Injury, Int. J. Care Injured 50 (2019) 61–64

Contents lists available at ScienceDirect

Injury

journal homepage: www.elsevier.com/locate/injury

Cycling related traumatic brain injury requiring intensive care: association with non-helmet wearing in young people

Laura Carone[a,*], Rohan Ardley[b], Patrick Davies[c,d]

[a] LNR Deanery, United Kingdom
[b] Sheffield Teaching Hospitals NHS Foundation Trust, United Kingdom
[c] Paediatric Critical Care Unit, Nottingham Children's Hospital, United Kingdom
[d] University of Nottingham, United Kingdom

ARTICLE INFO

Keywords:
Head injury
Bike safety
Intensive care
Neurological deficit
Helmets

ABSTRACT

Introduction: Traumatic injury is the leading cause of death in children after infancy. Almost 25% of all cyclists killed in the UK are children, and two thirds of these will die because of their head injuries. We compared the population of young people wearing helmets whilst cycling, to those admitted with serious post cycling head injuries to our paediatric critical care unit.
Method: All children aged 0–18 years admitted to our intensive care following a bicycle accident between the years January 2011–June 2018 were identified and information on the mechanism of injury, and both immediate and long term clinical data were collected. For comparison data, helmet wearing on a random morning was observed from six schools. All pupils arriving at school by bicycle were observed. Data collected included the school year and sex of the child, and whether each child was wearing a helmet or not.
Results: Of 28 cases, 22 were admitted due to head injuries. None wore a helmet. 23/133 school pupils wore a helmet. The intensive care population were significantly less likely to be wearing helmets than the general population ($p = 0.044$, Fisher's exact test). A Chi-Square test for helmet wearing by school year showed a reduction in helmet wearing with increasing school year with a p value of 0.0026. There was no association between helmet wearing and abdominal injury.
Conclusion: Young people admitted to a Critical Care Unit with cycling related head trauma are statistically significantly less likely to wear a helmet than the general, age matched cycling population. Helmet wearing decreases as children get older. Outcomes were mixed, but in the head trauma group only 3/18 recovered with no neurological deficit

Introduction

Traumatic injury is the leading cause of death in children after infancy [1]. In the year 2014, 2005 children were involved in bicycle accidents in the UK. Of these, 6 were killed and 273 were seriously injured [2]. Almost one quarter of all cyclists killed in the UK are children, and two thirds of these will die as a result of head injuries. Furthermore, 45% of children who attend A&E following a bicycle accident have a head injury [2,3]. Successful prevention strategies often include multifaceted approaches such as education, incentives for safe human behaviour, legislation and enforcement, and environmental changes. Preventive programs must weigh both societal and economic values and costs [1]. The use of bicycle helmets has been linked to a 63%–88% reduction in the risk of head and severe brain injury for all ages of bicyclists [4] and, as the number of people wearing bicycle helmets rises, the number of head injury admissions in children falls [5]. A review of all 12.6 million emergency admissions in the UK during a four-year period showed that 35,056 were for injuries sustained while cycling, and 'Head injury' was the primary diagnosis in 34% of these admissions. Over half of these admission for head injuries following bicycle accidents affected children, and as bicycle helmet use increased, the number of serious head injuries among cyclists fell dramatically [6].

Despite the safety benefits of wearing a bicycle helmet, many studies have found that people, and in particular young people, are reluctant to wear helmets. In America it is estimated that only about 25% of children between 5 and 14 years of age wear a helmet when riding a bicycle, and older teenagers rarely use helmets [1]. In the UK, surveys have found that 32% of boys and 29% of girls aged

* Corresponding author.
E-mail addresses: laurajayne.carone@nhs.net (L. Carone), rardley@doctors.org.uk (R. Ardley), Patrick.davies@nuh.nhs.uk (P. Davies).

https://doi.org/10.1016/j.injury.2018.08.015
0020-1383/

10–12 years, and 14% of boys and 10% of girls aged 14–16 years, self-reported that they always wear helmets. Further research has found that helmet use amongst teenagers is very low: despite about 60% owning a helmet, only 3–29% actually claim to wear it [8–12]. Such data needs to be interpreted with caution: parents can wrongly assume that their child wears their helmet [12], or teenagers could be not telling the truth. We could find no observational UK population data on the number of children seen wearing bicycle helmets.

A randomised trial of bicycle helmet wearing is unfeasible, so we compared the population of children and young people wearing helmets whilst cycling, to those admitted with serious post cycling head injuries to our regional paediatric critical care unit.

Method

Ten secondary schools across Nottinghamshire were identified by randomly selecting two schools from each council district in Nottinghamshire, ensuring a broad selection from different socio-economic areas. Six schools consented for the study team to observe helmet wearing on a randomly selected morning. Five schools were academies and one school was an independent fee-paying school. All pupils arriving at school by bicycle were observed. Data collected included the school year and sex of the child, and whether each child was wearing a helmet, carrying a helmet or having no visible helmet at all.

All children aged 0 to 18 years admitted to intensive care at the Queen's Medical Centre in Nottingham following a bicycle accident between the years January 2011 and June 2018 were identified from a mixture of admission data and discharge summaries. Health records were examined and demographic data, information on the mechanism of injury, and both immediate and long term clinical data were collected. Cases were split in to two groups: those whose admission with primary head trauma, and those with primary non head trauma. Children admitted due to non trauma related factors were excluded

A Fisher's Exact test using double the one-tailed exact probability was carried out comparing helmet wearing amongst the population data and the children admitted to the Paediatric Critical Care Unit, for both the head trauma and the non-head trauma patients.

Results

Observational data

133 children in total were observed over 6 schools arriving to school on a bicycle. 126 were males and 7 were female. Of these, only 23 (17.3%) children were wearing a helmet. None of the seven girls were wearing a helmet (Fig. 1).

Case review of children admitted to intensive care

In a 7-year period (2011–2018), 31 children under the age of 18 were admitted to critical care following a bicycle injury. Two were excluded as they were injured taking part in cycle racing, where helmet use is mandatory, and where the risks are significantly different to normal cycling. One was excluded as their reason for admission was not related to their cycle accident.

Six children were admitted to PCCU with primarily abdominal injuries and the remaining 22 were admitted with primarily head injuries

Primarily abdominal injuries

All the children were males of ages ranging from 4.9 to 15.3 years, with a mean age of 12.4 years. All the children were admitted following a fall from their bicycle, and all of them had fallen onto the handle bars, suffering abdominal injuries. All the children underwent abdominal and pelvic CT scans.

Five children were successfully managed without surgical intervention or intubation. One needed a laparotomy for duodenal perforation. One child required a 2 night stay in PCCU and the other 4 children only required 1 day. The total length of stay ranged from 1 to 13 days, with a mean of 7.3 days. All the children made a full recovery. Two children were wearing a helmet at the time of injury.

Primarily head injuries

There were 20 males and 2 females, ages ranging from 5.3 years to 17.1 years with a mean age of 12.8 years. No admitted head injured patients were wearing a helmet (0/22, 0%).

Fifteen children sustained their injuries after being hit by a motor vehicle, six children sustained their injuries by falling off their bicycles and hitting their head on the road, and one hit a tree. GCS at the scene ranged from 3 to 15 with a mean of 10.2. 20 children were ventilated.

All children with primarily head injuries underwent a CT head scan, with 19 out of the 22 having an abnormal CT head (Fig. 2).

Seven children underwent neurosurgery and seven had an Intra-cranial pressure monitoring bolt inserted.

The average length of stay on PCCU ranged from 1 to 18 days (mean 4.5) The total length of hospital stays ranged from 2 to 57 days (mean 10.9), however please note one child is still currently an in-patient.

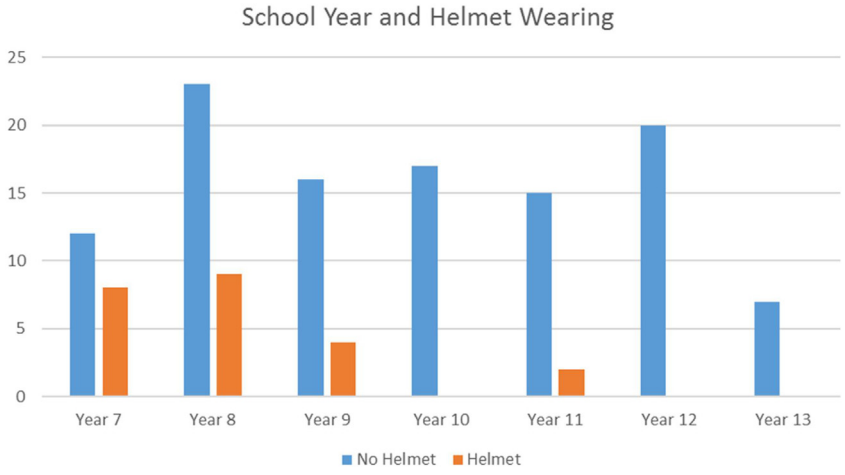

Fig. 1. School year and Helmet wearing.

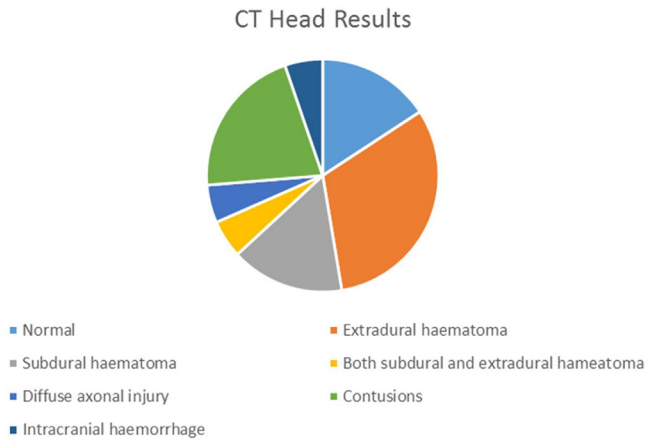

Fig. 2. CT head scan results in children admitted to Paediatric Intensive Care with cycling related head injury.

Of the 22 children with head injuries, we could obtain long-term outcomes for 18. Four children made a full recovery, however one of these had a pneumococcal meningitis one year after injury, caused by a persistent communicating tract from his basal skull fractures. He was severely neurologically damaged by this. Three children had mild complications, which consisted of further surgery for scarring, Terson syndrome or headaches. Seven children suffered moderate long-term complications such as hemiplegia, arm weakness, memory problems, foot drop and behavioural problems. Two children acquired long-term severe neurological disabilities as a direct result of their head injuries; one with a GCS of 4 and long-term tracheostomy, and the other with severe neurological deficits requiring long term naso-gastric feeding. Both required long term 24-hour nursing care after discharge. One child died. For four children, we were not able to obtain long-term outcomes: one was transferred to another hospital out of area and another child did not attend their follow-ups and two were only recently discharged (Fig. 3).

Statistics

Doubling the one tailed Fisher's Exact test for association with helmet wearing and abdominal injuries showed a p value of 0.59. There is no association between helmet wearing and the risk of abdominal injury. Fisher's Exact test for association with helmet wearing and head injury requiring intensive care showed a p value of 0.044, showing that population admitted to intensive care with head injury post cycle accident is significantly less likely to be wearing a helmet than the general population. A Chi Squared test for helmet wearing by school year showed a reduction in helmet wearing with increasing school year with a p value of 0.0026 (Fig. 1)

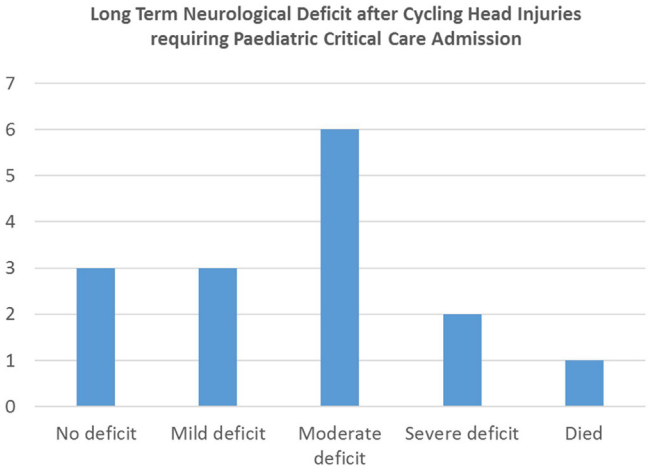

Fig. 3. Long term neurological outcomes.

Discussion

Our study found that in this population, the children admitted to Paediatric Critical Care with cycling related head injury were less likely than the uninjured population to wear a bicycle helmet. This association was not found with abdominal injuries.

From our population data, helmet wearing was observed in only 17.3% of the population, which is in the range of 5.5–32% quoted in various previous literature [7–12]. Helmet wearing was associated with a lower age. Furthermore, although the number of females observed riding a bicycle was very small, there were no females wearing a helmet in any age group. Previous literature supports the view that as children become older and become independent parental influence over helmet wearing decreases [7,8,10,12].

The reasons why teenagers are reluctant to wear helmets have been previously studied in depth. There are significant links to parental education and social deprivation, with low parental education and low socio-economic background being linked to low helmet use [8,10,12], whereas parental encouragement to wear a helmet and seeing friends wearing helmets have been linked to increased use of helmets [7,8,10,13]. Low perceived danger also reduced helmet wearing. However, the most common reason reported in the literature for children not to wear helmets is the perceived effect that a helmet has on their appearance, with many teenagers believing that helmets are ugly and make them appear less "cool" [7–14].

Previous studies have shown that helmet wearing helps prevent minor head injuries altogether, and reduces the severity of head injuries if they do occur [16–18]; furthermore, meta-analysis shows that helmet wearing prevents deaths and serious injuries and concludes that helmet wearing rates are suboptimal and should be further encouraged to the extent that it is uniformly accepted and analogous to the use of seat belts by motor vehicle occupants [19]

There are concerns that helmet wearing may increase levels of risk taking, the "risk compensation" theory. Our study counteracts this: the patients with serious head injuries were the ones without helmets. On the other hand, it could be argued that helmet wearers are by their very nature more cautious. A true randomised controlled trial is impossible in this area.

Worldwide, there have been different initiatives to try and increase helmet wearing. Some states in America and Canada have made the use of helmets compulsory. Helmet use doubled after it was made compulsory, and the number of head injuries in children halved [20,21]. However, other studies have found that even in areas where helmets are compulsory, still fewer than 25% of teenagers wear a helmet [11]. Reviews have found that when legislation is introduced, and in particular when it is aimed at young people, it increases the rates of helmet wearing by between 10 and 40% [22].

Education and awareness around the importance of helmet wearing have been found to be successful in increasing rates [23,24]. Hospital-based education programmes have especially been found to have a profound impact, with many children self-reporting that they now wear helmets after attending a programme run by clinicians [25].

This study has its limitations. Our population data covered only six schools in Nottinghamshire and the number of children riding bicycles to school was quite low. The data was collected in April

when potentially fewer children ride their bicycles due to the cooler weather. The data also only represents the admissions to one regional trauma centre and the number of admission for bicycle admissions were, compared to the total number admissions, quite small. This study also did not look at admissions to other wards with bicycle injuries that did not warrant an intensive care bed. There were also three children lost to long term follow up.

Conclusion

Young people admitted to a Paediatric Intensive Care Unit with cycling related serious head trauma are statistically significantly less likely to wear a helmet than the general, age matched cycling population. There is no association between helmet wearing and the risk of abdominal injury. Helmet wearing decreases as children get older. Outcomes for these young people with head trauma were mixed, but only 3/18 recovered with no neurological deficit. This study adds evidence supporting the use of helmets in young people.

References

[1] Dowd M.D., Keenan HT, Bratton SL. Epidemiology and prevention of childhood injuries. Crit Care Med 2002;30(11):S385–92.
[2] The Royal Society for Prevention of Accidents. Road safety information: cycling accidents. 2015.
[3] Knowles J, Adams S, Cuerden R, Savill T, Reid S, Tight M. Collisions involving pedal cyclists on Britain's roads: establishing the causes. TRL published project report. .
[4] Thompson DC, Rivara FP, Thompson R. Helmets for preventing head and facial injuries in bicyclists. Cochrane Database Syst Rev 1999;4:.
[5] Wesson D, Spence L, Hu X, Parkin P. Trends in bicycling-related head injuries in children after implementation of a community-based bike helmet campaign. J Pediatr Surg 2000;35(5):688–9.
[6] Cook A, Sheikh A. Trends in serious head injuries among cyclists in England: analysis of routinely collected data. Bmj 2000;321(7268):1055.
[7] Cryer PC, Cole J, Davidson LL, Rahman M, Ching V, Goodall JB. Rates of, and the factors affecting, cycle helmet use among secondary schoolchildren in East Sussex and Kent. Inj Prev 1998;4(2):106–10.
[8] Kendrick D, Royal S. Inequalities in cycle helmet use: cross sectional survey in schools in deprived areas of Nottingham. Arch Dis Child 2003;88(10):876–80.
[9] DiGuiseppi CG, Rivara FP, Koepsell TD. Attitudes toward bicycle helmet ownership and use by school-age children. Arch Pediatr Adolesc Med 1990;144(1) p. 83.
[10] Berg P, Westerling R. Bicycle helmet use among schoolchildren—the influence of parental involvement and children's attitudes. Inj Prev 2001;7(3):218–22.
[11] Finch CF. Teenagers' attitudes towards bicycle helmets three years after the introduction of mandatory wearing. Inj Prev 1996;2(2):126–30.
[12] Towner P, Marvel MK. A school-based intervention to increase the use of bicycle helmets. Fam Med 1992;24(2):156–8.
[13] Lajunen T, Räsänen M. Why teenagers owning a bicycle helmet do not use their helmets. J Safety Res 2001;32(3):323–32.
[14] Loubeau PR. Exploration of the barriers to bicycle helmet use among 12 and 13 year old children. Accid Anal Prev 2000;32(1):111–5.
[16] Worrell J. Head injuries in pedal cyclists: how much will protection help? Injury 1987;18(1):5–6.
[17] Grimard G, Nolan T, Carlin JB. Head injuries in helmeted child bicyclists. Inj Prev 1995;1(1):21–5.
[18] Thompson DC, Rivara FP, Thompson RS. Effectiveness of bicycle safety helmets in preventing head injuries: a case-control study. JAMA 1996;276(24):1968–73.
[19] Attewell RG, Glase K, McFadden M. Bicycle helmet efficacy: a meta-analysis. Accid Anal Prev 2001;33(3):345–52.
[20] Dannenberg AL, Gielen AC, Beilenson PL, Wilson MH, Joffe A. Bicycle helmet laws and educational campaigns: an evaluation of strategies. Am J Public Health 1993;83(5):667–74.
[21] Dennis J, Ramsay T, Turgeon AF, Zarychanski R. Helmet legislation and admissions to hospital for cycling related head injuries in Canadian provinces and territories: interrupted time series analysis. BMJ 2013;346:.
[22] Karkhaneh M, Kalenga JC, Hagel BE, Rowe BH. Effectiveness of bicycle helmet legislation to increase helmet use: a systematic review. Inj Prev 2006;12 (2):76–82.
[23] Berg P, Westerling R. A decrease in both mild and severe bicycle-related head injuries in helmet wearing ages—trend analyses in Sweden. Health Promot Int 2007;22(3):191–7.
[24] Bergman AB, Rivara FP, Richards DD, Rogers LW. The Seattle children's bicycle helmet campaign. Am J Dis Child 1990;144(6):727–31.
[25] Lee AJ, Mann NP, Takriti R. A hospital led promotion campaign aimed to increase bicycle helmet wearing among children aged 11–15 living in West Berkshire 1992–98. Inj Prev 2000;6(2):151–3.