A review of evaluations of bicycle safety education as a countermeasure for child cyclist injury

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Introduction

Children should be encouraged to cycle for its health and psychological benefits [1] and because of the value of forming healthy habits early in life [2]. Children who cycle are more likely to become adults who cycle, and cycling has clear health benefits, even when injury risks are accounted for [3,4]. Cycling also has social benefits and, when it replaces motorised transport, environmental benefits [5].

Naturally, if children are encouraged to cycle there is an imperative to address cycling safety, both as a duty of care and by way of encouraging cycling. It can be assumed that people are most likely to allow and encourage their children to cycle if they perceive it to be safe – given that perceived cycling safety is one of the strongest predictors of whether they cycle themselves [6].

Although it is likely that cycling safety is best addressed by providing safe and amenable cycling infrastructure [7], public education programs may also have a role to play. Programs that aim to teach children safe cycling skills exist in many countries, including Australia (e.g. *Bike Ed*) and the United Kingdom (e.g. National Cycling Proficiency Scheme). It is important to evaluate such programs to determine how they might be best developed or how resources for improving child cycling safety could be best allocated.

A review of literature regarding education to improve cycling safety, particularly for children, was undertaken.

Methods

Searches were conducted in Medline, Psychinfo, and Google Scholar combining the terms presented in Table 1, and focussing on peer-reviewed publications since 1990. Search results were scanned to identify relevant articles, which were obtained and reviewed. Relevant articles cited in the obtained articles were also reviewed.

Table 1. Outline of search strategy employed

Bicycle, *or*	*and*	Injury, *or*	*and*	Education
Cycle, *or*		Injuries, *or*		Training
Bicyclist, *or*		Safety, *or*		Skills
Cyclist, *or*				

Results

The literature search identified many reports and evaluations of 'educational' interventions that have sought to promote helmet wearing. Reviews of this literature are available (see [8]), so it will not be reviewed here. The literature search also highlighted that relatively few educational programs have sought to improve other behaviours or attitudes. The interventions that do exist mostly target child cyclists, and emphasise bicycle-handling skills. Evaluations are fairly limited, and mostly do not assess injury outcomes. The key studies available are summarised in Table 2.

Crashes

Colwell and Culverwell [9] examined the cross-sectional relationship between cycle training under the UK's National Cycling Proficiency Scheme (NCPS), cycling attitudes and self-reported behaviour, and cycle accidents, among children. The NCPS includes instruction on cycle rules and control skills.

Table 2. Summary of studies evaluating cycle safety education for children

Author	Year	Country	Outcome	Design	Finding
Carlin, Taylor and Nolan	1998	Australia	Hospitalised injury	Case-control	Negative effect
Colwell and Culverwell	2002	UK	Crashes Self-report behaviour Attitudes	Cross-sectional	Null effect
Kirsch and Pullen	2003	US	Self-report behaviour Knowledge	Cross-sectional	Positive effect
Macarthur, Parkin, Sidky and Wallace	1998	Canada	Observed behaviour	Randomised control trial	Null effect
McLaughlin and Glang	2010	US	Knowledge	Randomised control trial	Positive effect
Nagel, Hankenhof, Kimmel and Saxe	2003	US	Knowledge	Before-after	Positive effect
Stutts and Hunter	1990	US	Observed behaviour Knowledge	Cross-sectional	Positive effect

336 children were sampled from two schools, with 154 reporting having taken the NCPS. Training was not associated with crashes (n=64). Training took place, on average, four years prior to the study. There may have been a self-selection bias in terms of completing the NCPS, although it is not clear how this would have influenced results.

Hospitalised injury

Carlin et al [10] conducted a case-control evaluation of an Australian school-based bicycle safety education program, *Bike Ed*, which aims to cover safe riding skills, traffic knowledge and skills, and basic bike mechanics. 148 cases were recruited from the emergency department of two hospitals in Melbourne, and 130 controls were recruited by random telephone survey. All participants were aged 9-14 years. The Case and Control groups were compared in terms of rate of participation in *Bike Ed*. Results suggested a negative impact of the program (OR: 1.64, 95%CI: 0.98-2.75), which was unaffected by adjustment for sex, age, SES, and cycling exposure. There was no consideration of the time since completing *Bike Ed*.

Observed behaviour

Macarthur et al. [11] conducted a randomised controlled trial of a bicycle skills training program for young children in Canada. Schools were randomly selected for playground-based bicycle-handling skills training to be given to their Grade 4 children, and compared to control schools. The schools did not differ significantly in terms of straight line riding (90% vs 88%, p=.78), coming to a complete stop (90% vs 76%, p=.23), or shoulder-checking before turning (0% vs 2%, p=1.00), and authors concluded that the training was 'not effective in improving safe cycling behaviour, knowledge, or attitudes'.

Stutts and Hunter [12] evaluated *Basics for bicycling*, an on-bike closed-course training program for elementary school age children in the United States. Curriculum schools demonstrated improvements in observed riding skills (as well as helmet use) compared to control schools. However, potential confounding differences between curriculum and control schools were not considered.

Self-reported behaviour

Colwell and Culverwell [9] found no cross-sectional relationship between cycle training (under the NCPS) and self-reported 'safe cycling' behaviours (e.g. 'give an arm signal before turning', or 'showing off' behaviours (e.g. 'ride through traffic lights if safe'). Training occurred, on average, four years prior to the study and there may have been a self-selection bias in terms of completing the NCPS.

Kirsch and Pullen [13] evaluated a school-based education program to promote bicycle safety, the *Safety Central* program. Among 284 students currently enrolled in 5th and 6th grades, those who had completed the *Safety Central* program in the 4th Grade demonstrated improved knowledge of self-reported safety-related practices compared to those who had not. There may have been a self-selection bias in terms of completing the *Safety Central* program.

Knowledge and attitudes

McLaughlin and Glang [14] conducted a randomised controlled trial of the *Bike Smart* program, an eHealth software program that teaches bicycle safety behaviours to young children. 206 students in grades Kindergarten to Grade 3 in the US were assigned to either the treatment condition (*Bike Smart*) or the control condition (a video on childhood safety). Regardless of gender, cohort and grade, the participants in the treatment group showed greater gains than control participants in the computer-presented knowledge items (as well as an observational helmet measure).

Colwell and Culverwell [9] found no cross-sectional relationship between cycle training (under the NCPS), and 'safer attitudes' (e.g. concentrating properly when riding). Training occurred, on average, four years prior to the study, and there may have been a self-selection bias in terms of completing the NCPS.

Kirsch and Pullen [13] found that 5th and 6th graders who had completed the *Safety Central* program in the 4th Grade demonstrated improved knowledge of safety-related behaviours compared to those who had not. There may have been a self-selection bias in terms of completing the *Safety Central* program.

Stutts and Hunter [12] found that schools with the *Basics for bicycling* curriculum demonstrated improvements in bicycle safety knowledge compared to control schools. However, potential confounding differences between curriculum and control schools were not considered.

Nagel et al. [15] evaluated a 'structured bicycle safety program' for grade school children in the US. Students viewed a video and listened to structured discussion of rules. The 251 students who underwent post-testing at one month demonstrated improved knowledge about riding with traffic, warning pedestrians, and stopping before riding onto the street (as well as helmet wearing) compared to pre-test. Although there was no control group, it is unlikely that any intervening events (including maturing) are likely to have wrought these changes.

Conclusions

Existing research provides only inconsistent support for cycle safety education for children. The only study to consider crashes as an outcome showed no effect of cycle safety education (Colwell and Culverwell [9]), while the only study to consider injury outcomes showed a negative effect of training (Carlin et

al. [10]). A randomised control trial that considered observed behaviour showed no effect [11]. Although Stutts and Hunter [12] found a positive effect on observed behaviour, this may have been produced by self-selection bias. Although Kirsch and Pullen [13] reported a positive effect of a school-based education program on self-reported behaviours, Colwell and Culverwell found no cross-sectional relationship between cycle training (under the NCPS) and self-reported 'safe cycling' behaviours; both studies employed cross-sectional designs which may have involved self-selection biases. One randomised control trial reported a positive effect of a software program (*Bike Smart*) on knowledge [14]. Positive effects were also demonstrated in two cross-sectional studies ([12,13]; but see [9]), and one before-after trial [15]. On the whole, it appears that cycle safety programs for children may improve knowledge, but this is unlikely to translate into improved behaviour or crash outcomes.

Importantly, none of the papers give much detail about the contents of the cycling safety program – and some components may be more beneficial than others. Most of the programs considered appear to address bicycle-handling skills which are likely to be necessary but not sufficient for cycling safely. Moreover, young driver research suggests that training which addresses vehicle-handling skills is less useful than training which addresses risk awareness and styles of driving (including motives for risky driving), and may even be detrimental (see [16]). This is interesting in view of Carlin et al.'s [10] finding that young people who were hospitalised due to injuries from cycle crashes were more likely to have participated in *Bike Ed* than those who were not. Driving skills training is thought to be detrimental when it results in overconfidence – a belief that one can handle situations that are beyond one's true skills – or increased driving exposure at an early age. Developers of cycle safety programs should also be wary of producing overconfidence or increased cycling exposure, because both are likely to increase injury risk.

A number of programs exist for adults, some of which include training on cycling style. Several of these are founded on the the co-operative cycling approach (also known as vehicular cycling), which essentially advises cyclists to ride their bicycle like any other vehicle in traffic. For example, Franklin's [17] related book, *Cyclecraft*, underpins the UK's national standard for cycle training (*Bikeability*) which has, in turn, informed bicycle safety education in Australia. These programs are yet to be evaluated.

Although evidence for cycle safety education for children remains uncompelling, and there is cause for concern regarding training that focuses on cycle-handling skills, training that addresses cycling style (including co-operative cycling) and risk awareness may well be beneficial. Research is required to evaluate such training.

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