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Bicycle safety for children and young people: An analysis of child deaths in Queensland

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Introduction

Bicycle riding can be a positive experience for children and young people that builds confidence, independence and promotes healthy recreation. However, these benefits are dependent upon safe bicycle-riding practices. Between 1 January 2004 and 31 December 2011, 12 children and young people under the age of 18 years died in bicycle incidents in Queensland [1]. An additional 1736 bicycle-related injuries requiring emergency department attendance are estimated to have occurred between 2008 and 2009 in Queensland for children and young people under the age of 18 years [2].

Of the twelve bicycle-related deaths between 2004 and 2011 in Queensland, two children were aged between 5 and 9 years, five young people were 10-14 years of age and five young people were between 15 and 17 years. The two children aged 5-9 years were riding their bikes for recreation. Children aged 10-14 years were most likely to have been killed in an incident while riding to school in the morning, with teenagers aged 15-17 years most likely to be killed in incidents occurring after school and in the evening [1].

Bicycle riders are vulnerable road users, particularly children and young people. This is due to several factors that can be grouped into (i) developmental characteristics such as body size and proportions, perceptual and attentional issues, road safety awareness and risk taking behaviours, and (ii) environmental factors such as supervision and shared road use with vehicles. This paper examines safety issues for children and young people who have died in bicycle-related incidents in Queensland, and outlines areas of focus for injury prevention practitioners.

Developmental characteristics

International evidence has found bicycle injuries and deaths disproportionately affect children and young people [3-4].

Children and young people may be at greater risk of bicycle-related injury and death compared to adults due to developmental characteristics unique to childhood and adolescence because the ability to negotiate the complexities of the road environment safely develops with their age and stage of development [2]. Nominating a specific age at which children can be objectively considered to be safe road users is challenging due to physical and cognitive skills developing at different rates and individual differences can be quite large. However, some broad conclusions on children's developmental abilities have been prepared on the basis of recent empirical studies.

Physical development

Children's motor skills and responses do not easily adapt to visual and auditory stimuli. Younger children have difficulty controlling their movements; for bicycling, they only fully master balance at ages 13 or 14 [2]. In addition, their smaller physical stature can pose safety challenges, because it limits their ability to see or be seen over certain heights. Cars and other environmental features such as shrubbery can mask a child and his/her view of oncoming traffic and present a safety hazard at crossings and intersections [2].

Will [5] stated that the small body size and disproportionate head to body ratio affects children's abilities to endure crashes and lends themselves to more head injuries when involved in a crash, with their small size also contributing to their poor visibility to motorists. These vulnerabilities are exacerbated when combined with the challenges of yet-to-be-developed skills in traffic perception and attention.

Perceptual and attentional development

According to the Organisation for Co-operation and Economic Development (OECD), children's acquired intellectual skills and knowledge in terms of understanding movement in space,

time and distance relationships, and physics and the law of mechanics continue developing through adolescence [2]. Until they reach an adult level of understanding, children do not understand and react to complex traffic situations in the same way as adults. Children's observational and reactive capabilities are different from those of adults, and their senses are not fully developed or well co-ordinated.

Will also found children's poorly developed perceptions of depth and hearing/kinaesthetic senses affect their speed and distance estimates, and their inattentiveness and preponderance to risk taking behaviour results in poor hazard perception [5]. Bakovic investigated risks for pedestrians and noted there are different safety considerations required for children of different ages, including ability to detect the presence of traffic, visual timing judgements, co-ordination of information from different directions, and co-ordination of perception and action [6].

Rider characteristics by gender

According to the Queensland Child Death Register, all 12 bicycle-related deaths between 1 January 2004 and 31 December 2011 in Queensland were male children and young people [1]. This finding mirrors closely the New Zealand child fatality data where 11 males and 1 female child died as a result of a bicycle-related crash between 2003-2007, with the highest risk in males aged 10-14 years [7]. Furthermore, international research has also identified males (predominantly the 10-14 year age group) as substantially over-represented in child cyclist fatalities compared to females [8].

While research suggests a limited risk differential between males and females after adjusting for exposure rates [9, 10], Barton and Schwebel [11] suggest some gender-related behavioural explanations for higher rates of unintentional injuries in males in general including greater impulsivity, risk taking and lack of risk perception, and higher levels of activity.

Risk-taking behaviour

Children and young people ride bicycles for varied reasons: for recreation and fitness, to travel to and from school, and to increase independence to participate in employment and social activities. The function of a bicycle changes as a child ages. Therefore it is important to consider the developmental abilities of a child or young person and the intended use of a bicycle when developing road safety messages and initiatives. An OECD report examining international best practice approaches to road safety for children recommended that education and road safety messages should be developmentally appropriate and integrated into the national school curriculum throughout a child's schooling life [2].

The majority of Queensland fatal bicycle incidents involved the young cyclists being hit by motorists [1]. In a large number of cases, the young cyclists were engaging in intentional risk-taking behaviour while others were unintentionally increasing their risk due to lack of riding experience, such as unexpectedly

crossing roads without waiting for traffic to clear, riding at night in poorly lit areas or riding on the wrong side of the road. None of the twelve incidents featured a motorist who was considered criminally responsible for the death of the child or young person.

The use of bicycle helmets

Wearing a bicycle helmet is one of the most effective safety measures a child can take to prevent injury [12]. In Australia, it is compulsory for people riding bicycles to wear bicycle helmets. The law adopted by each state and territory is laid out in Part 15 of the Australian Road Rules, approved by the Australian Transport Council [13]. As outlined in Table 1, only four of the 12 children who have died in bicycle incidents in Queensland since 2004 were known to be wearing helmets [1]. There is further evidence to suggest that in at least one of the four instances where helmets were worn, the helmet may not have been fastened and in another incident the helmet may not have been the correct size for the child.

Parkin and Howard concluded that bicycle helmets are effective in reducing injury, as is the promotion of bicycle helmets via the community and physicians and bicycle helmet legislation [14]. With only two of the 12 children who died from bicycle-related incidents correctly wearing a helmet, it is essential that young people and their parents understand the importance of correctly wearing an appropriately-sized helmet. Unfortunately, public attitudes towards wearing helmets do not seem very positive. A recent survey of 1000 Australians by the Cycling Promotion Fund and Heart Foundation of Australia found that 515 respondents were not interested in cycling for transport, with 15.7% citing 'don't like wearing a helmet' as one of their reasons. The use of a helmet has previously been cited as an inhibitor to bicycle riding [15]. Using examples of public role models, such as professional cyclists and BMX riders, where helmet wearing is standard within the sport, may assist in reducing the stigma of wearing helmets, particularly for teenagers.

Table 1. Number of children and young people known to be wearing a helmet at time of fatal bicycle incident

Bicycle Helmet Worn	Age Category			Total
	5-9 years	10-14 years	15-17 years	
Yes (Correct Use)	0	2	0	2
Yes (Incorrect Use)	0	2	0	2
No	1	1	5	7
Unknown	1	0	0	1
Total	2	5	5	12

Alcohol and drug use

Of the five young people aged 15-17 who died in bicycle-related incidents in Queensland between 2004 and 2011, three were affected by drugs or alcohol at the time of their deaths [1]. Teenagers often use their bicycle to increase independence and enable them to participate in social and employment activities. However, young people need to be taught that the risks and consequences of drink driving are not just for motor vehicles, but for bicycles too.

Environmental risk factors

Keeping children safe whilst participating in the broader traffic environment requires an understanding of the developmental factors that can influence their safety and adequate safety messages put in place to minimise the impact of the environment in intensifying that risk.

Child cyclists on major roads and highways

With high population growth in Queensland, particularly regional areas, there is an increased reliance on major roads and highways for private and commercial vehicles. Roads and highways previously used primarily for accessing residential areas are increasingly being used by commercial and heavy industry vehicles [2, 16]. Additionally, research indicates more parents are driving their children to and from school, with close to 60% reporting this is their primary method of transport [17]. High numbers of cars on residential and major roads during peak school starting and finishing times can also increase risks to child cyclists sharing the road.

For example, using evidence from the Queensland Child Death Register [1], three of the five young people aged 10-14 years who died between 2004 and 2011 were riding on roads with a speed limit of 80km/h or more. These children were all riding unaccompanied to school or school bus stops during a peak traffic period. In two of these three incidents, the roads did not have any designated bicycle lanes. This can potentially increase the risk for cyclists and also for motorists (if required to veer onto the incorrect side of the road to avoid cyclists).

Perceptions that some vehicles are safer than others due to high road visibility, braking features or other safety mechanisms were not supported in the Queensland data [1]. Figure 1 illustrates that all common forms of transportation used on residential and main roads as well as highways have been involved in transport fatalities. The impact of any vehicle making contact with a bicycle rider can lead to serious injury or death. As such, drivers of any model or size of vehicle on any type or speed of road need to be aware of the vulnerabilities of child cyclists.

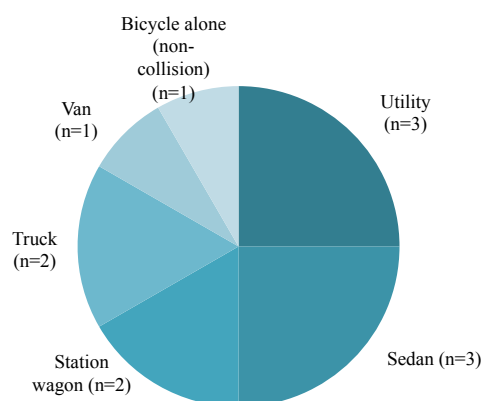


Figure 1. Type of motor vehicle in child bicycle fatalities in Queensland, 2004-2011

Table 2 below shows that most child cyclist fatalities in Queensland occurred on residential streets with a maximum speed limit of 60km/h, closely followed by major roads with a speed limit between 60 and 90km/h [1]. The challenges for children and young people to navigate roads and highways using underdeveloped perceptual and attentional skills, as well as inexperience in bicycle riding or manoeuvring in different environments all play a factor in increasing the likelihood of injury or death. One of the most effective strategies to mitigate these risks is active supervision from an appropriate adult.

Table 2. Number of bicycle-related deaths by place of incident

Place of incident	Age category			Total
	5-9 years	10-14 years	15-17 years	
Highway (100-110km/h)	0	1	1	2
Major road (60-90km/h)	0	2	2	4
Residential street (up to 60 km/h)	1	2	2	5
Private property (no posted limit)	1	0	0	1
Total	2	5	5	12

Unaccompanied child cyclists

Safety prevention experts, Kidsafe Queensland, advise that child cyclists should be accompanied by an adult until at least 10 years of age [18]. None of the four Queensland children aged 10 years or under who died whilst riding a bicycle were being supervised by an adult (as can be seen in Table 3). Further, two of these children were riding unaccompanied for some distance on major roads during a peak traffic period.

Table 3. Number of child cyclists riding alone or with peers at time of fatal incident

Age category	Riding alone	Riding with peers	Riding with an adult
5-9 years	1	1	0
10-14 years	5	0	0
15-17 years	3	2	0
Total	9	3	0

Three of the children and young people who died in bicycle incidents were travelling with peers at the time. Whilst parents may hold to the adage there is safety in numbers, the above evidence regarding developmental vulnerabilities of children and young people, including risk-taking behaviour, highlights that multiple riders travelling together is not a protective factor in and of itself. Road safety experts recommend that primary school-aged children should ride on major roads only when accompanied by an adult who is able to provide appropriate supervision and direction [2, 4, 17].

Safety Messages

Understanding the complex interplay of vulnerability factors that may increase a child's risk of injury whilst bicycle riding can help to inform government and non-government safety campaigns, infrastructure and community planning and increase the enjoyment and participation of bicycle riding in our communities. Table 4 (Appendix A) provides a summary of developmental characteristics and environmental factors that require attention when considering safety messages for young cyclists.

Children's perceptions of speed, distance and time are not as developed as those of adults. Children under 10 years of age are recommended to ride only while supervised by a capable adult and should ride on the footpath rather than main roads. This corresponds with a recent survey of 1005 Australian parents with school-aged children [17]. The main concerns expressed by parents were centred on safety and the dangers posed by traffic and other users. Parents said they would be more likely to let their child ride a bicycle to and from school if personal safety, footpaths/cycle paths, safety of intersections/crossings, or speed/volume of traffic was changed or improved. Additionally, on average, parents stated that children should be 11 years old to ride a bike to and from school and over 10 years old to ride a bike for fun and recreation without supervision.

The authors support the development of infrastructure in our communities that enable safe bicycle riding. The establishment of designated off-road bike paths, separated bike lanes and community awareness campaigns can greatly assist in improving the safety of bike riding. However, designated bicycle lanes do not reduce the importance of appropriate adult supervision, obeying the road rules, correctly wearing a helmet and riding a bike that fits and is in good condition.

The data held by the Queensland Child Death Register demonstrates young riders can engage in intentional risk-taking behaviours while riding their bikes, including riding in and out of traffic, riding at night without lights or reflective clothing, as well as riding without a helmet. That only two of the twelve children and young people who died in Queensland from bicycle incidents were correctly wearing a helmet underscores the importance of basic safety messages being understood by these vulnerable riders.

Conclusion

The main findings of the literature review and evidence from the Queensland Child Death Register were

- While the development of children and young people is individual, there are common vulnerabilities that occur at different stages. Younger children have difficulties perceiving and attending to factors such as speed and distance, as well as poor hazard perception. Even older children require time to develop physical skills in balancing and manoeuvring a bicycle.
- Risk-taking behaviours, whether intentional (such as riding whilst intoxicated) or unintentional (such as steering into traffic), can increase risk of injury. Non-compliance with helmet use is a common risk for children and young people across all ages.
- Bicycle fatalities can occur on any type of road, with any type of vehicle.
- Children and young people require active supervision and modelling of safety behaviours from appropriate adults.

Under Queensland state laws, a bicycle is a vehicle and therefore the rider, including a child of any age, is required to obey all road rules – the same as motorists. It is important that children learn the road rules and understand their responsibilities as riders. Parents can help children by modelling safe bicycle riding themselves and supporting children and young people to engage in safety programs.

Bicycle safety programs are available in schools and local communities. They offer training for children and young people at all age and skill levels. These programs help children improve their knowledge of road rules, improve riding skills and can build confidence on how to stay safe. The authors support initiatives to address road safety for children and young people.

Reducing the incidence of children and young people who die in bicycle incidents in Queensland requires commitment from parents, the community and organisations responsible for safe roads. It is important that injury prevention research drives effective partnerships that promote key education and prevention messages to improve the safety of children and young people riding bicycles in Queensland.

Appendix A

Table 4. Factors affecting bicycle safety of children and young people

Developmental Characteristics	Age of Child	Cyclist characteristics	Environmental risk factors
Physical size and strength and co-ordination	5-9 years	Cyclist line of sight is reduced	Increasing number of motorists on roads, especially during peak periods when child cyclists are also using roads (travel to and from school)
	10-14 years	Cyclist lacks strength to negotiate hazards such as wind gusts from passing heavy vehicles Motorist visibility is reduced	
Perception	5-9 years	Cyclist has limited depth perception significantly affecting their estimates of speed and distance	Rural roads are not designed for shared space between motorists and cyclists
	10-14 years	Cyclist has difficulty understanding direction of sounds	Child cyclists riding on roads with high speed limits of 80km/h or more
Attention span, intelligence and experience	5-9 years	Cyclist has limited attention span	Supervision of child cyclists under the age of 12 is often inadequate (i.e. using a sibling or older peer to supervise)
	10-14 years	Cyclist unfamiliar with, and lacks understanding of routes, traffic, traffic patterns, signals, warnings and road rules Cyclist lacks ability to assess environment for risks and hazards	
	15-17 years	Cyclist adopts attitude of invincibility and is over-confident Cyclists riding more frequently as a means of travel	Child cyclists riding unaccompanied by an adult
Risk-taking behaviour	5-9 years	Cyclist may act impulsively such as suddenly crossing roads and intersections	
	10-14 years	Cyclist may not wear helmet or wear helmet incorrectly (such as not fastened correctly) by choice	
	15-17 years	Cyclist may be affected by alcohol and/or drugs Cyclist may be travelling at night time with no lights or reflective equipment	

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Pavement markings should be visible in all driving conditions, not just during dry daytime conditions.

It's road safety basics, isn't it?



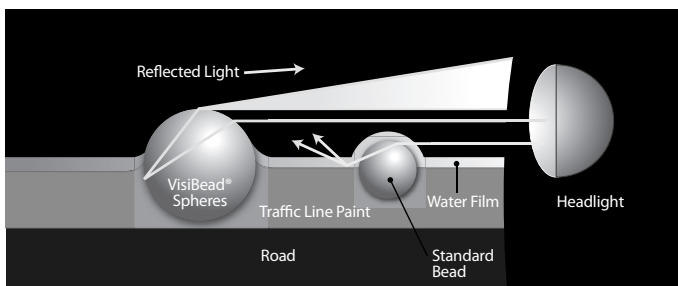
Conventional painted pavement marking (left), and Visibead® pavement marking (right).



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