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Bicycle-related genitourinary injuries in the USA from 2002–2010

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ABSTRACT

Among children, the incidence of bicycle-related genitourinary (GU) injuries was 448 per 100 000 (95% CI 383 to 514) and, among adults, was 53 per 100 000 (95% CI 36 to 71). Although children sustained more injuries, adults were more likely to be admitted to the hospital for the GU injury (OR 1.95, 95% CI 1.13 to 3.37). Children sustain nearly 10 times more GU injuries due to bicycles than adults, but adults have higher odds of sustaining injuries requiring admission.

INTRODUCTION

Despite obvious health benefits associated with cycling, there is an inherent risk of injury, which ranges from minor soft tissue injuries to serious head trauma.^{1–2} In earlier studies, we found that bicycles are the product most often associated with genitourinary (GU) injuries, accounting for 13% and 8% of all GU injuries in children and adults, respectively.^{3–4} However, the types of GU injuries associated with bicycles, and the characteristics of patients in which they occur, are unclear. GU injuries could be an important focus of injury prevention efforts, given the high prevalence of injury and resulting use of health services. Our aim was to characterise GU injuries associated with bicycles, and to identify patient cohorts at highest risk for these injuries.

MATERIALS AND METHODS

We conducted a cross-sectional study of adults and children with GU injuries due to bicycles presenting to a nationally representative sample of emergency departments (ED) in the USA from 2002 to 2010.

Data source

The National Electronic Injury Surveillance System (NEISS) is a stratified probability sample of hospitals that is validated to produce national estimates of all patients who present to EDs in the USA with an injury. As described by the US Consumer Product Safety Commission, NEISS prospectively collects data on injured patients who present to approximately 100 US hospitals of different sizes, including eight children's hospitals, which provide 24 h emergency care.⁵ Clinical data (eg, stage of traumatic injury) are not available, and follow-up information is limited to the patient's disposition from the ED.

Variables

We identified all patients who sustained GU injuries associated with bicycles from 2002 to 2010. Age, gender and disposition from the ED were included in NEISS. Three additional variables (specific GU organ

injured, mechanism of injury, and bicycle part associated with injury) were determined by two authors (AAA, GET) by reviewing the injury narratives.

Statistical analysis

Sample weights supplied by NEISS were applied to the raw number of injuries to estimate the annual number of bicycle-associated GU injuries. All prevalence data are reported as national estimates along with 95% CIs unless specified as being actual, unweighted case numbers. The incidence of specific GU injuries (per 100 000 persons) were estimated using the 2010 census.⁶

Separate logistic regression models were used to estimate the odds of different types of GU injuries and the bicycle part associated with the injury among those who sustained injuries. The primary predictor was age, which was analysed as a categorical variable (2–5; 6–11; 12–17; 18–35; 36–50; > 50 years). The models were adjusted for gender and race (white/non-white). All analyses were performed on subjects with complete data. Analyses were performed using Stata V.12 (Stata, College Station, Texas, USA).

RESULTS

Demographic characteristics

Based on 1627 observed cases, an estimated 43 202 patients (95% CI 36 143 to 50 260) sustained GU injuries associated with bicycles from 2002 to 2010. Annually, over 4000 children and adults sustained GU injuries due to bicycles (range 4131–5432). The average annual incidence of bicycle-associated GU injuries among children was 448 per 100 000 (95% CI 383 to 514). Among adults, the incidence was nearly 10 times lower at 53 per 100 000 (95% CI 36 to 71). Sixty-one per cent of injuries occurred in males and 39% occurred in females.

Of those injured, 75% (32 371) were children. Among the injured children, the mean age was 9 years (95% CI 8 to 9). Four to 7-year-olds sustained the highest proportion of injuries in the paediatric and general population. The mean age of adults sustaining bicycle injuries was 36 years (95% CI 33 to 39 years). Among adults, 19–28-year-olds sustained the most injuries (4478; 95% CI 3040 to 5917).

Male patients sustained more bicycle-related GU injuries observed only after age 7 years. Sixty-four per cent of injured children aged between 4 and 7 years were girls, whereas 78% of children aged between 12 and 15 years were boys. Among those older than 18 years, more men (8132; 75%) were injured than women (2699; 25%).



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Mechanisms and types of injury

Injury characteristics are shown in table 1.

Most (84%) injuries involved the external genitalia and perineum. Table 2 presents the adjusted ORs for the association between patient characteristics and each type of GU organ injury.

Table 3 presents the adjusted ORs for the association between patient characteristics and the bicycle part associated with GU injury.

Mechanisms of injury were similar between children and adults. Injuries were stable over the study period.

Overall, 7% of children and 12% of adults who sustained bicycle-related GU injuries required admission. Although, overall, more children were injured, adults were more likely to be admitted (OR 1.95; 95% CI 1.13 to 3.37). Admission was most often due to kidney injuries. The mean age of patients with kidney injuries was 30 years (95% CI 28 to 33), and 76% of kidney injuries occurred in males (95% CI 72 to 81).

Fifty-six per cent of patients with kidney injuries were admitted or transferred to another hospital.

DISCUSSION

In this cross-sectional study, we observed that bicycles account for over 4000 GU injuries in the USA each year. This is approximately three times higher than the number of injuries attributed to cribs, playpens and bassinets, which have been targeted as products in need of prevention strategies to reduce their associated hazards.⁷ After approximately age 5 years, males are more likely to sustain GU injuries due to riding bicycles. This is consistent with other types of bicycling injuries in school-age children.⁸

Most injuries were to the genitalia. Injuries to the female external genitalia accounted for one-third of all paediatric injuries and nearly 20% of all adult injuries. Given our findings, and with only two case series of vulvovaginal trauma identified in the literature, the risk of perineal and vaginal trauma in girls

Table 1 Characteristics of bicycle-related GU injuries occurring among children (<18 years) and adults who presented to US emergency departments, 2002–2010

	National estimate	95% CI	Weighted proportion (%)
<i>Children</i>			
Mechanisms*			
Fall from bicycle	7060	5378 to 8741	26
Direct contact with bike	19 456	15 791 to 23 121	72
Collision	5226	3646 to 6807	19
Associated bicycle part			
Top tube	6323	5699 to 8964	46
Handlebar	3435	2396 to 4475	25
Seat	3172	2211 to 4132	23
Wheel	359	97 to 621	3
GU organ injured			
Male external genitalia			
Penis	5903	5643 to 7163	18
Scrotum/testicle	7511	5665 to 9757	23
Female external genitalia			
Urethra	281	53 to 509	1
Kidney	1100	593 to 1607	3
Hospital admission	2133	1430 to 2827	7
<i>Adults</i>			
Mechanisms			
Fall from bike	2310	1472 to 3148	25
Direct contact with bike	6459	4070 to 8849	70
Collision	2315	1047 to 3583	25
Associated bicycle part			
Top tube	2489	1394 to 3583	47
Handlebar	871	240 to 1503	16
Seat	1806	605 to 3007	34
Wheel	15	0 to 44	<0.1%
GU organ injured			
Male external genitalia			
Penis	640	299 to 981	6
Scrotum/Testicle	4505	2811 to 6198	42
Female external genitalia			
Urethra	419	48 to 789	4
Kidney	1101	449 to 1753	10
Hospital admission	1311	534 to 2088	12

*Mechanisms of injury are not mutually exclusive.

Agreement between the two investigators abstracting the variables was very good (mean $\kappa=0.79$). GU, genitourinary.

Table 2 Association between patient characteristics and injured GU organ occurring among patients who presented to US emergency departments with GU injuries, 2002–2010

	Penis OR (95% CI)	Testicle OR (95% CI)	Female genitalia OR (95% CI)	Urethra OR (95% CI)	Kidney OR (95% CI)
Female	NA	NA	NA	0.94 (0.29 to 3.03)	0.24 (0.11 to 0.52)*
Age (years)					
2–5	Referent	Referent	Referent	Referent	No injuries
6–11	0.99 (0.55 to 1.80)	0.67 (0.29 to 1.55)	0.67 (0.34 to 1.31)	0.43 (0.11 to 1.77)	0.08 (0.03 to 0.22)*
12–17	0.29 (0.14 to 0.62)*	0.86 (0.36 to 2.05)	0.47 (0.16 to 1.42)	2.14 (0.38 to 12.17)	0.43 (0.23 to 0.82)*
18–35	0.09 (0.04 to 0.25)*	2.04 (0.92 to 4.54)	0.35 (0.13 to 0.95)*	5.37 (0.93 to 30.90)	0.31 (0.13 to 0.69)*
36–50	0.19 (0.06 to 0.61)*	2.32 (0.85 to 6.34)	0.36 (0.06 to 2.05)	2.00 (0.23 to 17.50)	0.29 (0.07 to 1.22)
>50	0.03 (0.01 to 0.16)*	0.70 (0.22 to 2.20)	0.36 (0.06 to 2.22)	1.87 (0.16 to 21.24)	Referent
Caucasian	0.92 (0.58 to 1.45)	1.70 (0.94 to 3.08)	2.21 (1.23 to 3.96)*	1.22 (0.33 to 4.44)	2.20 (0.61 to 2.36)

*p<0.05.
GU, genitourinary.

associated with bicycles is under-reported and likely underappreciated by physicians and by experts involved in injury prevention initiatives.^{9–10} We believe further attention should be paid to this common type of GU injury caused by bicycles. We observed that the odds of sustaining an injury to the external genitalia due to contact with the bicycle top tube was 3.5 times higher in females than in males. Modifications to bicycles that reduce the risk of major abdominal trauma associated with bicycle handlebars have been developed.^{11–12} It is possible that simple preventative measures, such as girls and women using bikes with a downward sloping top tube wrapped with a foam pad may reduce the incidence of genital injuries. However, our observations are exploratory and only hypothesis-generating. Further research is needed to understand how bicycle design contributes to GU injuries and what simple modification to bicycle design could be made to reduce the risk and the associated morbidity of GU injuries.

While the overall incidence of these bicycle-associated injuries is higher in children, we observed that adults were more likely to sustain kidney injuries and injuries that required admission. Approximately 15% of patients evaluated for non-road traffic injuries are admitted to the hospital,¹³ which is similar to the proportion of patients we observed who were admitted for bicycle-associated GU injuries. Although the risk of kidney injury among patients riding bicycles had been widely reported in the literature, we observed that kidney injuries were

uncommon relative to other bicycling-associated GU injuries, particularly among children. In this study, 3% of children and 10% of adults with bicycle-associated GU injuries evaluated in an ED sustained renal trauma. This is in stark contrast with the 44% of children who sustained kidney injuries selected from a sample of children with GU or abdominal trauma who presented to a regional paediatric trauma centre.¹⁴ Our study was conducted in a national population database, and thus, likely provides more valid estimates of bicycle-associated GU injuries than studies that included only those who presented to trauma centres. Limiting the treating hospital to trauma centres introduces selection bias by including only patients with more severe injuries.^{14–16}

We used a population-based sample to investigate the epidemiology of all GU injuries associated with bicycles sustained by children and adults who present to EDs in the USA. However, limitations to the study exist. First, insight into the circumstances surrounding the injury, and specifics regarding the injury (eg, severity of and treatment for the injury) is not known. Second, because baseline numbers of bicycle riders in the USA are unknown, we are unable to report injury rates for those that ride bicycles, which could be viewed as the true at-risk population. Finally, NEISS does not capture patients who present to urgent care centres with an injury. Therefore, it is likely this study underestimates the true prevalence of bicycle-related GU injuries.

Table 3 Association between patient characteristics and bicycle part among patients who presented to US emergency departments with GU injuries, 2002–2010

	Top tube OR (95% CI)	Handlebar OR (95% CI)	Seat OR (95% CI)	Wheel OR (95% CI)
Female	3.47 (2.27 to 5.33)*	0.28 (0.15 to 0.52)	0.65 (0.37 to 1.12)	1.51 (0.33 to 7.84)
Age (years)				
2–5	referent	referent	referent	referent
6–11	0.52 (0.25 to 1.05)	3.32 (1.17 to 9.38)*	1.37 (0.56 to 3.34)	0.56 (0.14 to 2.20)
12–17	0.48 (0.18 to 1.29)	4.76 (1.28 to 17.61)*	0.84 (0.28 to 2.56)	0.40 (0.00 to 0.40)
18–35	0.79 (0.36 to 1.76)	1.60 (0.43 to 4.85)	1.62 (0.71 to 3.73)	No injuries
36–50	0.98 (0.38 to 2.56)	1.28 (0.37 to 4.38)	1.69 (0.61 to 4.71)	No injuries
>50	0.23 (0.06 to 0.83)	1.49 (0.24 to 10.59)	5.13 (1.14 to 23.07)*	0.41 (0.04 to 3.88)
Caucasian	0.77 (0.47 to 1.28)	1.05 (0.54 to 2.03)	1.19 (0.70 to 2.05)	0.70 (0.21 to 2.38)

*p<0.05.
GU, genitourinary.

CONCLUSIONS

Children sustain nearly 10 times more GU injuries due to bicycles than adults, but adults have higher odds of sustaining injuries requiring admission. Future studies are needed to determine how to best reduce the risk of GU injuries specific to each cohort.

What is already known on this subject

Bicycles are the consumer product most commonly associated with genitourinary injuries.

What this study adds

- ▶ After approximately age 5 years, males are more likely to sustain genitourinary (GU) injuries due to riding bicycles than females.
- ▶ Children sustain nearly 10 times more GU injuries due to bicycles than adults, but adults have higher odds of sustaining injuries that require admission, such as renal trauma.

Contributors BNB and JWM conceived this study, while GET and AAA (in addition to BNB and JWM) designed the study. HSB and SB made substantial contributions to the initial acquisition and analysis of data. AAA and GET were responsible for recording additional data. CEM was largely responsible for data analysis, and CEM, GET and AAA contributed to interpretation of data for the work. GET and AAA drafted the initial abstract and manuscript, and GET was responsible for subsequent drafting of revisions. BNB, JWM, SB, HSB, CEM and AAA critically revised aforementioned revision drafts. All authors gave final approval of the version to be published, and BNB takes responsibility for the work on the whole.

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Competing interests None.

Ethics approval The University of California, San Francisco Institutional Review Board (IRB) determined this study exempt from review.

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement NEISS data used for this study is published by the USA Consumer Product Safety Commission, and is publicly available online.

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