drivers chose to reverse over a very long stretch of road instead of turning the car around, a manoeuvre which can often cause problems, since it is more difficult for a driver to see where he/she is going when reversing than when driving forwards.

The AIB has found that, overall, the view through the rear window of 5 of the involved cars was not very good. This was mostly related to vehicle body design in the newer cars, where the lower edges of the side windows as well as the rear window are higher. Combined with heavy pillars or frames between side and rear windows, the glass areas to see through are consequently smaller.

In a few of the accidents, the vehicles were equipped with a sensor for reversing, but in none of the cases studied did the driver act on the alarm.

Accidents on the sidewalk

In 6 of the 27 accidents, the pedestrians on the sidewalk were hit by a car whose driver had lost control. In none of these cases could the pedestrian be said to have contributed to the occurrence of the accident.

Half the motorists involved were young, probably willing to take risks and maybe even enjoyed the speed of the vehicle. A few of the drivers were not very experienced, and experienced difficulties in managing the vehicle and reacting properly when the car went out of control.

In half of the accidents (3 out of the 6), high speed was shown to be an important contributory factor to the accident taking place.
Accidents involving children

In 9 of the 27 accidents the pedestrian was a child aged from 1½ to 14 years old.

For the driver it was often insufficient perceptions of the surroundings, misinterpretation of the pedestrian behaviour, or driving through red/yellow traffic lights which contributed to the accident taking place. In most cases, the driver’s lack of concentration was the reason behind these accidents.

With regard to the children, in 4 cases, the AIB assessed that they were too young to be on their own in traffic. In 5 of the 9 accidents in this category, due to their young ages, the children could not orientate themselves, which contributed to the accident. Children are generally more easily distracted, with shorter concentration spans, and thus easily lose sight of what they should be doing in the traffic environment. Some of children were distracted by the friends who were with them.

7 out of 9 children either suddenly walked or ran out onto the road from the sidewalk, either because they were busy with a game, or a competition, or talking to their friends.

All accidents involving children took place during the daytime, most of them close to the child’s home or in familiar surroundings (e.g. on the way to/from school or recreational activities).

In the vast majority of crossing accidents, it is believed that the pedestrian had chosen a sensible place as a logically chosen part of a route in order to cross the road, even if the pedestrian actually crossed the road only 30-100 meters from a pedestrian crossing, which, in principle, he or she could have used.
It is the opinion of the AIB that in only 4 of these accidents the pedestrian actually contributed to the accident by crossing the road in a risky place. This type of accident has also shown that pedestrian crossing behaviour is guided by the road or urban design, and the “built-in” natural routes between different functions in the area (e.g., the route between housing and shopping areas, or home and play areas).

2 accidents happened partly because there was not a safe crossing opportunity in a place where there was an obvious need for it. In several situations, it was thought that there was a need for better planning and installation of safe crossing points for pedestrians.

**Personal injuries and pedestrian-friendly vehicles**

In this study, 27 pedestrians were injured, and only 3 people in the vehicles got minor injuries. The proportion of moderate or serious injuries to pedestrians to those incurred by drivers was high. 4 pedestrians were killed.

Pedestrian injuries came about as a result of the actual collision with the vehicle, or were caused by subsequent collision with the roadway or another solid object, e.g., landing after being hurled through the air.

This study therefore confirms, like previous studies, that low-impact speed is critical for pedestrian safety. Most of the serious injuries were caused in collisions with vehicle speeds of more than 30 km/h. While only about 1/3 of the pedestrians are seriously injured or die when colliding with a car going at less than 30 km/h, the proportion is more than twice as high, at 75%, when vehicles are moving at more than 30 km/h.
The study also confirms that pedestrian-friendly fronts on vehicles are an essential design element for ensuring pedestrian protection. In this study 15 pedestrians were hit by the front of the vehicle. In 3 of these cases, the vehicles with pedestrian-friendly fronts were concluded to have reduced the level of injury. However, none of the vehicles involved were equipped with exterior pedestrian airbags, the presence of which would probably have had a positive effect in approx. ¼ of the investigated accidents.

DANISH ROAD TRAFFIC ACCIDENT INVESTIGATION BOARD
The objective of the AIB is to compile knowledge of road traffic accidents. The AIB is comprised by an interdisciplinary group of members engaged in in-depth analyses of frequent and serious types of road traffic accidents. The AIB investigates the circumstances of individual accidents in order to form a precise picture of the factors leading to the accident.

AIB carries out analyses based on available material from the police, vehicle inspectors, road authorities, hospitals/emergency rooms and the Department of Forensic Medicine. The AIB complements this material with its own investigation of the vehicles involved and of the scene of the accident, and interviews with the parties involved in the accident as well as any witnesses, the police and the rescue team.

The AIB is commissioned to contribute new or supplementary knowledge in road safety, which leads to preventive action against road traffic accidents. The object is not to determine the question of guilt or innocence in a legal sense.
AIB RECOMMENDATIONS

Communication initiatives, driver training and police checks
• Young children in the traffic environment should be supervised at all times, and older children must be taught safe traffic behaviour, also, when they are with friends.
• Communication initiatives must teach motorists to take the most vulnerable pedestrians into account. At the same time, pedestrians must learn to use obviously placed pedestrian facilities.
• Communication initiatives, company policies and police checks at night should be focused on intoxicated pedestrians and speed offenders.
• Police checks should focus on speeding and vehicles crossing traffic lights on red in cities.
• Communication initiatives and education must teach drivers to reverse for as short a distance as possible, and to do it safely.
• Mandatory taking of blood samples from all drivers, and eventually all road users, in serious road accidents.

Vehicle technology
• Technology that can reduce risky driving should be promoted.
• Cars must be equipped with an automatic emergency braking system with pedestrian detection and night view.
• Cars should be fitted with pedestrian-friendly fronts with, for example, extra features such as exterior pedestrian airbags.
• Cars should have a rear view camera in combination with a rear parking or emergency braking system.
• The different systems and safety precautions suggested in this report should be supported through tax reduction and eventual EU requirements.
• Headrests should be designed in such a way that they can be easily lowered and raised for purposes of reversing.
• Reversing should only be possible at low speed.

Engineering
• More low speed zones can increase pedestrian safety, for example in central urban areas.
• Pedestrian crossings must be located and designed correctly.
• The traffic environment must be safe where there are many children.
• Danish road standards should contain examples of pedestrian-friendly parking areas.
• Danish road standards should be more specific with regard to signal phases associated with turns.
• There should be a study on the risks associated with safety at bus stops.