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Pediatric bicycle helmet legislation and crash-related traumatic brain injury in Illinois, 1999-2009

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ABSTRACT

Background: Bicycling is one of the most popular forms of play and exercise for children in the US. However, over 200,000 children per year are injured in bicycle crashes, and an estimated 22,000 pediatric bicycle-related traumatic brain injuries (TBIs) occur annually. Bicycle helmets are known to decrease the risk of head injury, but efficacy and magnitude of the effect of helmet legislation have not been fully elucidated.

Methods: This was a retrospective, observational study of children aged <18, who presented after a bicycle crash in Illinois from 1999 to 2009. Demographic information, injury types, injury severity, helmet usage, and location of injury data were collected. Multiple logistic regression analysis was used to quantify the independent effects of helmet usage on TBI. Data were compared between communities with and without helmet legislation.

Results: A total of 3080 pediatric bicycle-related crashes were identified. Children wearing helmets were less likely to sustain a TBI, odds ratio [OR] = 0.56 (95% confidence interval [CI] 0.37-0.84, $P < 0.001$). Overall 5.0% of patients were noted as wearing helmets. Black and Hispanic children were less likely to wear helmets, OR = 0.24 (95% CI 0.09-0.68, $P < 0.001$) and OR = 0.10 (95% CI 0.02-0.42, $P < 0.001$), respectively. There was no significant change in helmet usage between before and after legislation in helmet legislation areas or over time in non–helmet legislation areas.

Discussion: Helmet use was protective against TBI, but socioeconomic and racial disparities exist in usage. Local legislation did not appear to impact helmet usage or admissions for bicycle-related TBIs in these areas.

Introduction

Bicycling is increasingly becoming an integral part of everyday life for children in US. In 1994, approximately 27.7 million children aged <15 rode bicycles.[1] Unfortunately, bicycling is accompanied by numerous risks of injury. In 2013 alone, there were approximately 217,957 unintentional nonfatal injuries in the US from bicycle crashes in children aged <18.[2] Of these injuries, traumatic brain injuries (TBIs) represent a particularly concerning portion of morbidity in pediatric cyclists.

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In the overall pediatric population, TBI is the injury that is most associated with mortality.[3] In addition, approximately 22,000 pediatric bicycle-related TBIs occur annually.[4] Numerous studies have shown the negative impact of pediatric TBIs. If occurring in early or midlife, TBI has been shown to increase the rate of dementia two- to four-fold,[5] as well as other poor outcomes such as criminal behavior[6] and school achievement.[7]

Numerous studies have shown the benefit of both helmet usage and helmet legislation on pediatric TBI and mortality. A Cochrane review looking at the outcomes after injury in bicyclists found a 63%-88% reduction in the rate of head and brain injury with the use of helmets.[8] Grant *et al.*[9] used the Fatality Analysis Reporting System to look at the overall impact of helmet legislation on mortality and estimated that 130 deaths per year have been prevented secondary to pediatric helmet laws instituted across the country.

Despite the burden of TBI, there is no federal law requiring children to wear bicycle helmets. Throughout the country, only 21 states and the District of Columbia have instituted legislation surrounding pediatric helmet usage.[10] What is more is that helmet laws are not universally effective. A wide variety of factors, including enforcement, prelegislation usage, behavioral interventions, socioeconomic status (SES), age, race, and ethnicity, significantly influence the success of helmet laws. Several studies have suggested lower efficacy of bicycle helmet laws for minority, lower SES, and teen populations.[11,12] Although helmet laws in California have shown decreases in pediatric TBI, there appears to be a dampened effect for lower SES and non-white race. Lee *et al.*[11] demonstrated an 18.2% reduction in the proportion of TBI among injured bicyclists in youth populations overall, without any significant effect on black youth in the same regions. In addition, the impact that helmet legislation laws have on teen usage is minimal. In a Seattle metropolis-area population, with mandatory pediatric helmet use, teens were the least likely group to wear helmets. Only 32.3% of teens aged 13-19 wore helmets compared with 63.8% of those aged >20 y.[12]

Despite being the fifth most populous state in the nation, Illinois does not have a statewide law for pediatric helmet usage. As of this publication, there are laws in only five cities, Barrington (1997), Cicero (1997), Inverness (1999), Libertyville (1997), and Skokie (2002). All these states require children aged <16 to wear helmets; Barrington also requires those aged <17 y to wear helmets. Barrington, Inverness, and Cicero have specific sanctions written into law. The other two cities do not have any specifics about penalties.

With this study, we hoped to determine whether pediatric helmet use legislation would increase helmet usage and if usage would decrease pediatric TBIs in Illinois. Because helmet laws were already in place in three of the five communities with legislation at the onset of the study, we compared helmet usage among patients both before and after legislation when possible, but compared usage between communities, and also studied longitudinal trends within these areas.

Methods

Patient population

These data were taken from the Illinois Trauma Registry. The Illinois State Trauma Registry is maintained by the Illinois Department of Public Health as a record of all trauma admissions statewide to level I or level II trauma centers. In Illinois, level I and level II designation is determined based on trauma surgeon coverage, availability of specialists, and participation in organizing the overall trauma system. One-third of the hospitals in Illinois are classified as either level I or level II trauma centers. Unlike other states, Illinois does not have level III or IV trauma centers. The patient population included in the study is de-identified and obtained from the 64 level I and level II trauma centers in Illinois between 1999 and 2009.

All subjects aged <18 y with bicycle injury were included in the analysis. Patients included in the data set must have been treated in a trauma center for more than 12 h with an International Classification of Disease 9th Revision External Cause of Injury Code (ICD-9 E-code) of 826.1, "Pedal cycle accident injuring pedal cyclist." Scene deaths and patients dead on arrival are not included in the database. The registry contains age, sex, race, vital signs, Injury Severity Score, alcohol and drug testing, home zip code, scene zip code, outcomes, helmet usage, and ICD-9 injury diagnosis codes (Table 1). Markers of severe injury were prehospital or emergency department systolic blood pressure <90, Injury Severity Score >15, and prehospital or emergency department Glasgow Coma Scale <8. Positive alcohol use included any blood alcohol level >0. Positive drug screen was defined as a urine toxicology positive for marijuana, cocaine, or amphetamines. A positive test for either alcohol use or drug use was considered broadly as drug use in the analysis.

Data on income were not included in the trauma registry. As a proxy, zip code tabulation area median household income using linear extrapolation of census data from the American Community Survey was used for the years 1999 and 2009. American Community Survey median income data were linked to patients through home zip code or accident scene zip code when home zip code was not available.

To define patients within helmet legislation zones, home zip codes were used where possible. If home zip code was

Table 1 – ICD-9 Codes used.

Injury	Primary ICD-9 code
Traumatic brain injury	800-801.99, 803-804.99, and 850-854.19
Face injury	802.00-802.99, 870-807.99, 873.40-873.60, 910.00, and 920.00-921.99
Upper extremity injury	810.00-819.99, 813.00-834.99, 882.00, 886.00, 913.00, 923.00, and 959.20-959.39