MANAGING THE SAFETY OF YOUNG PEDESTRIANS AND CYCLISTS

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1.1 A brief statement of the issue

Although adults make up the largest percentage of fatal pedestrian and cyclist crashes, young children's safety as pedestrians and cyclists is of particular concern in view of their vulnerability in traffic situations and the special value society places on children. Their vulnerability stems from a number of factors including their smaller stature, cognitive development, unpredictability and lack of experience as road users. These aspects pose particular challenges in the development of effective countermeasures.

1.2 An assessment of the road safety issue

1.2.1 Fatalities and fatality rates

Although pedestrian and cyclist fatalities in Australasia have fallen over the last decade, they still represented 15.9% of all road fatalities in Australia in 2003 and a similar proportion in New Zealand. Children under the age of 16 constitute a substantial proportion of pedestrian and cyclist deaths, comprising 14.8% and 20.3% in Australia and New Zealand, respectively - thereby representing 1.5% of all road deaths (ATSB 2005, LTNZ 2005).

Figure 6.1 shows the rate of pedestrian and cyclist fatalities per 100,000 population by age group between 2000 and 2004 in Australia and New Zealand. Note that in all age groups, rates of pedestrian deaths are much greater than cyclist deaths (except for 10 to 14 year olds in New Zealand where the rate of cyclist deaths is relatively high).

Ideally, exposure measures such as distance travelled, number of trips and type of road travelled should be used to enable a better understanding of the risks to pedestrians and cyclists and to make meaningful comparisons. However, there are no recent exposure measures for these road user groups in Australia. A study by Anderson et al. (1989) is the most recent comprehensive study of fatality rates by age and road user type in Australia. Because of the travel diary method used to collect exposure data, only children aged nine or older participated in the study. Some of the key findings of that study were:

- For pedestrians, there was little difference in the number of crashes per million kilometres walked for children compared to adults. However because children aged nine to 15 did approximately twice as much walking as adults aged between 20 and 60, they experienced considerably more crashes per capita.
- As cyclists, children experienced considerably higher fatality rates than did adults per distance travelled. On average, they also cycled more, adding to the high rate of fatalities per capita.

However, these data are now 20 years old. The changes in population profiles and patterns of urban development which have occurred in the intervening years require that the results must be used with caution.

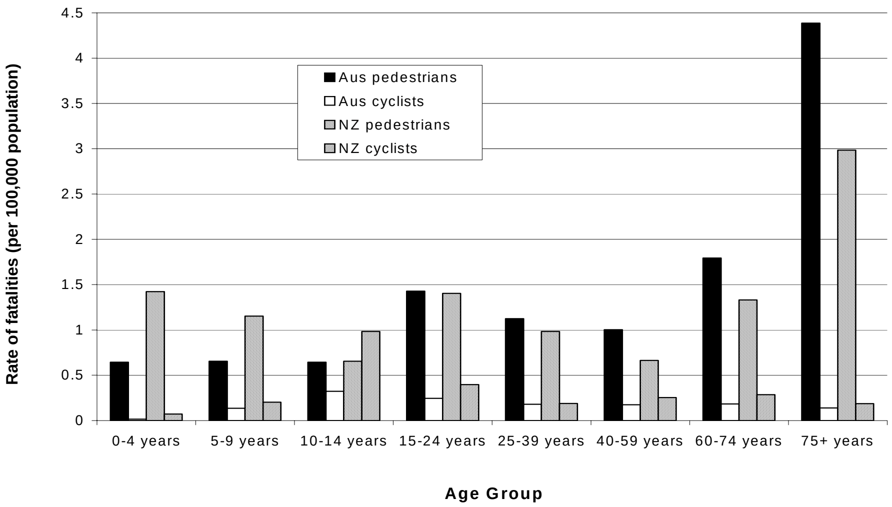

Figure 0.1: Rate of pedestrian and cyclist fatalities per 100,000 population by age group, Australia and New Zealand, 2000-2004 (ATSB 2005, LTNZ 2005)

A more recent study from New Zealand, based on a travel survey carried out in 1997/98, confirmed some of these points but contradicted others (LTSA 2000):

- Children experienced a higher risk of death or injury than adults for each hour spent walking. Boys, especially those in the five to nine age group, were at higher risk than girls. As was the case in Australia, children spent more time walking than adults.
- Child cyclists aged five to 14 experienced slightly higher rates of death and injury per distance travelled than adults and, on average, they cycled more than adults. Ten to 14 year-olds had the highest casualties per capita, more than six times the rate of adults over 20 years.

1.2.2 Injuries and injury rates

In Australia in 2002, serious injuries to pedestrians and cyclists comprised 22.7% of all serious injuries due to road collisions. Of this, 7.4% comprised children under 16 years. In contrast, in New Zealand, serious injuries to pedestrians and cyclists comprised only 13.2% of all serious injuries and of this, 2.6% were children under 14 years (ATSB 2004; LTNZ 2005).

Figures 6.2 and 6.3 show the latest available pedestrian and cyclist serious injury rates per 100 000 population for Australia and New Zealand, categorised by age group. The rates of serious injuries to child pedestrians in Australia are comparable to other age groups but child cyclists are over-represented in serious injury crashes compared to other age groups. In New Zealand, rates of serious injuries are generally higher than in Australia for all age groups. Moreover, rates of serious injuries to pedestrians and cyclists aged between five and 24 years are substantially higher compared to Australian figures and compared to other age groups within New Zealand. It is interesting to note that, in Australia, the incidence of child cyclist and pedestrian serious injuries as a proportion of total serious injuries is high (particularly for cyclists), compared with the fatality rate. The reasons for this difference are unclear and warrant further investigation.

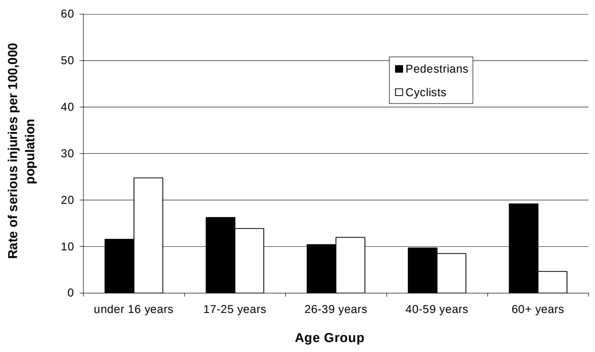

Figure 0.2: Rate of pedestrian and cyclist serious injuries per 100,000 population by age group, Australia 2002 (ATSB 2004)

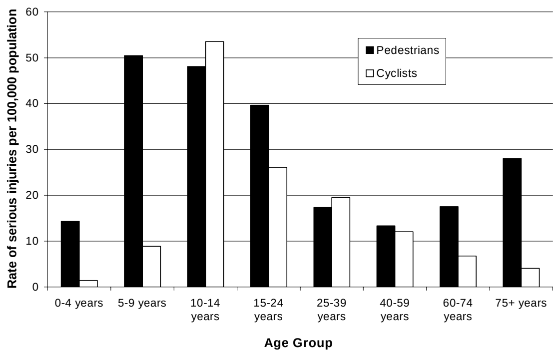

Figure 0.3: Rate of pedestrian and cyclist serious injuries per 100,000 population by age group, New Zealand, 2003 (LTNZ 2005)

1.2.3 Crash types and travel patterns

In Australia and New Zealand, as in other motorised countries, the great majority of pedestrian and cyclist collisions occur on urban roads (over 90%), most often on local streets, close to home and while the child is unsupervised. Many occur while the child is on the way home from school or playing after school (Anderson et al. 1989, Struik et al. 1988). In New Zealand, the majority of cyclist collisions occur at intersections but there is an even spread of pedestrian crashes at intersections and at mid-block locations (LTNZ 2005). Overseas figures show similar patterns.

1.3 A review of the research

Much of the literature on child pedestrian and cyclist safety has focussed on the contributing factors to crash risk. These factors include: the behaviour of children in traffic; driver behaviour (particularly fast or inappropriate speeds and over-estimating the abilities of child pedestrians and cyclists); the road environment (which is largely designed for vehicle use and is often unforgiving of the needs and capabilities of vulnerable road users); and vehicle design.

1.3.1 The behaviour of children in traffic

Due to immature and less well-developed cognitive, attentional, perceptual and visual skills, young children are less competent in traffic than older children and adults and this consequently increases their risk as pedestrians and cyclists (Dunbar et al. 2001, Sarkar et al. 2003, Tabibi and Pfeffer 2002, Whitebread and Neilson 2000, Zeedyk et al. 2001, Zeedyk et al. 2002). Younger children under seven years experience great difficulty particularly in dangerous locations and choosing a safe location to cross, judging safe gaps in traffic, being distracted by irrelevant information and attending strategically to traffic in complex traffic situations, and controlling impulsive reactions. For children aged seven years or older, the abilities necessary to interact safely in traffic improve markedly in a number of important aspects but, for many children, these abilities may not be fully developed until at least 11 to 12 years of age.

The small stature of young pedestrians is another identified source of difficulty. They have greater difficulty seeing over parked cars and other obstacles, and are in turn more easily hidden by them (Demetre and Gaffin 1994; Leadbetter 1998).

There may also be socio-economic differentials in child pedestrian casualty rates. Some argue that, in the UK, children from lower socio-economic status backgrounds have up to five times the risk of pedestrian injury compared with children from higher socio-economic status backgrounds (Hewson 2004; Thomson et al. 2001). Similar findings are reported in Sweden (Hasselberg and Laflamme 2004). Whether this is due to behavioural factors on the part of the pedestrian or driver, or to environmental factors, has not been determined.

1.3.2 Driver behaviour and the road environment

The safety of pedestrians and cyclists is compromised to a large extent by the design and operation of the road-transport system, which is generally designed for vehicles and, for the most part, seems to be unforgiving for the most vulnerable road users. Dominant attitudes by drivers, failure to acknowledge the rights of pedestrians and cyclists and fast speeds of drivers in areas of high pedestrian/cycling activity greatly increase the potential for crashes and, more importantly, the injury consequences once a collision occurs (Job et al. 1994; Preusser et al. 2002; Summala et al. 1996).

1.3.3 Vehicle design

Current design of vehicle frontal structures of passenger cars and other larger vehicles contributes significantly to the severity of injuries sustained in a collision. Pedestrians and cyclists struck by a car or four-wheel-drive vehicle with high bumpers and more blunt frontal profiles, are more likely to incur serious head, thoracic, abdominal and spinal injuries than when struck by a bonnet-type passenger car. In contrast, as passenger cars are more aerodynamically streamlined and have lower bumpers than vans, utilities and four-wheel-drives, pedestrians and cyclists struck by a car are much more likely to incur a leg injury (Ballesteros et al. 2004, Lefler and Gabler 2004, Maki et al. 2003).

The fitting of rigid bull-bars to many large vehicles is of concern to pedestrian and cyclist safety. Zellmer and Otte (1995) reported that bull-bars strongly increased the risk of injury in crashes with pedestrians and cyclists, noting that injury risk for a child in an impact with a bull-bar at 20 km/h is similar to an impact with an off-road vehicle at 30 km/h and a regular passenger vehicle at 40 km/h. They also noted that hip and lower limb fracture risk for an adult impacting a bull-bar at 25 km/h is similar to impacting a car bonnet at 40 km/h. Others, too, have noted the increased risk of injury for pedestrians even at low impact speeds when a bull-bar is fitted to vehicles (Reilly-Jones and Griffiths 1996; Anderson and McLean 1998). More recently, Attewell and Glase (2000) attempted to analyse the contribution of bull-bars to fatal road crashes in Australia and found little evidence of an increased risk for pedestrians, although they did show a different injury profile of pedestrians killed in bull-bar impacts (an increase in severe abdominal and chest injury as well as a high level of head injury). They did acknowledge, however, that there were substantial limitations in the data and concluded that, on balance, bull-bars present an additional risk to pedestrians and other vulnerable road users and that vehicle size and speed are confounding factors.

1.3.4 Strategies for managing young pedestrian and cyclist safety

There are a number of ways to improve child pedestrian and cyclist safety including training children in skills for interacting safely with traffic, adapting the environment to be more forgiving, and vehicle design improvements.

Supervision, training and education

Common sense dictates that when young children are exposed to traffic, supervision is essential. Generally, child pedestrians should be supervised until they reach the age of nine or ten. It has been argued that the accompanying older person should hold the hand of the child until they reach the age of six, although allowance should be made for the capacities of the individual child. It should be noted that although there is agreement that supervision of young children is necessary, there is little consensus on developmental milestones such as no longer holding hands and allowing independent travel on foot or by bicycle.

Many jurisdictions provide supervision at key crossing points in the form of adult crossing supervisors. However, their effectiveness in preventing crashes at school crossings has not been determined.

It is generally argued that children can be effectively taught critical road safety skills and behaviours. There are a number of programs that promote walking and cycling of which some incorporate safety messages. While there may be associated health and environmental benefits (Collins and Kearns 2005; Dellinger 1999), walking and cycling still remain a relatively risky form of travel for school children compared to car and bus travel (Transportation Research Board [TRB] 2002). Moreover, it appears that the transfer from knowledge to safer performance or behaviour is poor and transfer is not automatic (Ampofo-Boateng and Thomson 1991; Rothengatter 1981; Zeedyk et al. 2001). Moreover, education may produce negative effects in that children's increased knowledge can create a false sense of confidence amongst parents and children that their ability to face the road environment is improving (Zeedyk and Wallace 2003).

All Australasian jurisdictions have some form of comprehensive road safety education program that takes students from pedestrian education in pre-school and early primary years, through bicycle education in later primary and secondary years, to pre-driver education in later secondary years. However very few rigorous evaluations of these types of programs have been attempted and their effectiveness is hence largely unknown. Some examples are described below.

- 'Travel smart schools' programs such as 'Walking School Bus' can be found in most Australasian jurisdictions. These programs generally aim to promote children walking and cycling to and from school under adult supervision as a safe and active form of transport. According to TravelSmart, these programs are successful and popular programs, particularly in terms of the health, safety, social and environmental benefits (TravelSmart Australia 2005). Further independent evaluation of the programs is required.
- 'Safe Routes to School' are community-based programs which combine engineering treatments and education (supplemented by enforcement where necessary) to reduce the incidence and severity of road crashes involving primary and secondary school aged children. Programs rely on separating students from traffic as much as is practical, encouraging crossing at supervised or identified safe crossing points and incorporating training activities to ensure students can use the various facilities on the appropriate routes. At least some of these programs stress the need for adult supervision for travel to and from school. Evaluations generally show safety, social and environmental benefits (Cairney 2003; Rose 2000).
- Programs for children at younger ages, such as VicRoads' 'Starting Out Safely' and New Zealand's 'Safe Start / Small Steps' aim to provide information to parents on their role as model, teacher and supervisor to their young children. Information is generally distributed through pre-schools and kindergartens. Although the objective of this earlier training is not to encourage earlier independent road use by children, this may be an outcome if parents and carers believe the children are capable of behaving safely in traffic on their own – in which instance earlier training could be counterproductive. No formal evaluations have been conducted on these programs.

- ‘Bike Ed’, developed by VicRoads is a bicycle safety education course aimed at students aged 9 to 13. It is a practical course that includes safety checks of bicycles and equipment, bicycle handling and riding skills and road rules. On-road practical training with a problem-solving approach designed to develop traffic safety awareness as well as parental support are features of this program. On-road supervised cycling experience has been shown to be an important element in effective courses (Savill et al. 1996) but some jurisdictions do not include this component. Moreover, there is some, albeit limited, evidence that the program may be counter-productive (Carlin et al. 1998). Others, too, have questioned the effectiveness of child cycling training programs (Bailey 1994; Colwell and Culverwell 2002).

Some promising evidence notwithstanding, there does not appear to be any specific program directed towards improving road safety for child pedestrians or cyclists to which casualty reductions can be unequivocally attributed.

Bailey (1995) reviewed studies of road safety education, pointing out that on the rare occasions when road safety education is evaluated, it tends to focus on knowledge and attitudes derived from rote learning, rather than skills required to understand and function in traffic environments. Bailey is particularly critical of one-off and other short- term programs where there is no linking of the lesson to prior knowledge, and no follow-up. Since Bailey’s review and as indicated by the Australian programs already listed, many jurisdictions have now developed hands-on programs for pre-school children with linked, on-going programs in primary and high schools.

More recently, Duperrex et al. (2002) applied much tighter criteria to the studies considered and sought to identify pedestrian safety education programs which randomly allocated individuals to experimental or control treatments. They identified 15 studies, 14 of them dealing with children. They found that the methodological quality of the trials was generally poor and that the trials all used different measures and employed different intervals between the education and the evaluation. None used injury reduction as a criterion, but five of the studies compared the effects of the different treatments on observed behaviour. As the authors pointed out, linking behaviour to accident reductions depends on untested causal assumptions which, even if true, leave some unanswered questions regarding the relationship between the size of the behavioural effect and the extent of crash reductions.

In addition, while the emphasis has changed from teaching simple rules to training in real-traffic environments and examining pedestrian skills, there still remains a large amount to be learned about children’s behaviour in actual traffic environments. Bailey and Natora (1999) explored some characteristics of children cycling in traffic and the duty of care responsibilities of parents and children. They concluded that informed parental decision making, appropriate to the development of the child and the cycling circumstances in question, may contribute to a solution to the question of when children would be capable of riding alone in traffic. Zeedyk and Kelly (2003) argued that parents provide reasonably good models of pedestrian behaviour to children when accompanying them on trips. However, they also found that few adults treat the crossing event as an opportunity to teach their children explicitly about road safety, do not adapt pedestrian outings to match children’s skill levels and that children therefore have little opportunity to exercise or develop their own pedestrian skills. What is still needed is a better understanding of the developmental and behavioural characteristics that put young children at increased risk for pedestrian and cyclist injuries.

Legislation

The protective effect of bicycle helmets for all cyclists is well documented. Current studies indicate that cyclists who wear helmets experience fewer head injuries and decreased severity of injury (for a detailed review of bicycle helmet use and effectiveness, see O'Hare et al. 2004). Most recently, Ho-Yin Lee et al. (2005) examined the effect of bicycle helmet legislation on injury rates in California. They found that bicycle safety helmet legislation was associated with a significant 18% reduction in traumatic brain injuries amongst cyclists aged 17 years and under (who were subjected to the law). There were no changes in the proportions of head injury outcomes for adult cyclists (not subjected to the law). The authors make the point that the data used in this study did not include fatal injury cases and that the reductions in head injury may, in fact, be conservative because most bicycle fatalities result from head trauma and the legislation may have prevented some fatal injuries. It was also found that the legislation was accompanied by a 9% increase in non-head injuries – a finding attributed to a shift in primary diagnoses in the absence of serious head injuries. While data on level of compliance, enforcement of this law and potential changes in bicycle use were not provided, these findings provide strong evidence that wearing helmets reduced head injury.

Bailey and Natora (1999) discussed the merits of introducing a minimum cycling age for children who ride unsupervised. Given that there are many factors to consider here, they concluded that, if a minimum age recommendation or stipulation were to be proposed, it would be best implemented, not as a measure in isolation, but in the context of a broad inter-disciplinary strategy for unprotected road users as a matter of public health policy.

There are legislative options also for better managing pedestrian safety. For example, Japan has required that from 2005, all new cars and car-based vehicles meet new design standards aimed at reducing pedestrian head injuries – with all cars and car-based vehicles needing to comply by 2010. While equivalent steps have also been taken by the European Commission, there is currently no indication that similar legislation is being considered for Australia or New Zealand.

Road design and operation

Engineering countermeasures have the potential to quickly and effectively create a safer and more 'crashworthy' travel environment for vulnerable road users. To be successful, it is imperative that any improvements should be made to those parts of the road-transport system that present the greatest risk to young pedestrians and cyclists, that is, in high activity areas such as on residential streets, and around school zones. The improvements that appear to provide the most benefit for children include: measures to reduce travel speeds where children are present (lower speed zones and traffic-calming measures), and provision of infrastructure that gives higher priority to pedestrians and cyclists in critical locations (through separation of travel modes, e.g. school crossings, supervision, provision of foot and bike paths, signing to warn of presence of children).

Moderation of vehicle speed

Research shows unequivocally that crash incidence and crash severity decline whenever speed limits are reduced and increase when speed limits are raised (Anderson et al. 1997; Haworth et al. 2001). Moderation of vehicle speeds in high pedestrian/cyclist activity areas can provide a highly cost-effective option that can offer benefits not only to child pedestrian/cyclist safety but to all other road users and to local communities (environmental and amenity advantages). Speed moderation is also likely to have only a minor impact on the mobility of drivers in most urban settings.

Pedestrians and cyclists are only safe when vehicle speeds are low, in the order of 30 to 40 km/h (ETSC 1999, Wramborg 2003, Yeates 2001). At these speeds, most potential collision situations can be recognised and avoided, and, if a collision does occur, damage and injury should be light to severe, but rarely fatal. Most OECD countries have adopted general urban speed limits of 50 km/h and some permit zoning at lower speeds in residential areas and school zones. In most Australasian jurisdictions, speed limits in residential streets have been set at 50 km/h in order to reduce the severity of injury to pedestrians and cyclists, and many have introduced a time-based 40 km/h limit at and around school sites.

Traffic calming measures can be used to support lower speed limits in local streets and in areas where there is high pedestrian and cyclist activity. They act to make drivers more attentive to their surroundings, indicate that speeding is not appropriate in areas when there is high pedestrian/cyclist activity, and drive more slowly or appropriately for the environment. The '*woonerf*' concept encourages drivers to drive slowly by physical modifications to the roadway (such as pavement narrowing, refuge islands, alterations to the road surface, speed humps, roundabouts and gateway treatments). These are now common in Europe, with many reports of success, particularly in terms of speed reduction, crash reduction, increased walking and cycling activity, and changes in driver behaviour (ETSC 1999; Summala et al. 1996).

Separation between road user groups

Separating pedestrians from vehicles either in time or space, is common practice and there are three broad types of possible treatments to reduce or eliminate conflicts including i) horizontal separation (e.g., provision of malls and car-free zones, bicycle lanes and footpaths, fencing bollards), ii) time separation (e.g., formal pedestrian crossings), and iii) vertical separation (underpasses and overpasses).

Provision of vehicle-free zones is an extremely effective way of improving safety and mobility for pedestrians. Even partial separation in the form of vehicle-restricted zones can be beneficial. Vehicle-restricted areas are used worldwide and usually involve the use of traffic-calming measures and environmental beautification to deter or slow down vehicular traffic. There are many reports of successful treatments of this sort (Dijkstra et al., 1998; Danish Government, 1993).

Barrier fencing and guardrails on road edges and between opposing lanes of traffic are effective at limiting access to the road at hazardous mid-block locations, and good placement and design of fencing and guardrails is essential for compliance. In some locations, alternative types of barriers (such as garden beds, raised planter boxes and outdoor seating) can be used, both for aesthetic reasons and to achieve greater compliance – they may realize higher acceptance from pedestrians because they appear as natural elements of the streetscape, rather than overt attempts to re-direct pedestrians from their most convenient path (Oxley et al., 2004).

Footpaths, bicycle lanes and tracks are integral components of the pedestrian and cyclist transport networks. The provision of well-maintained paved footpaths and shoulders is associated with fewer pedestrian collisions, injuries and deaths (Institution of Transport Engineers, 1998). Footpaths also provide a comfortable and safe place to walk, improve pedestrian access and increase positive experiences while walking. For cyclists, it is argued that the provision of clearly marked tracks, paths and lanes that have direct connections is essential for cyclist safety. One of the main issues is to determine the most appropriate facility for road type and use, i.e., whether complete separation is necessary (provision of tracks), or the provision of marked lanes on the roadway is adequate. The ETSC (1999) argued that cyclists can mix safely with traffic at speeds below 30km/h, but where traffic speeds are between 50km/h and 65km/h, segregation or additional lane width is necessary. Above 65km/h, segregation is essential. Moreover, at intersections, highly conspicuous and clearly marked separate cycle areas can increase cyclist safety (Jensen & Nielsen, 1996; Hunter, Harkey, Stewart & Birk, 2000).

The provision of formal pedestrian crossings act to control pedestrian and vehicle movements, separate their use of the roadway in time, and concentrate pedestrian movements to selected locations where potential conflicts can be more effectively managed. There are two facts to consider when installing formal crossings: type and location. In general, the requirement for facilities is determined by vehicular volumes and gaps, pedestrian crossing volumes, speed limit, and other general conditions such as traffic controls, geometry, crash history, and pedestrian visibility. In addition, crossings should be placed at appropriate locations for people to use them. Pedestrians of all ages often prefer to take the most direct path and are unlikely to walk very far from their intended path to a crossing point far away.

Grade-separation of crossings is another excellent way to eliminate conflict between vulnerable road users and vehicles, however, these treatments have not met with much success, because of the effort required to walk up and down stairs or along long ramps, and security issues. Nevertheless, footbridges or subways that are designed to keep pedestrians on their natural desired line while motorists undergo the changes in grade and level, and that have no steps or troublesome ramps may be effective (ETSC, 1999).

Vehicle design

The influences of vehicle frontal structures on pedestrian and cyclist kinematics and injuries have been widely reported. Even though the significance of child pedestrian and cyclist injuries has been recognised for a number of decades, there is still very limited progress in the injury prevention of child pedestrians and cyclists. Indeed, due to the absence of experimental data with child dummies, the biomechanical responses and injury tolerance levels of children have not been well understood (ETSC 1999). There is, however, some progress in developing mathematical models to represent child pedestrians, taking into account differences in anatomical structure and age-dependent properties of biological tissues (Liu and Yang 2002).

In addition, research associated with Australia's New Car Assessment Program (see website: www.aaa.asn.au/ancap.htm) has looked at the issue of car-inflicted pedestrian injuries. The work explores the injuries likely to be sustained by pedestrians when struck by a vehicle travelling at 40 km/h – with the different injury outcomes demonstrating that vehicle design aspects can result in substantial differences in the severity of child and adult head and leg injuries. At least some vehicle manufacturers have responded to this research.

There are moves, world-wide, to ban the manufacture and use of aggressive bull-bars and to design low profile, contour-hugging bull-bars that are made of plastic or composite metal/plastic materials (Hong Kong Department of Transport 2003; LTSA 2003; UK Department of Transport 2003).

1.4 Political, social and other factors associated with managing the safety of child pedestrians and cyclists

Although child pedestrian and cyclist crashes are a relatively small part of the overall road toll, great emotion attaches to child deaths and injuries, and the community has high expectations for child safety. There is also a pervasive anxiety concerning children's personal safety. One consequence of this is a reluctance to shift funds from adult crossing supervisor programs to other areas of road safety where they might return greater benefits. In the absence of documented benefits, some practitioners question the contribution crossing supervisors make to road safety but recognise that communities are unlikely to accept a reduction of the programs.

While a great deal of effort has been invested in Safe Routes to (and from) Schools programs, most child pedestrian and cyclist fatalities happen in the late afternoon or early evening. It seems likely that many of these do not occur on the way directly from school to home. These patterns are currently not well understood.

Over the last decade or so, children are increasingly being driven to school or leisure outings even though they could walk or cycle. Child pedestrian crashes would probably be considerably higher were it not for the fact that many children now tend to be driven to and picked up from schools and other destinations. In 1999, 26% of primary school-aged children in Perth, Australia, walked to or from school, including only 42% of those who lived within a 10 minute walk from school. Further, 81% of all trips made by children aged five to 9 years and 62% of those made by children aged 10 to14 years were by car (Morris et al. 2001).

Cooper and Ryan (1998) examined the proportions of injured school children using each travel mode to and from school in Western Australia from 1987 to 1996. They reported that 64% of children were injured in passenger vehicles, 2% in buses and 35% while cycling and/or walking. While this data confirms the car as the dominant mode of transport, it does not adjust for mean trip distance. In contrast, United States data shows the relative fatality rates by travel mode during normal school travel hours per 100 million student trips and 100 million student miles (Table 6.1). Clearly, walking and cycling are relatively more risky travel modes than other travel modes (TRB 2002).

Table 0.1: Estimated student fatality rates by travel mode in normal school travel hours

(Source: TRB, 2002).

Travel mode	Fatalities per 100 million student trips	Fatalities per 100 million student miles
School bus	0.3	0.1
Other bus	0.1	<0.1
Passenger vehicle, adult driver	1.6	0.3
Passenger vehicle, teen driver	13.2	2.4
Bicycle	9.6	12.2
Walking	4.6	8.7
Overall rate	3.5	0.7

It is understandable that parents wish to protect their children from perceived risks associated with walking and cycling. However widespread transport by car contributes to congestion and traffic complexity, deprives children of the opportunity to undertake regular, incidental physical activity that will lead to long-term better health and most importantly, reduces the opportunity to develop an awareness of traffic and to learn fundamental road safety practice when they can be supervised by a parent/carer (Collins and Kearns 2005, Timperio et al. 2004).

The argument to promote safe walking by children - as well as pointing to the health benefits arising from physical activity, including reduced obesity – may be extended to a claim for “safety in numbers”: more people walking (and cycling) may mean fewer crashes as drivers become more aware of their presence.

1.5 Conclusions

Fatal and injury crashes involving child pedestrians and cyclists are relatively few in number. In the absence of good exposure data, fatality rates on a population basis indicate that the problem lies mainly amongst the elderly for pedestrian fatal crashes, but that school-aged cyclists in New Zealand are also at increased risk, compared to other age groups. Serious injury data shows that child cyclists in Australia and children as both pedestrians and cyclists in New Zealand are more likely to be involved in a serious injury crash, compared to adults.

Three broad strategies are available for managing child pedestrian safety – education/ supervision/training, improvements to road design and operation and improvements in vehicle design. It is important to note that none of the three strategies is a sufficient solution by itself. Gains in children’s safety in traffic require innovative combinations of improvements in all three areas.

Children face a number of difficulties stemming from their cognitive development, impulsivity and smaller stature. Recent evidence suggests that realistic training in real-life settings can result in success in coping with more complex situations, and recent recommendations are for road safety education to begin at even earlier ages and be tailored to target ‘at-risk’ children. Despite impressive behavioural changes, it is not known whether road safety education reduces crashes amongst children. Although there is evidence that pedestrian safety education is effective in increasing knowledge and changing crossing behaviour, there is no clear evidence that this results in fewer child pedestrian crashes. Further, although there is no evidence to show they are an effective road safety measure, adult crossing supervisor programs consume a large proportion of road safety budgets in jurisdictions which run such programs. However, the public has high expectations regarding child traffic safety, so that it would be very difficult to divert funding to other road safety activities with greater benefits.

Vehicle design improvements are underway, however, vehicles are inherently limited in their ability to protect vulnerable road users, and pedestrian and cyclist safety is unlikely to be markedly improved in the near future through vehicle design changes.

In contrast, engineering countermeasures offer quick and effective measures to provide safe environments in which children can walk and cycle. Measures to reduce vehicle speeds where there is high pedestrian and cyclist activity along with measures to separate travel modes are highly desirable.

REFERENCES

Ampofo-Boateng K & Thomson J 1991, 'Children's perception of safety and danger on the road', *British Journal of Psychology*, vol.82, pp.487-505.

Anderson R, & McLean A 1998, 'Crashworthiness research at the NHMRC Road Accident Research Unit', *Developing safer motor vehicles for Australia: proceedings of a seminar, Parliament House, Sydney*, Staysafe 44, Parliament of NSW Joint Standing Committee on Road Safety, pp.99-108.

Anderson R, McLean A, Farmer M, Lee B & Brooks C, 1997, 'Vehicle travel speeds and the incidence of fatal pedestrian crashes', *Accident Analysis and Prevention*, vol.29, no.5, pp.667-674.

Anderson P, Montesin H, & Adena M 1989, *Road fatality rates in Australia 1984-85*, report CR 70, Federal Office of Road Safety, Canberra, Australia.

Attewell R & Glase K 2000, *Bull bars and road trauma*, report CR 200, Australian Transport Safety Bureau, Canberra, Australia.

ATSB 2004, *Serious injury due to road crashes*, viewed 11 April 2006, http://www.atsb.gov.au/pdfs/serious_injury_2004.pdf

ATSB 2005, *The fatal road crash database*, viewed 11 April 2006, http://www.atsb.gov.au/road/fatal_road_crash_database.aspx

Australian New Car Assessment Program, 'ANCAP crash testing for safety', (see website: www.aaa.asn.au/ancap.htm)

Bailey T 1994, *The efficacy of young children's bicycle skills training: a literature review,* report 3/94, Office of Road Safety, Department of Transport, South Australia.

Bailey T 1995, 'The effectiveness of occasional or short-term school road safety education programs: technical note', *Road and Transport Research*, vol.4, no.3, pp.71-75.

Bailey T & Natora A (eds.) 1999, *Children cycling in traffic: Statistical, development and legal perspectives*, report 1/99, Office of Road Safety, Department of Transport, South Australia.

Ballesteros M, Dischinger P & Langenberg P 2004, 'Pedestrian injuries and vehicle type in Maryland, 1995-1999', *Accident Analysis and Prevention*, vol.36, no.1, pp.73-81.

Cairney P 2003, 'The impact of Safe Routes to Schools program on road safety knowledge and behaviour in Victorian primary schools', p*roceedings Road Safety Research, Policing and Education Conference*, *Sydney*, Roads and Traffic Authority, Sydney, vol.2, pp.114-118.

Carlin J, Taylor P & Nolan T 1998, 'School-based bicycle safety education and bicycle injuries in children: a case-control study', *Injury Prevention*, vol.4, pp.22-27.

Collins D & Kearns R 2005, 'Geographies of inequality: child pedestrian injury and walking school buses in Auckland, New Zealand', *Social Science and Medicine*, vol.60, pp.61-69.

Colwell J & Culverwell A 2002, 'An examination of the relationship between cycle training, cycle accidents, attitudes and cycling behaviour among children', *Ergonomics*, vol.45, no.9, pp.640-648.

Cooper L & Ryan G 1998, *The risk of injury associated with travel to and from school by bus and other modes of transport and analysis of data for Western Australia*, report RR63, University of Western Australia, Road Accident Prevention Research Unit, Perth, Western Australia.

Danish Government 1993, White paper on transport. Copenhagen, Denmark.

Dellinger A 1999, 'Barriers to children walking and biking to school – United States, 1999', *Journal of American Medical Association*, vol.288, no.11, pp.1343-1344.

Demetre J & Gaffin S 1994, 'The salience of occluding vehicles to child pedestrians', *British Journal of Educational Psychology*, vol.64, pp.243-251.

Dijkstra A, Levelt P, Thomsen J, Thorson O, Van Severen J, Vansevenant P, Nilsson, P, Jørgensen E, la Cour Lund B, & Laursen J 1998, Best practice to promote cycling and walking (ADONIS). Research project for the EU Transport RTD programme, European Commission. Copenhagen, Denmark: Directorate General for Transport, Danish Road Directorate.

Dunbar G, Hill R & Lewis V 2001, 'Children's attentional skills and road behaviour', *Journal of Experimental Psychology: Applied*, vol.7, no.3, pp.227-234.

Duperrex O, Bunn F & Roberts I 2002, 'Safety education of pedestrians for injury prevention: a systematic review of randomised controlled trials, *British Medical Journal*, vol.324, no.7346, pp.1129-1137.

ETSC 1999, *Safety of pedestrians and cyclists in urban areas*, European Transport Safety Council, Brussels, Belgium.

Hasselberg M & Laflamme L 2004, 'Children at risk in traffic: improvement potentials in the Swedish context', *Acta Paediatrica*, vol.93, pp.113-119.

Haworth N, Ungers B, Vulcan P & Corben B 2001, *Evaluation of a 50km/h default urban speed limit for Australia*, National Road Transport Commission, Melbourne.

Hewson P 2004, 'Deprived children or deprived neighbourhoods? A public health approach to the investigation of links between deprivation and injury risk with specific reference to child road safety in Devon County, UK', *BMC Public Health*, vol.4, no.15, http://www.biomedcentral.com/1471-2458/4/15

Hong Kong Department of Transport 2003, *Proposal to ban aggressive bull-bars fitted to vehicle fronts*, Consultation paper, Hong Kong Transport Department, http://www.info.gov.hk/td/eng/whatsnew

Ho-Yin Lee B, Schofer J & Koppelman F 2005, 'Bicycle safety helmet legislation and bicycle-related non-fatal injuries in California', *Accident Analysis and Prevention*, vol.37, pp.93-102.

Hunter W, Harkey D, Stewart J & Birk M 2000, Evaluation of blue bike-lane treatment in Portland, Oregon. *Transportation Record*, 1705.

Institution of Transportation Engineers 1998, Design and safety of pedestrian facilities. (Report No. 5A-5). Institute of Transportation Engineers, Technical Council Committee; Chapel Hill, USA.

Jensen S & Nielsen M 1996, Cykelfelter. Sikkerhedsmæssig effekt i signalregulerede kryds. (Bicycle crossings. The safety effect in signalised junctions). (Rapport 51). Trafiksikkerhed of Miljø, Vejdirektoratet, Copenhagen, Denmark.

Job R, Prabhakar T, Lee S, Haynes J & Quach J 1994, *Elderly pedestrian behaviour and driver attitudes and knowledge regarding pedestrians. Volume 2: Driver attitude and knowledge survey and pedestrian behaviour at Zebra crossing study*, report to the Roads and Traffic Authority of NSW, Department of Psychology and Soames Job and Associates, University of Sydney, Sydney, Australia.

Leadbetter C 1998, 'Road smart children', *proceedings of the conference on pedestrian safety, Melbourne*, Australian College of Road Safety, Canberra, pp. 50-54.

Lefler D & Gabler H 2004, 'The fatality and injury risk of light truck impacts with pedestrians in the United States', *Accident Analysis and Prevention*, vol.36, no.2, pp.295-304.

Liu X & Yang J 2002, 'Development of child pedestrian mathematical models and evaluation with accident reconstruction', *Traffic Injury Prevention*, vol.3, pp.321-329.

LTNZ 2005, *Annual Statistics, Motor Vehicle Crashes in New Zealand, 2003*, http://www.ltas.govt.nz/research/annual-statistics-2003/index.html

LTSA 2000, *Travel Survey Report 1997/98*. LTSA, Wellington, New Zealand.

LTSA 2003, *Bull-bars*, fact sheet No 22, Wellington, New Zealand, LTSA.

Maki T, Kajzer J, Mizuno K & Sekine Y 2003, 'Comparative analysis of vehicle-bicyclist and vehicle-pedestrian accidents in Japan', *Accident Analysis and Prevention*, vol.35, no.6, pp.927-940.

Morris J, Wang F & Lilja L 2001, 'School children's travel patterns: a look back and a way forward', *proceedings of the 24th Australasian Transport Research Forum, Hobart, Tasmania*, Tasmania Department of Infrastructure, Energy and Resources, Hobart, 16pp.

O'Hare M, Langford J, Johnston I & Vulcan P 2004, *Bicycle helmet use and effectiveness*, report for Swedish National Road Administration, Monash University Accident Research Centre, Melbourne.

Oxley J, Corben B, Fildes B, O'Hare M, Rothengatter T 2004, Older vulnerable road users – measures to reduce crash and injury risk, Report 218, Monash University Accident Research Centre, Melbourne.

Preusser D, Wells J, Williams A & Weinstein H 2002, 'Pedestrian crashes in Washington, DC and Baltimore', *Accident Analysis and Prevention*, vol.34, pp.703-710.

Reilly-Jones C & Griffiths M 1996, 'The effects of bull bars on pedestrian injury mechanisms and kinematics', *15th International technical conference on the Enhanced Safety of Vehicles*, report DOTHS 808 465, NHTSA, Washington DC, pp 1782-1787

Rose G 2000, 'Safe Routes to School implementation in Australia', *Road and Transport Research*, vol.9, no.3, pp.3-16.

Rothengatter J 1981, *Traffic education for young children: An empirical approach*, Swets Publishing, Lisse.

Sarkar S, Kaschade C & de Faria F 2003, 'How well can child pedestrians estimate potential traffic hazards?' *Transportation Research Record*, 1828, pp.38-46, Transportation Research Board, Washington DC, USA

Savill T, Bryan-Brown K & Harland G 1996, *The effectiveness of child cycle training schemes,* report 241, Transport Research Laboratory, Crowthorne, UK.

Struik M, Alexander K, Cave T, Fleming A, Lyttle J & Stone A 1988, *Pedestrian accident project, literature review of factors contributing to pedestrian accidents,* report 4, Road Traffic Authority, Melbourne.

Summala H, Pasanen E, Räsänen M & Sievänen J 1996, 'Bicycle accidents and drivers' visual search at left and right turns', *Accident Analysis and Prevention*, vol.28, no.2, pp.147-153.

Tabibi Z & Pfeffer K 2002, 'Choosing a safe place to cross the road: the relationship between attention and identification of safe and dangerous road-crossing sites, *Child: Care, Health and Development*, vol.29, no.4, pp.237-244.

Thomson J, Tolmie A & Mamoon T 2001, *Road accident involvement of children from ethnic minorities: a literature review*, road safety research report 19, Department for the Environment, Transport and the Regions, London, UK.

Timperio A, Crawford D, Telford A & Salmon J 2004, ‘Perceptions about the local neighborhood and walking and cycling among children’, *Preventive Medicine*, vol.38, pp.39-47.

Transportation Research Board 2002, *The relative risks of school travel. A national perspective and guidance for local community risk assessment*, special report 269, Transportation Research Board, Washington DC, USA.

TravelSmart Australia 2005, *Walking School Bus – A guide for parents and teachers*, http://www.travelsmart.gov.au/schools/schools2.html

UK Department of Transport 2003, *Bull-bars: Consultation on options for national action*, UK Department of Transport, London, viewed 11 April 2006, http://www.dft.gov.uk/stellent/groups/dft_roads/documents/page/dft_roads_506881.hcsp

Whitebread D & Neilson K 2000, ‘The contribution of visual search strategies to the development of pedestrian skills by 4-11 year old children’, *British Journal of Educational Psychology*, vol.70, pp.539-557.

Wramborg P 2003, The new approach to traffic planning and street design – focussing cycling, *Proceedings Velo City, Paris, France*.

Yeates M 2001, ‘60, 50, 40km/h – which is safest?’ *Australian Cyclist*, March 2001.

Zeedyk M & Kelly L 2003, ‘Behavioural observations of adult-child pairs at pedestrian crossings’, *Accident Analysis and Prevention*, vol.35, 771-776.

Zeedyk M & Wallace L 2003, ‘Tackling children’s road safety through edutainment: an evaluation of effectiveness’, *Health Education Research*, vol.18, no.4, pp.493-505.

Zeedyk M, Wallace L, Carcary B, Jones K & Larter K 2001, ‘Children and road safety: increasing knowledge does not improve behaviour’, *British Journal of Educational Psychology*, vol.71, pp.573-594.

Zeedyk M, Wallace L & Spry L 2002, ‘Stop, look, listen, and think? What young children really do when crossing the road’, *Accident Analysis and Prevention*, vol.34, pp.43-50.

Zellmer H & Otte D 1995, ‘Injury risk of vulnerable road users in case of accidents with crash bar equipped off-road vehicles’, *International IRCOBI Conference on the Biomechanics of Impacts*, *Brunnen, Switzerland,* International Research Council on Biokinetics of Impacts, Bron, France, pp.119-132.