A safe roading environment for children

The identification of factors contributing to crashes involving children as pedestrians and cyclists in The Netherlands and New Zealand

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Abstract

A research study in The Netherlands identified the factors and road conditions that contribute to crashes involving children. The study was aimed at children from 4 to 12 years old (primary school) who were pedestrians or cyclists. Analysis of crash data and field research determined a relationship between road conditions and crashes. It was concluded that residential streets with a speed limit of 30km/h were 3 times safer than streets with a 50km/h speed limit. Some other unsafe situations identified in the study were pedestrian crossings, one way residential streets, streets with on street parking and roads with objects blocking visibility. The New Zealand crash data for children in the age group from 4 to 12 years, travelling as a pedestrian or cyclist, show similarities to the Dutch data. Therefore the recommendations in this paper, like avoiding objects along streets that might block the visibility and the implementation of a consistent speed regime, are most likely to apply to both countries.

1. Introduction

The emphasis on vulnerable road users and how to accommodate for them in road design is increasing. This paper focuses on the vulnerability of child road users, as pedestrians and cyclists. This set of road users represents a unique group, with their own specific needs. The paper describes a research study carried out in The Netherlands, identifying factors and road characteristics that contribute to crashes involving children as cyclists and/or pedestrians. As a comparison a similar crash data analysis has been carried out for New Zealand. The conclusions of the paper will describe the relevance of the Dutch research for the New Zealand road environment.

2. Children and traffic

Children are not just “small adults”. Quite often adults consider that children are more capable than they actually are. Children are still developing their cognitive and social skills and abilities. For example until the age of 10 years most children still underestimate the speed of approaching cars. However boys between 10 and 14 years tend to overestimate the speed. To ride a bicycle and merging with traffic at the same time is a difficult task for even a college student. There is just too much information for children to deal with at once *(Breithaupt, 1999)*.

It is important for the development of a child that he/she can play outside and travel from one place to another independently. The street is an irreplaceable learning environment. This is the place where children develop their social, physical and creativity skills among other skills. However the learning environment needs to be safe for children, therefore it is important that children grow up in a safe roading environment.

3. How safe is the roading environment for children?

In New Zealand a total of 61,659 injuries and 2,330 fatalities were reported between 1998 and 2002 *(LTSA, 2003)*. A total of 3,720[1] children between the age of 4-12 were injured and 99 children died as a result of the crash. Of the total amount of children involved in crashes, 1,863 were travelling by bicycle or walking.

The following table shows a comparison with Dutch crash data.

	New Zealand (1998-2002) Average per year	**The Netherlands (1994-1998) Average per year (Round figures)**
Residents	3,844,000 *(LTSA, 2003)*	15,500,000
Injury	12,331	50,000
Injury per 100.000 population	320.8	322.6
Fatal	466	1,200
Fatal per 100.000 population	12.1	7.7
Total children 4-12 (fatal, injury, non injury)	792	4,000
Injury children	744 (=94% of 792)	2,900 (=73% of 4000)
Fatal	20 (=2.5% of 792)	28 (=0.7% of 4000)
Total children 4-12 walking and cycling (fatal, injury, non injury)	373	3,900

Table 1: Crashes in The Netherlands and New Zealand

Although the above data covers different time periods, the data gives an indication of the problem. The total amount of injuries in The Netherlands is much higher than in New Zealand, however rate of injuries per 100,000 population is about the same. The amount of fatalities per 100,000 population is much higher in New Zealand.

The percentage of crashes involving children is higher in New Zealand (assuming that the age representation of children in both countries is similar). Both the injury and fatal ratio with children is much higher in New Zealand. The above table shows also that only half of the crashes in New Zealand with children involve pedestrians and/ or cyclists, while in The Netherlands this percentage is much higher.

4. Research in The Netherlands

The total amount of crashes in The Netherlands is still considered to be too high. Therefore the concept of “Sustainable Safety”, a pro-active approach to traffic safety, was introduced in

[1] National Crash Analysis System.

1991. Within this concept the “man is considered to be the measure of all things”. Therefore the starting point is a fallible road user. During the development of this Sustainable Safety policy, the question was raised “how to cater for children within the Sustainable Safety concept?”. Also what road characteristics constitute a hazard for children and what factors make the roading environment more safe for children?

To answer these questions research *(Tutert, 2000)* was carried out by the University of Twente in conjunction with the National Transport Research Centre in 2000, to identify the factors and road characteristics that contribute to crashes involving children. The research was aimed at children from 4 up to and including 12 years old (primary school) who were pedestrians or cyclists.

A first step in the research was a crash analysis, using the Dutch crash analysis system. The second step involved local field research, which studied 272 sites in the city of Rotterdam.

4.1 Crash analysis

The initial crash analysis answered the question “under which circumstances (related to infrastructure) do crashes with children as pedestrian and/ or cyclist occur?”. The crash data used in the analysis was from a five year period 1994-1998. A total of 16,763 children in the age group from 4 to 12 years were involved in a crash as a pedestrian or cyclist.

Of the total amount of children involved, 71% were cyclists and 29% were pedestrians. In general the amount of cycling crashes increased with increasing age. However the pedestrian crashes were more evenly distributed per age. More boys (64%) than girls were involved in crashes.

Fewer crashes happened in the winter period and the summer school holiday period. Most accidents happened during the week. During the school week, only 38% of the crashes occurred while travelling to and from school (between 8:00-9:00, 12:00-13:15 and 15:00-16:00). The remaining crashes took place while children travelled to for example friends, sporting activities or the shop or while they were just hanging around on the streets.

Crashes with pedestrians and cyclists mainly happened during daylight and when it was dry. Approximately 7% of the crashes occurred while it was raining.

Most crashes occurred on urban roads with a 50km/h speed limit. However, taking into account the total length of road with a speed limit of 30km/hr and 50km/hr, more than three times as many crashes happened on a 50km/hr road than on a 30km/hr.

Pedestrians were mainly (78%) involved in crashes on a mid block as supposed to intersections. However cyclists were as often involved in an accident on an intersection as on a mid block. Only a small percentage of crashes involved crashes on curves (2% for pedestrians and 4% for cyclists).

Sometimes a police officer records the details of the location, for example when the crash occurs near a bus stop, pedestrian crossing or driveway. The percentage of crashes near a pedestrian crossing was relatively high.

The cause of pedestrian crashes was in most cases crossing from behind an obstacle (31%) or careless crossing of the road (42%). Crashes involving cyclists were mainly caused by failing to give way (25%), refusing to be taken over by for example a car (12%) and unexpectedly crossing (10%).

Pedestrians were mainly involved with crashes while crossing the road. A common crash manoeuvre by cyclists was crossing the road (13%) or when a cyclist went straight ahead while crossing other traffic flows (20%).

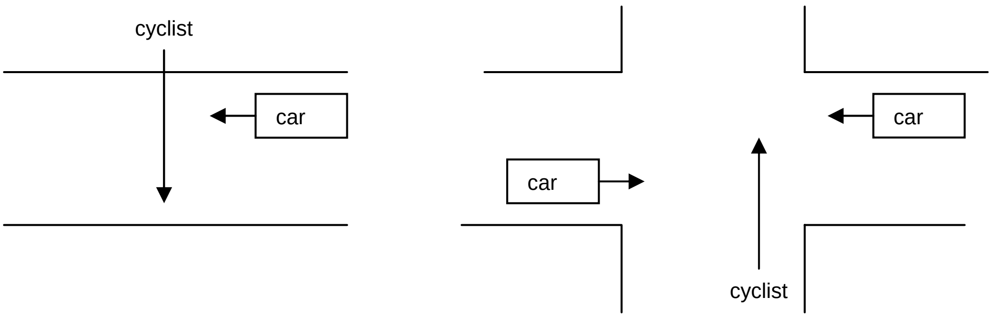


Figure 1: Situations in which a high percentage of crashes with cyclists occur

4.2 Field research

Although the above results give an understanding of the circumstances under which crashes with children occur, they were not all related to the infrastructure. Therefore further field research was carried out.

The field research included 136 locations in the city of Rotterdam where crashes occurred with children as pedestrians on mid block sections on urban roads in 1997 and 1998. In addition 136 control locations, which are locations where no crashes were reported, were included in the field research. By comparing the factors of the crash locations with the factors of the control group, the factors specific for crash sites were identified. The control locations reflected the ratio of arterials, collectors and local roads in the city of Rotterdam. The comparison was made with the chi-squared test.

A high percentage of crashes (35%) occurred on a collector road, while only 20% of streets in Rotterdam were classified as a collector road.

A separated cycle path is a common feature on streets in The Netherlands. The field research concluded that relatively high number of crashes occur on streets where there is no separate cycle path. This could be caused by the complex task of crossing a road, while watching out for cars, mopeds and cyclists all at the same time. While if there is a separate cycle path, children can focus on crossing the cycle path first before crossing the moving lanes.

Parked cars can block the visibility of and for children. A child is not tall enough to be seen behind the back of the car, nor can the child see past the car. The field survey identified a relatively high percentage of crashes on streets where there is parallel parking marked on the road.

Picture 1: A child crossing the road from behind parked cars (Rotterdam, The Netherlands)

A relatively high percentage of crashes occur on a one-way street. A similar result was obtained from a Canadian research *(Wazana, 1999)*. The Canadian research identified the following possible causes:

- One way streets are normally located in the lower social economic areas, where more children walk and play outside;
- Speed on one way streets might be higher;
- Motorists might lose their concentration, because there is no approaching traffic;
- Children might be used to first looking right before crossing, while the traffic actually approaches from the left.

With caution the field research concluded that a relatively high percentage of crashes occurs near crossing points, mainly zebra crossings. A Swedish research *(referred to by Molen, 1980)* analysed crashes with children on pedestrian crossings and made the following observations:

- A car passed another car that was waiting for the child to cross;
- Visibility was blocked;
- When there was plenty of visibility and the motorist noticed the child, only a small percentage of cars slowed down, the other motorists did not pay attention to the child.

More crashes seem to occur on streets with speed calming devices, however the difference with the control locations is just minor. A possible explanation is that the speed of cars is still too high and inconsistent due to insufficient measures and too much distance between the devices.

The field research did not identify any significant differences between the control and crash locations for the following factors:

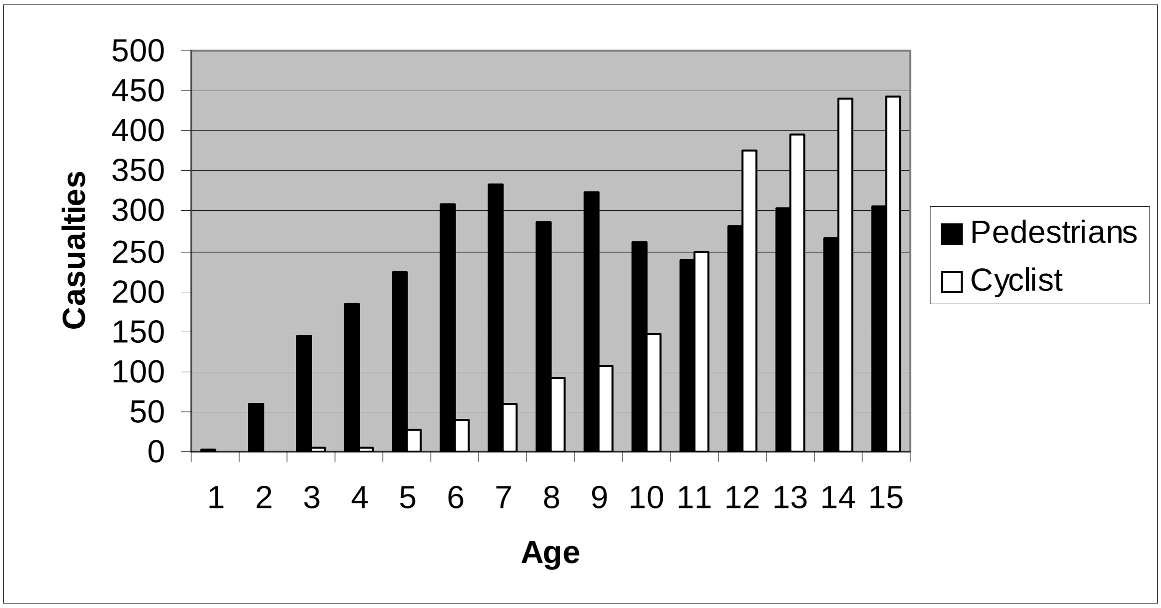
- Curvature of the road;
- Separation of moving lanes;
- Carriageway width;
- Location of a bus/ tram stop.

Not only parked cars, seem to block the visibility, also other objects like phone boxes, transformers, rubbish containers and planting areas can limit the visibility. A high percentage of crashes occurs near roads with facilities for children, like schools and playgrounds. Of course the presence of a relatively high number of children will increase the chance of a crash involving a child. Another situation where more crashes with children occur is in shopping street. The chaotic environment, parked cars and bicycles, tables and chairs, sandwich boards etc., could be a contributing factor.

5. New Zealand crash analysis

The Crash Analysis System (CAS) was used to analyse crashes with pedestrians and cyclists in New Zealand. All crashes involving children in the age group from 0 to 14, who travel as pedestrian and/ or cyclist in the period from 1993 to 2002 were selected. 5,776 crashes were reported in this period, which involved 5,909 children. All children involved were injured with the majority (75%) being minor, 22% were serious and 3% were fatal.

Of these children, 40% travelled by foot and 60% by bicycle. Of the pedestrians involved in a crash 40% were female, of the cyclist only 28% were female. The involvement of cyclists in crashes is increasing with age, while the involvement of pedestrians is more evenly spread over the different ages, with a peak between 6 and 9 years old.



Graph 1: Casualties per age and mode

The crashes are spread over the year with a slight increase in the summer months (except summer holidays) and a slight decrease in the winter. Relatively more crashes happen on a normal weekday compared with a Saturday or Sunday. 49% of the crashes occur while children travel to and from school (weekday (holiday period excluded)) between 8:00-9:00 and 15:00-16:00).

The majority of crashes (90%) occur during daylight, 13% of crashes occur when it is wet or icy. Most of the crashes (95%) occur in the urban area, mainly on roads with a 50km/h speed limit.

Most (71%) crashes with pedestrians happen at midblocks, while cyclists have as many crashes on intersections as at midblocks. 86% of the total crashes took place on a straight road, while 9% on a easy curve and 5% on a moderate to severe curve.

On the crash reports a police officer makes comments on the road markings. The table below shows the different road markings identified.

Road markings	Crashes (absolute)	Crashes (%)
Centre line	3302	57
No roadmarkings	1060	18
No passing lines	124	2
Painted island	264	5
Pedestrian crossing	423	7
Raised island	582	10
Unknown	21	0
Total	**5776**	**100**

Table 2: Road markings identified on Traffic Crash Report

The above table shows that 22% of the crashes occurs near crossing facilities, like a painted or a raised island or a pedestrian crossing.

In 25% of the crash locations, there is traffic control present. In most cases (56%) this is a give way control. Other controls are a stop control (4%), traffic signal (26%) and school patrol (2%).

From 52% of all the crashes distinction can be made between the types of intersection. Most of the crashes happen at a T-intersection (45%) or at cross roads (23%), however 25% happens at driveways.

6. Comparison between New Zealand and Dutch statistics

Although different age groups and data from different years have been used, a general comparison between the two countries can be made:

- In both countries more boys than girls as pedestrians or cyclists are involved in crashes;
- The age distribution for both modes is quite similar; increase in involvement of cyclists in crashes with increasing age and the pedestrian crashes more evenly spread per age;
- Statistics for both countries show a decrease in crashes in winter periods and during weekends;
- In New Zealand relatively more crashes with children occur during the hours in which you will expect children to travel to and from school;
- Most crashes happen with children as pedestrian or cyclist on urban roads with a 50km/h speed limit;
- Pedestrians crashes are mainly midblock as supposed to at an intersection, while cyclists have as many crashes at intersections as midblocks;
- In both countries a relatively high percentage of crashes occur near crossing facilities.

Although the New Zealand data is only based on an analysis with CAS and does not involve any field research, the data shows similarities. Therefore the recommendations from the research in The Netherlands would possibly be applicable and useful to the New Zealand situation.

7. Recommendations

The Dutch research identified that lowering the speed limit would make the road environment more safe for children. In The Netherlands 30km/h is becoming a common speed limit in some residential areas, in accordance with the Sustainable Safety Policy. Lowering speed limits in New Zealand is reflected in the 40km/h around schools. Lower speed limits have the following advantages *(Hoogeveen, 2000)*:

- The field of vision is wider and focused closer to the vehicle at a lower speed. The faster a motorist drives, the more his vision is focused on the carriageway only and at a greater distance;

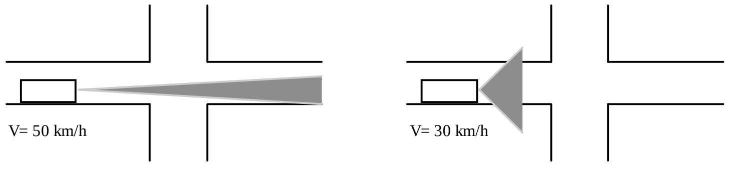
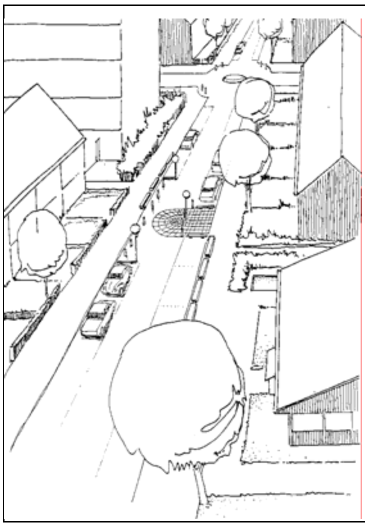


Figure 2: Field of vision with different speed

- The brake distance of a car driving 30km/h compared with a car driving 50km/h is much shorter;
- The severity of injuries as a result of a crash with a car decreases with lower speeds.

The design of the infrastructure should emphasis the presence of children. Children should be visible, this could be reflected in crossing points with good visibility for both the pedestrians as well as motorists.

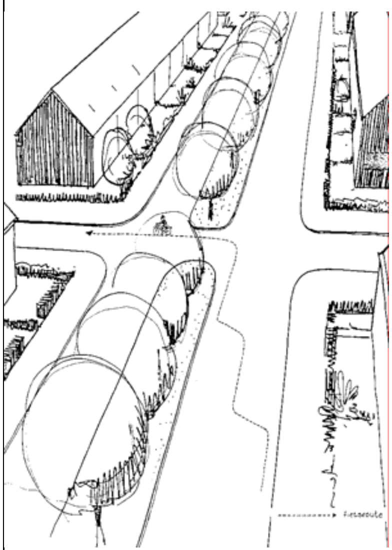


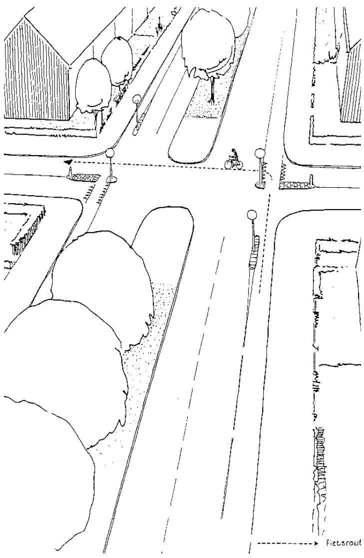
Source (AGV, 1984)

The picture on the left shows a good design of a crossing facility, showing a blister island, sufficient lighting, demarcations by bollards, different surface texture/ colour and open space around the crossing point. This crossing point is designed to “lure” children to this location to cross and to draw the attention of motorists.

Figure 3: Design of a pedestrian crossing facility

Unexpected movements should be prevented. A right turning cyclist for example could be separated from the moving lane first, after which it can cross at the intersection.





The above pictures (*Source (AGV, 1984)*) show a solution to prevent unpredicted behaviour (Dutch situation, where traffic drives at the right side of the road).

Figure 4: Design of an intersection to prevent unpredicted behaviour of cyclists

The following recommendations would improve the safety of children:

- Avoidance of objects along roads blocking visibility;
- Consistent speed regime;
- Good visibility near crossing points, so no objects or parked cars obstructing the view of the motorists or pedestrians;
- Speed reduction near major crossing points and/ or facilities for children like schools and playgrounds;
- Blister islands in streets with a lot of parking, so children do not have to cross between cars;
- No one way streets in areas with a high percentage of children, like in the vicinity of school and a speed reduction in these areas;
- Separated cycle paths at streets with high traffic and cycle volumes.

A further breakdown of New Zealand crash data and field research would assist in achieving more specific recommendations for New Zealand. The outcome of such a study would be useful for projects like "Safe Cycling to School Routes" and the "Safer Routes Project".

8. Conclusions

Children do not always act and react in traffic situations, as adults would expect from them. Their cognition and social and physical skills are still developing. Therefore children can not always be made responsible for their "mistakes" in traffic. This is also the responsibility of their parents, the road user and the road controlling authority. The infrastructure should be designed in such a way, that the design draws the road users attention to the presence of children.

However the road controlling authority has to balance the need of all road users. Therefore it is important that a roading hierarchy is identified. At local roads the above recommendations could apply, while the design of the arterials will be mainly focused on uninterrupted traffic flow.

Acknowledgements

It is acknowledged that a large part of this paper is based on the findings of "A safe road infrastructure for children, research of the circumstances of road accidents with children, in relation to the road design within the context of Sustainable Safety", a thesis research report, carried out by the author of this paper.

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