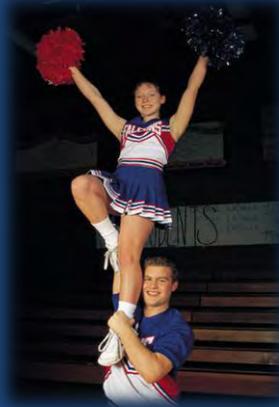


# SPORTS/RECREATION-RELATED TRAUMATIC BRAIN INJURIES AMONG OHIO'S 18 AND YOUNGER POPULATION



VIOLENCE AND INJURY PREVENTION PROGRAM  
OHIO DEPARTMENT OF HEALTH

MAY 2011

DATA PROVIDED BY THE OHIO HOSPITAL ASSOCIATION



## **OHIO DEPARTMENT OF HEALTH**

### **Office of Healthy Ohio Bureau of Health Promotion and Risk Reduction Violence and Injury Prevention Program**

Edward Socie, MS  
Injury Epidemiologist

Matthew Falb, MHS  
Injury Researcher

Christy Beeghly, MPH  
Violence and Injury Prevention Program Administrator

### **Acknowledgements**

Special thanks go to Dave Engler and Dan Paoletti of the Ohio Hospital Association for their data and assistance.

This publication was supported by the Cooperative Agreement Award Number 5U17CE52524801-06 (Core Injury Grant Program) and the Preventive Health and Health Services Block Grant from the Centers for Disease Control and Prevention (CDC). Its contents are solely the responsibility of the authors and do not necessarily represent the official views of the CDC.

---

## TABLE OF CONTENTS

## PAGE

---

<b>Ohio Violence and Injury Prevention Program Overview</b>	<b>4</b>
<b>Executive Summary</b>	<b>7</b>
<b>Section 1: Introduction and Overview of Traumatic Brain Injuries (TBIs)</b>	<b>8</b>
<b>Section 2: Sports/Recreation-related TBI Emergency Department Visits</b>	<b>9</b>
<b>Section 3: Sports/Recreation-related TBI Hospitalizations</b>	<b>24</b>
<b>Section 4: Sports/Recreation-related TBI Deaths</b>	<b>37</b>
<b>Section 5: Appendices</b>	<b>38</b>
<b>Appendix 1: Methods and Limitations</b>	<b>39</b>
<b>Appendix 2: ICD-9-CM Codes for TBI-Related Emergency Department Visits and Hospitalizations</b>	<b>41</b>
<b>Appendix 3: ICD-10 Codes for TBI-related Deaths</b>	<b>41</b>
<b>Appendix 4: E-Codes used to define 'sports/recreation' non-fatal injuries</b>	<b>42</b>
<b>Appendix 5: ED visits for sport/recreation-related TBIs, by 'how injured' category and specific-injury involved, year, Ohio, 2002-09</b>	<b>44</b>
<b>Appendix 6: Hospitalizations for sport/recreation-related TBIs, by 'how injured' category and specific-injury involved, Ohio, 2002-09</b>	<b>46</b>
<b>Appendix 7: E-codes used to define 'sports/recreation' fatal injuries</b>	<b>48</b>
<b>Appendix 8: Fatal sport/recreation-related TBIs, by 'how injured' category and specific-injury involved, Ohio, 2002-09</b>	<b>48</b>
<b>Appendix 9: Urbanity Classification for Ohio Counties</b>	<b>50</b>
<b>Appendix 10: Resources</b>	<b>51</b>

## THE OHIO VIOLENCE AND INJURY PREVENTION PROGRAM

Injuries are the leading cause of death for Ohioans ages 1 to 34 and the 5<sup>th</sup>-leading cause of death overall. The goal of the Ohio Violence and Injury Prevention Program (VIPP) is to continue development of a comprehensive injury prevention program through the establishment and sustainment of a solid infrastructure for injury prevention that includes statewide injury surveillance to inform and evaluate public policy, as well as comprehensive injury prevention and control programs.

The VIPP strives:

- To coordinate surveillance systems that collect injury data.
- To assess the burden of injuries and violence, and communicate information for the purpose of action.
- To promote evidence-based injury prevention interventions for at-risk populations.
- To coordinate and collaborate with partners in building program infrastructure.
- To encourage the adoption of policies and programs that lead to the prevention of injuries.
- To provide technical support and training as needed.
- *Ultimately, to make Ohio a safer place to live, work and play by reducing death and disability associated with intentional and unintentional injury.*

The VIPP is working to develop a comprehensive injury prevention program for the State of Ohio. Current VIPP initiatives include:

**Ohio Injury Prevention Partnership (OIPP)** – The OIPP is a group of professionals representing a broad range of agencies and organizations concerned with building Ohio's capacity to address the prevention of injury, particularly related to the group's identified priority areas of falls among older adults, drug poisonings, child injury and violence prevention (suicide and firearm related). The mission is, *To prevent injuries in Ohio using data and collaborative partnerships*. The vision for the OIPP is, *Working together to create a safe and injury-free Ohio*. The OIPP was convened in November 2007 and is coordinated by ODH with funds from the Centers for Disease Control and Prevention (CDC) National Center for Injury Prevention and Control (NCIPC). The OIPP helps to improve statewide collaboration around injury and will assist ODH with establishing priorities and future directions regarding injury and violence prevention in Ohio.

**Child Injury Action Group** – Injury remains the leading cause of death for children and youth. On average each year in Ohio, 260 children under the age of 14 die from injury and violence. For adolescents aged 15-19, unintentional injury, suicide and homicide are the three leading causes of death respectively. Through the umbrella of the OIPP and in coordination with the Ohio Chapter of the AAP, the VIPP oversees the Child Injury Action Group (CIAG). The function of the CIAG is to identify priorities and strategies to reduce child injury in Ohio.



Priorities of the CIAG include:

- Developing a strategic plan to address child injury with a focus on policy-level solutions.
- Increasing statewide collaboration around child injury prevention efforts.
- Building state and local capacity for child injury prevention efforts.
- Researching and assessing the feasibility of implementing evidence-based injury prevention policies and programs at the local and state level.
- Promoting evidence-based child and youth injury prevention programs throughout Ohio.

**Local Injury Prevention Grant Program** – Through the CDC's Preventive Health and Health Services Block Grant (PHHSBG), the VIPP provides \$605,000 annually to local programs targeting injury. The goal of this grant program is to reduce injury and injury-related deaths to Ohioans through the development of comprehensive, multi-faceted, population-based programs at the local level that address the risks associated with injuries. The nine currently-funded projects (2010-2013 cycle) focus on the following injury areas: unintentional child/youth injury; falls among older adults; and unintentional prescription drug poisoning.

**Child Passenger Safety (CPS) Program** – With fine monies collected through enforcement of Ohio's child restraint law (Ohio Revised Code Section 4511.81), ODH's CPS Program provides child safety seats to eligible low-income families in all Ohio counties. The program also targets the high-risk population of children ages 7 years and younger. The overall goal of this program is to increase the availability of child safety seats for low income families in Ohio and increase proper use and correct installation of child safety seats. The CPS Program works in coordination with nine regional occupant protection coordinators funded by the Ohio Department of Public Safety who serve as liaisons between ODH and the local program contacts. ODH distributes approximately 45-60 seats to each of the 88 counties per year based on the availability of funds.

### **Surveillance Activities**

- **Injury Surveillance** – The Injury Surveillance Program assesses the burden of overall injury and specific types of injury in Ohio through the examination of multiple data sets including hospital discharge, death, trauma registry and emergency medical services (EMS) data. It monitors trends and emerging injury issues, produces annual reports and responds to requests for data.
- **Census of Fatal Occupational Injuries (CFOI)** – With funding from the Bureau of Labor Statistics and the Ohio general revenue fund, the CFOI Program provides the public, employers and safety personnel with comprehensive data surrounding fatal occupational-related injuries in Ohio. Data are collected from several sources including death certificates, workers' compensation reports, Occupational Safety and Health Administration (OSHA) reports, traffic crash records, agricultural injury reports and media clippings. The data are collated at the national level and used to establish occupational safety policies and programs.

- **Ohio Violent Death Reporting System (OH-VDRS)** – In September 2009, the CDC awarded a grant to ODH to participate in the National VRDS (NVDRS), enabling Ohio to address a critical need in the state: the collection and analysis of high quality data on violent death. ODH will be obtaining and linking data from the following key data sources to better understand the circumstances surrounding and contributing to violent deaths in Ohio: Vital Statistics data; coroner data from the 88 county coroners; state and local law enforcement data; and child fatality review data. The NVDRS operates in 18 states, combining data on violent deaths including homicides, suicides, legal intervention deaths, unintentional firearm injury deaths, and deaths of undetermined intent.

*Please visit the VIPP website for more information, resources and program updates.*

Go to: <http://www.healthyohiprogram.org/vipp/injury.aspx>



## **EXECUTIVE SUMMARY**

This report reviews sports and recreation-related traumatic brain injuries (TBIs) for Ohioans 18 years and younger from 2002 to 2009. For this report, sports/recreation (S/R) activities include the following categories: pedal cycle (traffic and non-traffic), recreation, sports and wheeled recreation (non-motorized scooters, skateboards, roller skates, and inline skates). Data for this report were derived from Ohio Hospital Association hospital inpatient discharge and emergency department (ED) datasets and Ohio death certificate files.

### **Emergency Department Visits (ED):**

- From 2002 to 2009, 31,484 S/R-related TBIs were treated in EDs among those 18 years and younger in Ohio, accounting for 15 percent of all ED-treated TBIs in this age group.
- Over half (57 percent) of S/R TBIs treated in EDs resulted from sports activities and more than one-quarter (27 percent) resulted from pedal cycling (traffic and non-traffic).
- Boys were nearly 3 times more likely than girls to be treated in EDs for a S/R-related TBI.
- On average, nearly 4,000 youths were treated in EDs for S/R-related TBIs each year, with a significant rise over the course of the study period: from 2,859 in 2002 to 6,040 in 2009, an increase of 111 percent.
- Sports-related TBIs were the oldest of the comparison groups, with a mean age of 13.8 for both males and females.
- Rapid increases in the number of ED treated S/R-related TBIs were found for sports activities (142 percent), wheeled recreation (128 percent), recreation, no mention of wheels (110 percent) and pedal cycle (traffic and non-traffic, 53 percent) from 2002 to 2009.
- Treatment charges for all S/R-related TBI ED visits were \$45.5 million from 2002 and 2009.
- S/R-related TBIs resulting from sports activities accumulated the most ED treatment charges during the study period (\$25.8 million) while traffic-related pedal cycle TBIs were associated with the highest average cost per ED visit (\$2,648).

### **Hospitalizations:**

- 1,188, or about 11 percent of TBI hospitalizations among those 18 years and younger resulted from S/R-related activities between 2002 and 2009, with an average of 149 hospitalizations per year.
- Pedal cycle TBIs accounted for the greatest number of S/R-related hospitalizations. Over half (55 percent) of S/R-related hospitalizations resulted from pedal cycle (traffic and non-traffic) activities and one-quarter resulted from sports.
- S/R-related TBI hospitalizations were associated with a total of \$19.8 million in treatment charges. Traffic and non-traffic pedal cycle activities accounted for two-thirds (\$13.2 million) of these charges followed by sports at \$4.1 million.

### **Fatalities:**

- From 2002-2009, 11 young Ohioans 18 years and younger died from TBIs associated with S/R activities. All of the fatalities were caused by traffic related pedal cycle TBIs.

## SECTION 1:

### INTRODUCTION AND OVERVIEW OF TRAUMATIC BRAIN INJURY

#### TRAUMATIC BRAIN INJURY DEFINED:



As defined by the CDC, a traumatic brain injury or TBI is caused by a bump, blow or jolt to the head or a penetrating head injury that disrupts the normal function of the brain. TBIs can also occur from a fall or a blow to the body that causes the head and brain to move quickly back and forth. TBIs range in severity from mild (a brief change in mental status) to severe (prolonged period of unconsciousness or amnesia). The majority of TBIs are concussions or other forms of mild TBI.

According to the Centers for Disease Control and Prevention (CDC)<sup>1</sup>:

- Each year, U.S. emergency departments treat an estimated 135,000 sports/recreation-related TBIs, including concussions, among children ages 5 to 18.
- External causes *falls* and *struck-by/against* account for 75 percent of the estimated average percentage of annual TBI-combined ED visits, hospitalizations and deaths among children younger than 14 years in the United States.
- Children and teens are more likely to get a concussion and take longer to recover than adults.
- Athletes who have ever had a concussion are at increased risk for another concussion.
- Concussions can occur in *any* sport or recreation activity.
- Repeat concussions can increase the time it takes to recover and the likelihood of long term problems. In rare cases, repeat concussions in young people can result in permanent brain damage or death.
- Recognition and proper response to TBIs when they first occur can help prevent further injury and even death.

<sup>1</sup> <http://www.cdc.gov/concussion/sports/index.html>

## SECTION 2:

### SPORTS & RECREATION-RELATED TBI EMERGENCY DEPARTMENT VISITS

**Note:** Youth treated at an ED and later admitted to a hospital are removed from the ED dataset and added to the inpatient hospital dataset, presented in Section 3. Sports and Recreation Hospitalizations

#### OVERVIEW OF SPORTS AND RECREATION-RELATED TBI ED VISITS



About 15 percent of TBIs in Ohioans 18 or younger treated in emergency departments (EDs) from 2002 through 2009 were associated with sports or recreation (S/R) activities (as best they could be defined, taking into account the inherent limitations of using ICD-9-CM codes for such an undertaking (Appendix 2 and 4)).

On average, nearly 4,000 youths were treated in EDs for S/R TBIs each year, with a dramatic rise over the study period: from 2,859 in 2002 to 6,040 in 2009, an increase of 111 percent, (Table 1).

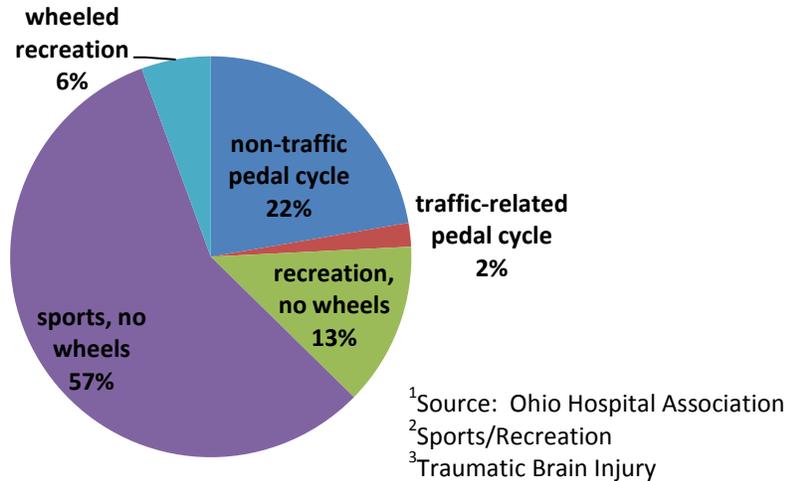
For purposes of this analysis, five 'how injured' categories were developed to capture all S/R injuries. *Sports* (which is based on three ICD-9-CM codes capturing general sports-related *fall & striking against* injuries) were by far the most common circumstance (57 percent; Figure 1.) and associated with the greatest increase, (142 percent from 2002-09).

**Table 1. Number of ED visits for sport/recreation-related TBIs among 18 years and younger, by how injured, year, Ohio, 2002-09<sup>1</sup>**

How Injured Category	Year of ED Visit								Total
	2002	2003	2004	2005	2006	2007	2008	2009	
non-traffic pedal cycle	744	725	834	822	870	987	868	1,170	<b>7,020</b>
traffic-related pedal cycle	77	71	64	64	86	81	73	83	<b>599</b>
recreation, no wheels	386	397	424	453	494	586	588	812	<b>4,140</b>
sports, no mention of wheels	1,495	1,593	1,770	1,911	2,462	2,589	2,524	3,617	<b>17,961</b>
wheeled recreation	157	161	193	167	227	253	248	358	<b>1,764</b>
<b>Total</b>	<b>2,859</b>	<b>2,947</b>	<b>3,285</b>	<b>3,417</b>	<b>4,139</b>	<b>4,496</b>	<b>4,301</b>	<b>6,040</b>	<b>31,484</b>

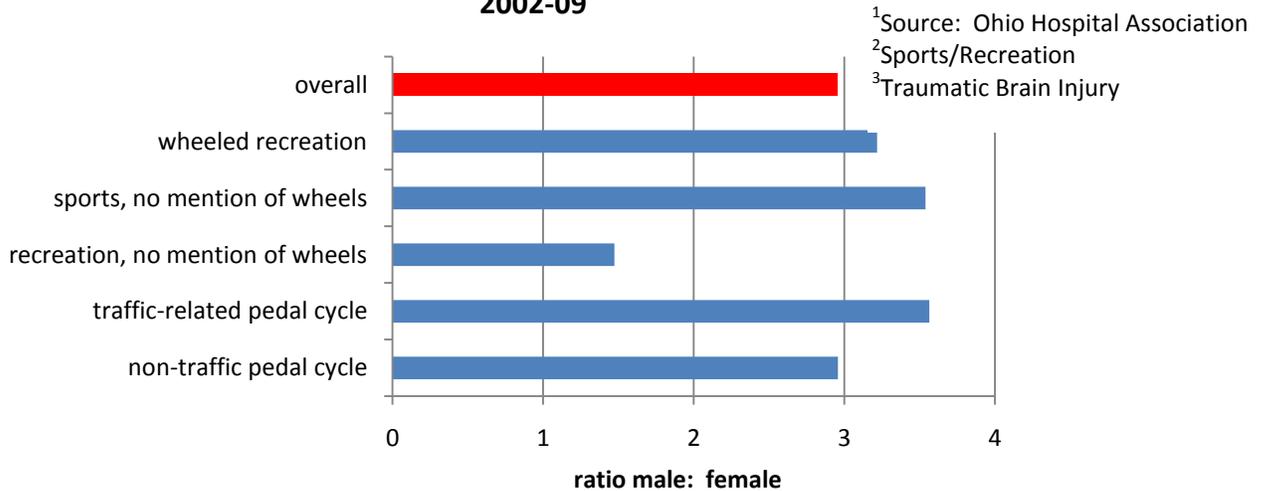
<sup>1</sup>Source: Ohio Hospital Association

**Figure 1. Proportional distribution of ED visits<sup>1</sup> for S/R<sup>2</sup>-related TBI<sup>3</sup> among Ohioans 18 and younger, by how injured, 2002-09**



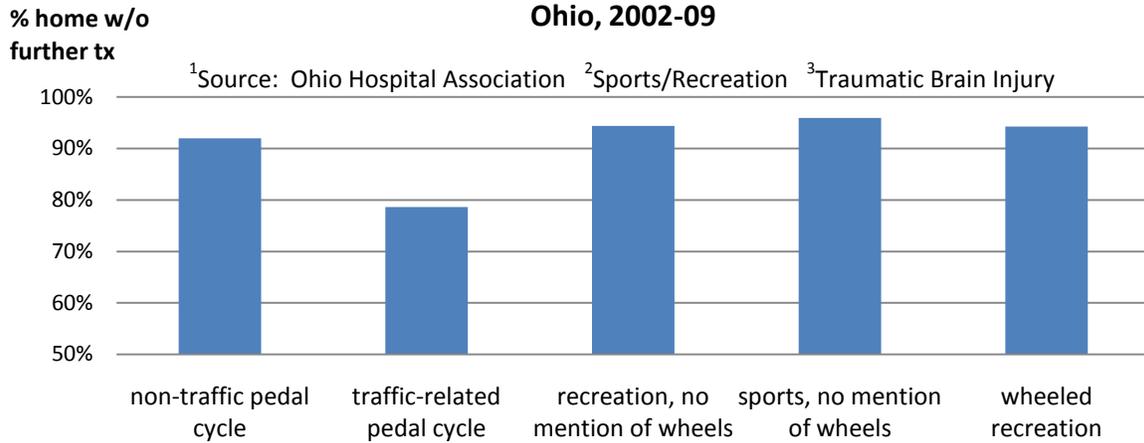
Nearly three times as many males as females were treated for a S/R-related, ED-treated TBI from 2002-09 (Figure 2). *Recreation, no mention of wheels* TBIs were associated with the least disparity between number of male and female victims.

**Figure 2. Ratio of number of male to female ED visits<sup>1</sup> for S/R<sup>2</sup>-related TBI<sup>3</sup> treatment among 18 years old and younger, by how injured, Ohio 2002-09**



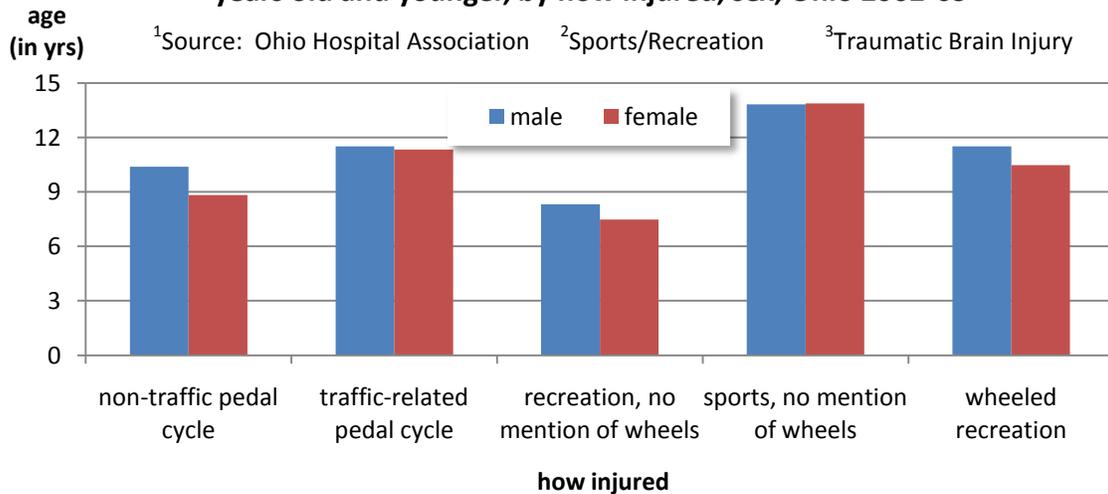
Persons who incurred their TBI from a traffic-related pedal cycle injury were the least likely to be discharged home without further treatment: 79 percent (Figure 3). For each of the other S/R 'how injured' categories, more than 91 percent were discharged home. (Persons who are treated at an ED and later admitted to a hospital are removed from the ED dataset and added to the inpatient dataset, and therefore would not be available for this analysis).

**Figure 3. Proportion of ED visitors<sup>1</sup> for S/R<sup>2</sup>-related TBIs<sup>3</sup> among 18 years old and younger who are discharged home, by how injured, Ohio, 2002-09**



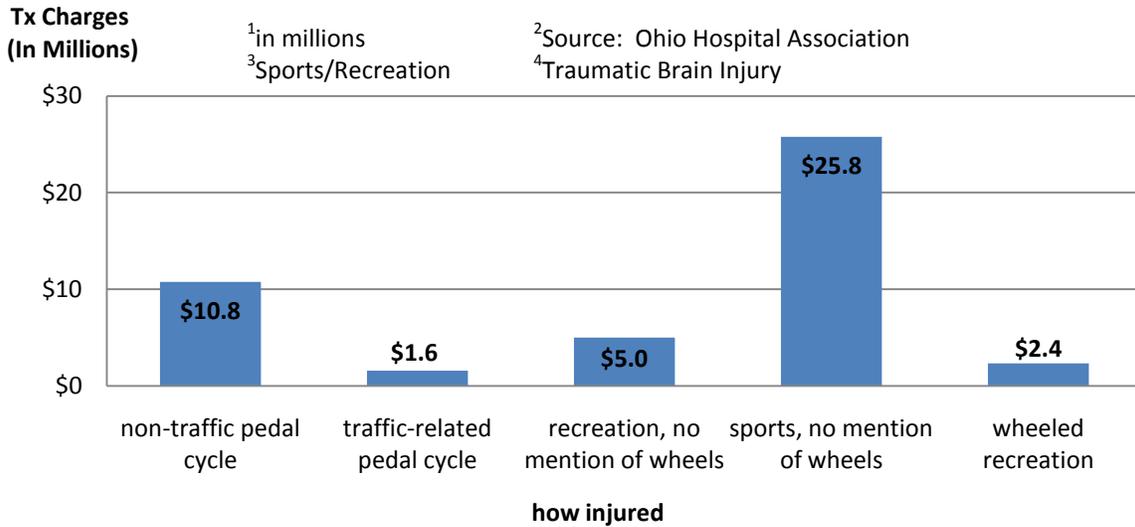
Males were as old or older than females for each of the 'how injured' categories (Figure 4). *Sports, no mention of wheels* injuries were the oldest of the comparison groups, with a mean age of 13.8 years for both males and females.

**Figure 4. Mean age of ED visitors<sup>1</sup> for S/R<sup>2</sup>-related TBIs<sup>3</sup>, among 18 years old and younger, by how injured, sex, Ohio 2002-09**



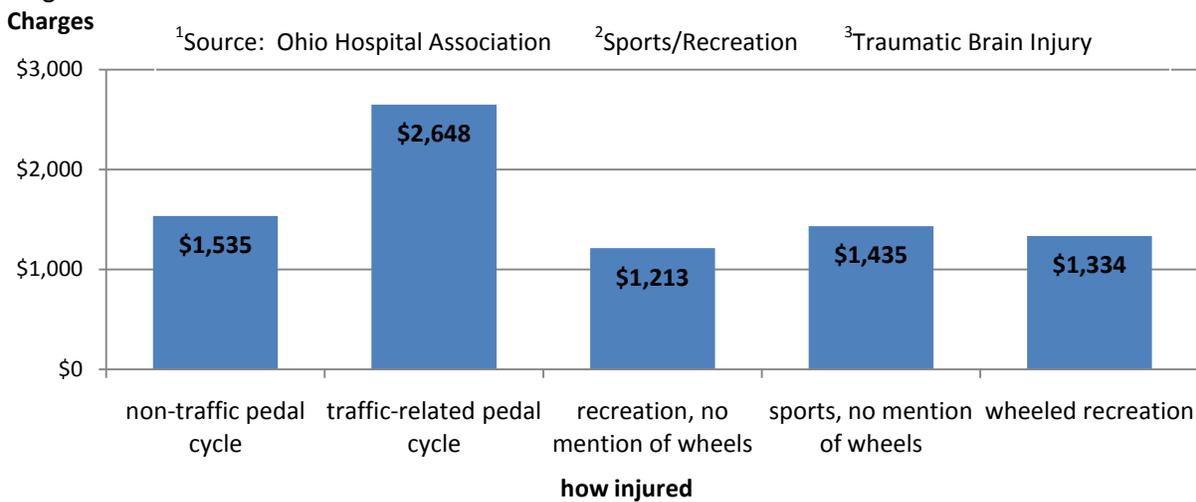
Treatment charges for ED visits totaled \$45.5 million with a range from \$25 to \$25,220 (Figure 5a). The 17,961 *sports, no mention of wheels* injuries accumulated during the eight year study period were associated with more than \$25.8 million in treatment charges.

**Figure 5a. Total treatment charges<sup>1</sup> for ED<sup>2</sup> visits for S/R<sup>3</sup>-related TBIs<sup>4</sup> among 18 years old or younger, by how injured, Ohio, 2002-09**



Mean treatment charges for *traffic-related pedal cycle* injuries (\$2,648) were 73 percent more costly than the next highest injury class, *non-traffic pedal cycle injuries* (\$1,535) (Figure 5b).

**Figure 5b. Average charges for ED visitors<sup>1</sup> with S/R<sup>2</sup>-related TBIs<sup>3</sup>, among 18 years old and younger, by how injured, 2002-09**



### ED VISITS FOR NON-TRAFFIC PEDAL CYCLE-RELATED TBIS

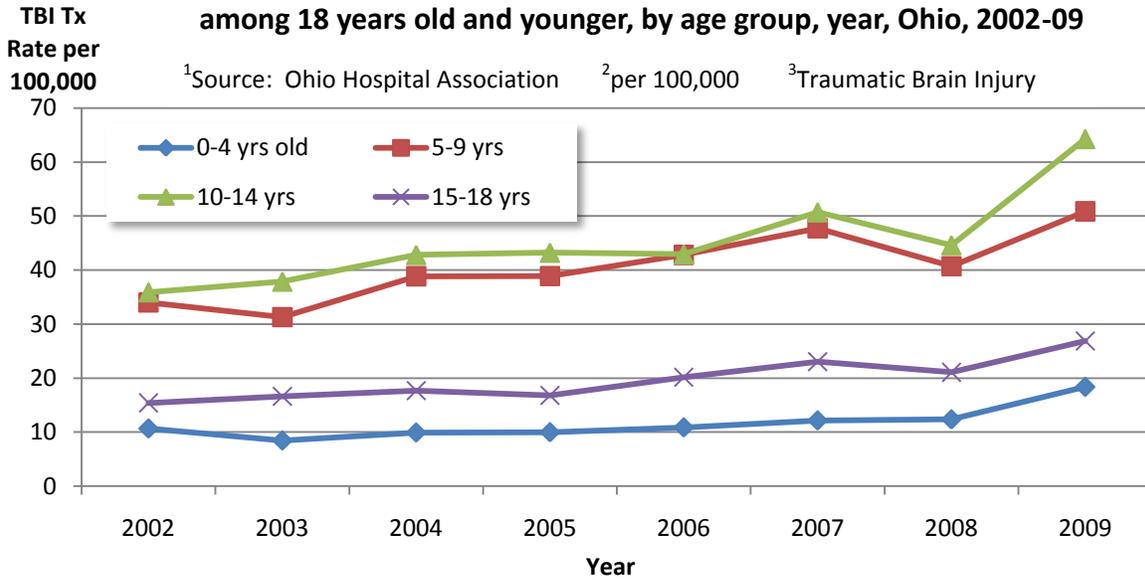
Twenty-two percent of ED-treated S/R-related TBIs were associated with *non-traffic pedal cycle* injuries (Figure 1). Youth 10-14 and 5-9 years of age had very similar rates of ED-treatment, while older youths had rates closer to those of 0-4 year olds, (Figure 6). Overall, the number of ED-

**Sports/Recreation-related Traumatic Brain Injuries among Ohio's Youth**

Ohio Violence and Injury Prevention Program, Ohio Department of Health

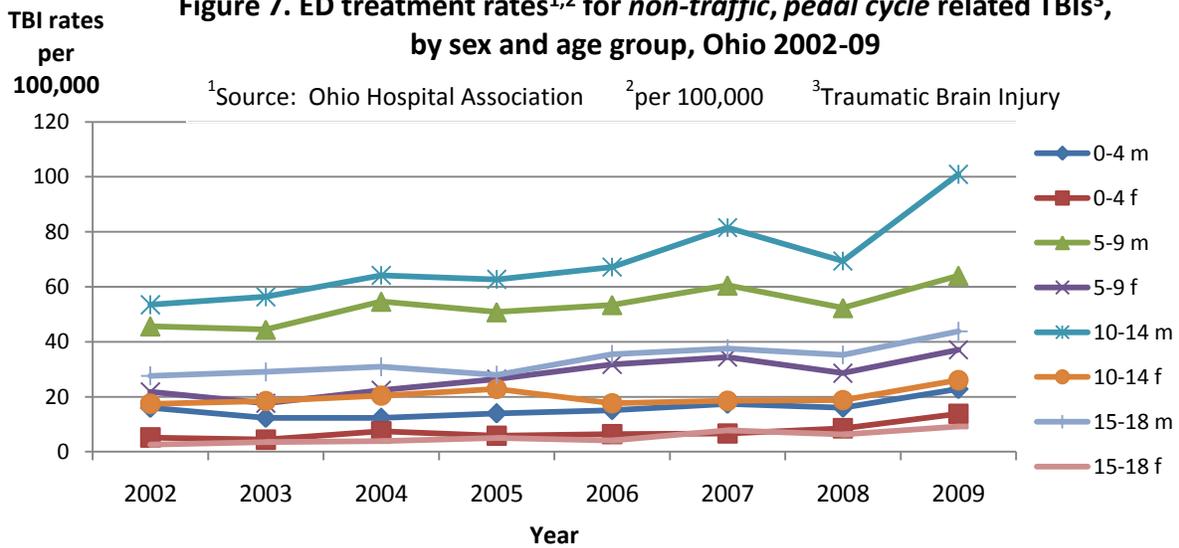
treated, *non-traffic pedal cycle* TBIs increased 57 percent from 744 in 2002 to 1,170 in 2009 (Table 1).

**Figure 6. ED treatment rates<sup>1,2</sup> for non-traffic, pedal cycle related TBIs<sup>2</sup>, among 18 years old and younger, by age group, year, Ohio, 2002-09**

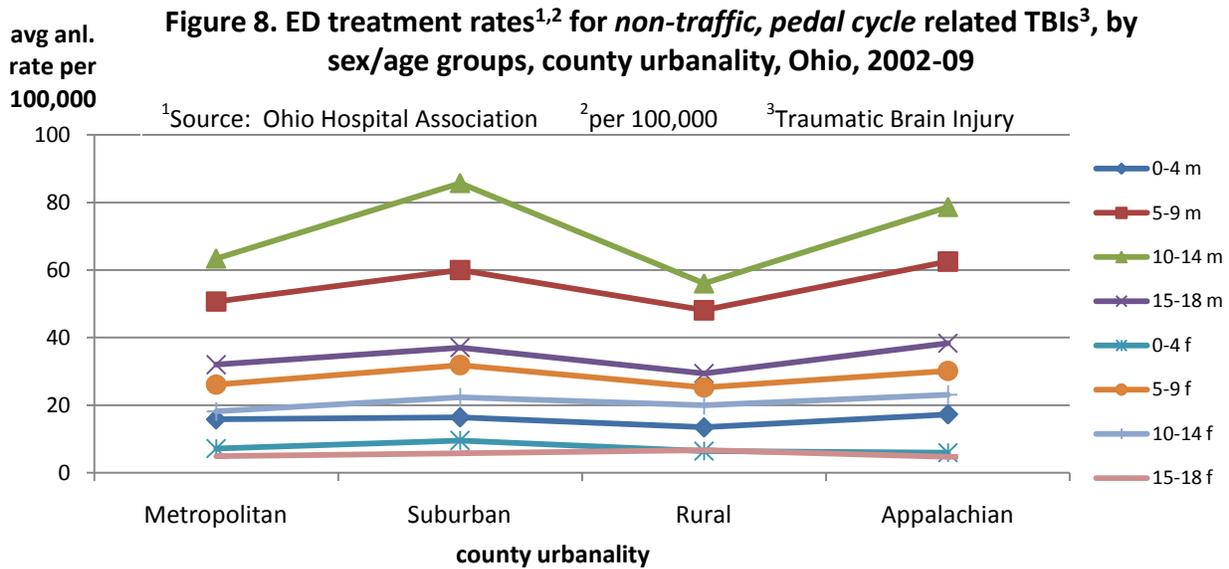


However, when these rates are broken down by gender, (Figure 7), the three sex/age groups with the highest rates are all male: 10-14, 5-9, and 15-18 year olds. The rate among 10-14 year old males nearly doubled from 2002 (53.5 per 100,000) to 2009 (100.9 per 100,000). Females had three of the four lowest rates; in 2009 the rate among 15-18 year olds was 9.2 per 100,000, 13.8 in 0-4 year olds, and 26.0 for 10-14 year olds. Among males, only those 0-4 had rates below 25 per 100,000. Rates increased for each subgroup over the study period and increased 65 percent overall (24.7 to 40.7 per 100,000).

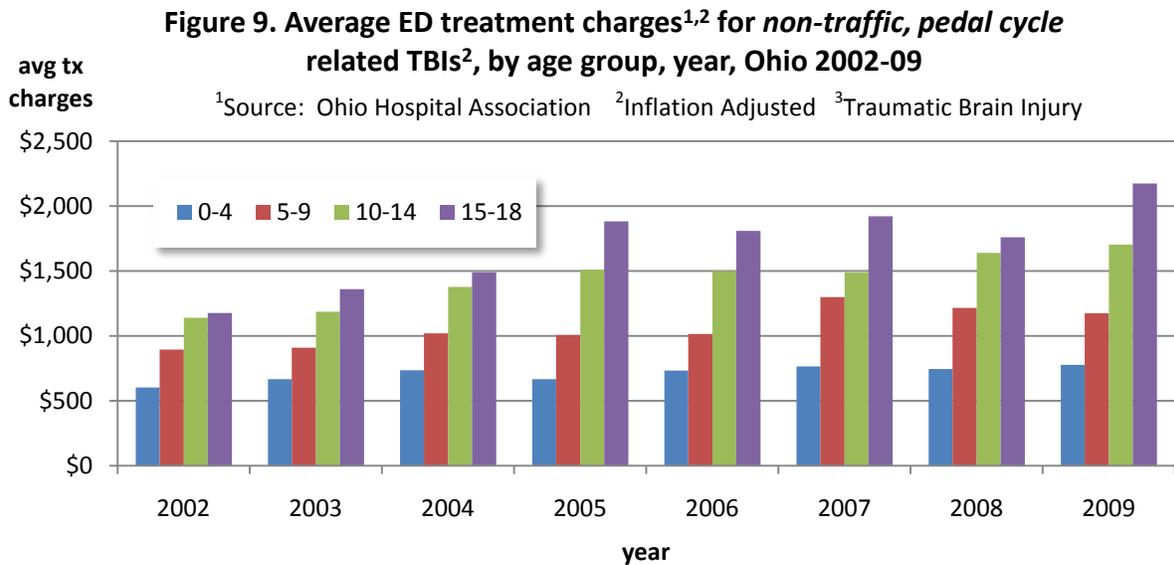
**Figure 7. ED treatment rates<sup>1,2</sup> for non-traffic, pedal cycle related TBIs<sup>3</sup>, by sex and age group, Ohio 2002-09**



The sex/age group with the consistently greatest risk of *non-traffic pedal cycle* TBIs was 10-14 year old males, who demonstrated rates of 86 per 100,000 for suburban county residents, (Figure 8). Males 5-9 had the second highest TBI rates, although they were at greatest risk in Appalachian counties (60 per 100,000). For all sex/age groups, either suburban or Appalachian counties were associated with the greatest likelihood of youths seeking TBI treatment at an ED after a *non-traffic pedal cycle* injury.



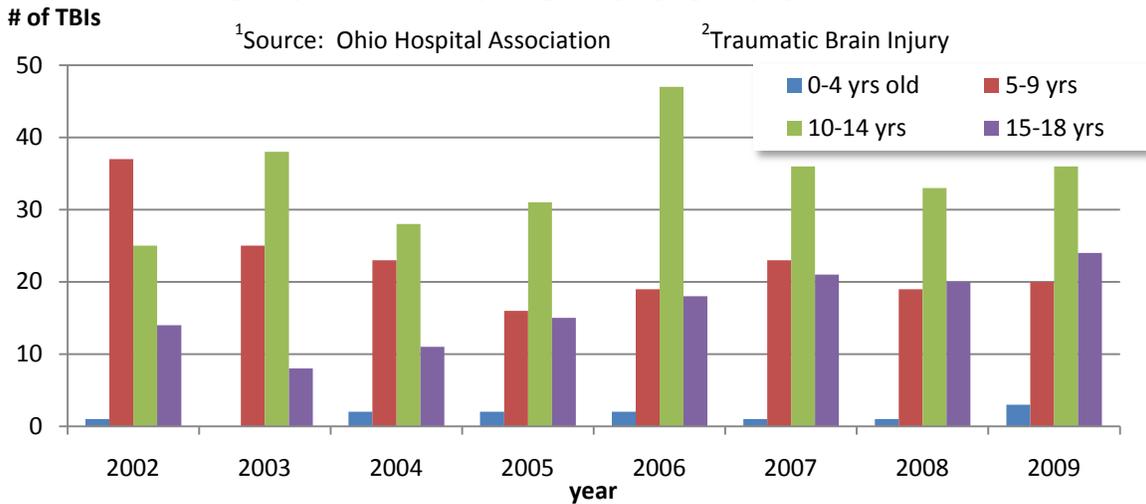
Among those with *non-traffic, pedal cycle*-related TBIs, 15-18 year olds had the highest treatment charges each study year (Figure 9) with an overall, unadjusted mean of \$2,077 (data not shown). After Consumer Price Index (CPI) adjustments, average charges increased 50 percent from 2002 (\$1,000) to 2009 (\$1,496), with 15-18 year olds showing the greatest increase (85 percent).



## ED VISITS FOR TRAFFIC-RELATED PEDAL CYCLE TBIs

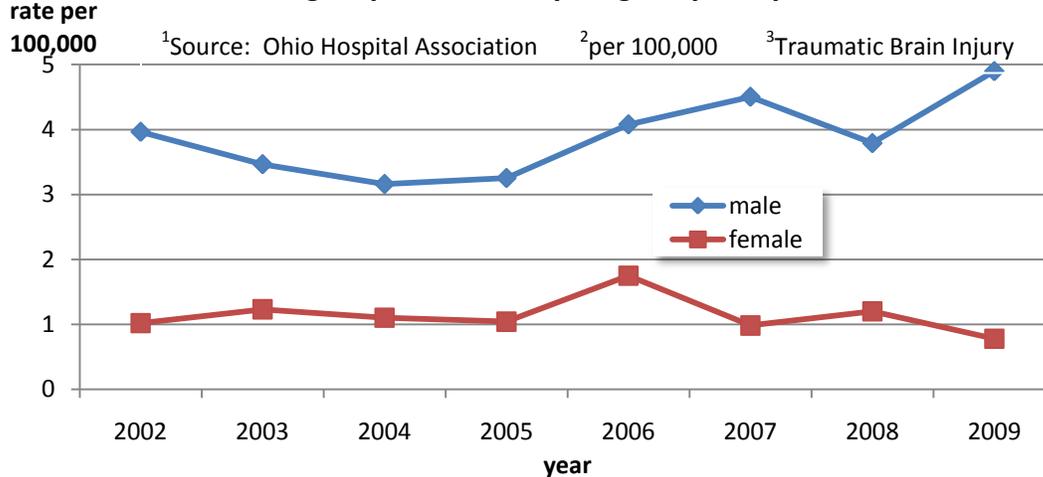
As indicated in Table 1, TBIs resulting from *traffic-related pedal cycles* remained consistent during the study period. This trend may be attributable to increased designation of bike lanes and enactment of city-wide helmet laws for the young. Youths 10-14, except for 2002, consistently had the highest number of ED-treated TBIs (Figure 10).

**Figure 10. Number of ED visits<sup>1</sup> for traffic-related pedal cycle TBIs<sup>2</sup>, among 18 years old and younger, by age group, year, Ohio, 2002-09**



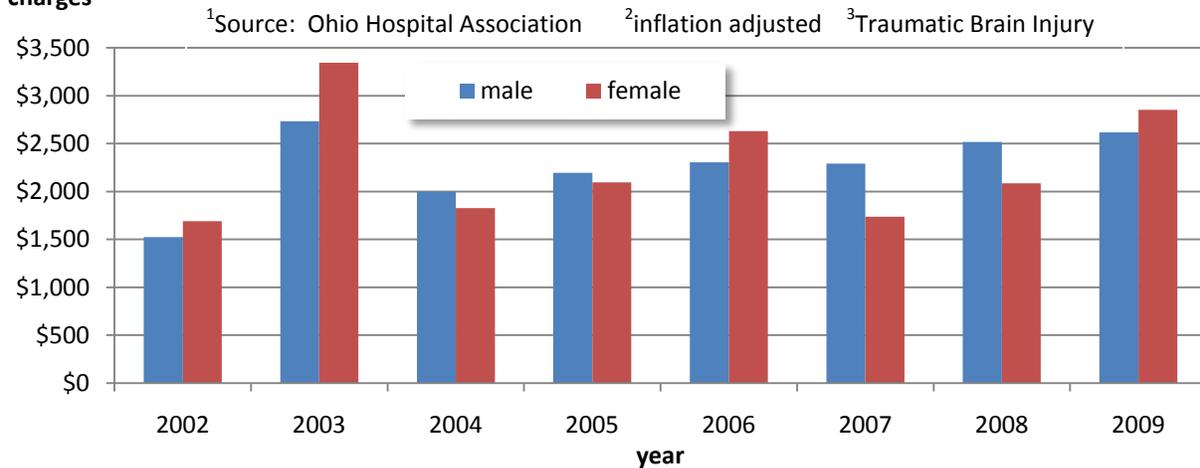
Since 2007, the treatment rate for males has been about four times greater than for females (Figure 11). Although the number of traffic-related pedal cycle TBIs has decreased slightly since 2006, the male and overall rates have increased slightly, due to a decline in the size of the 18 and younger population in Ohio.

**Figure 11. ED treatment rates<sup>1,2</sup> for traffic-related pedal cycle TBIs<sup>3</sup> among 18 years old and younger, by sex, year Ohio, 2002-09**



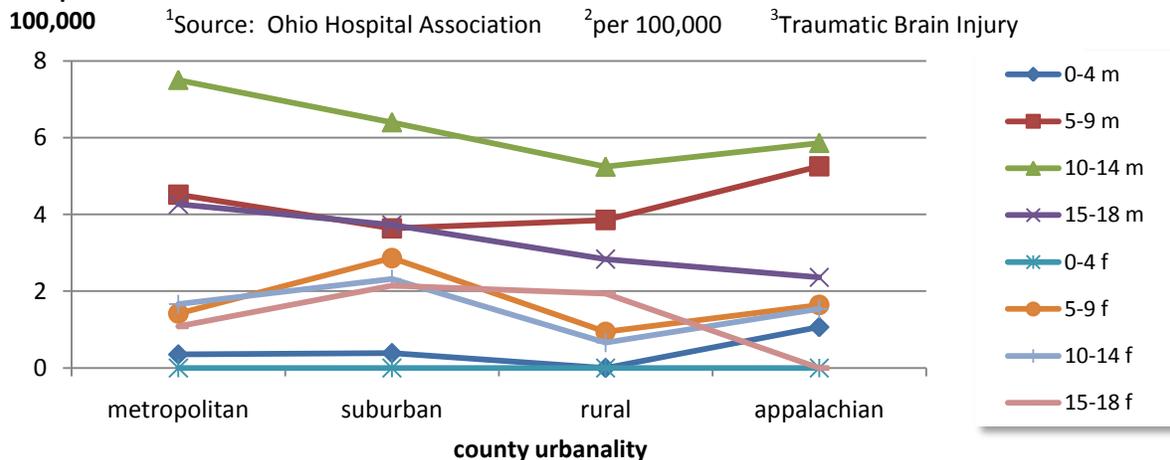
Unadjusted mean treatment charges for *traffic-related pedal cycle* TBIs, which ranged from \$29 to \$19,787, were nearly identical for males (\$2,654) and females (\$2,645). A significant temporary bump in charges was observed in 2003, which became much more pronounced after CPI-based inflation adjustment. In both 2003 and 2009, five patients had charges greater than \$10,000. Outside of three cases in 2006, no other *traffic-related pedal cycle* TBI ED patients incurred charges of this magnitude during the study period. Figure 12 depicts the slight, irregular rise in treatment charges from 2002-09, and the lack of a consistent relationship between sex and charges.

**Figure 12. Average ED treatment charges<sup>1,2</sup> for traffic-related pedal cycle TBIs<sup>3</sup> among 18 years old and younger, by sex, year, Ohio, 2002-09**



ED-treatment rates for *traffic-related pedal cycle* TBIs were consistently higher for males 5 years of age and older across all classes of urban development (Figure 13).

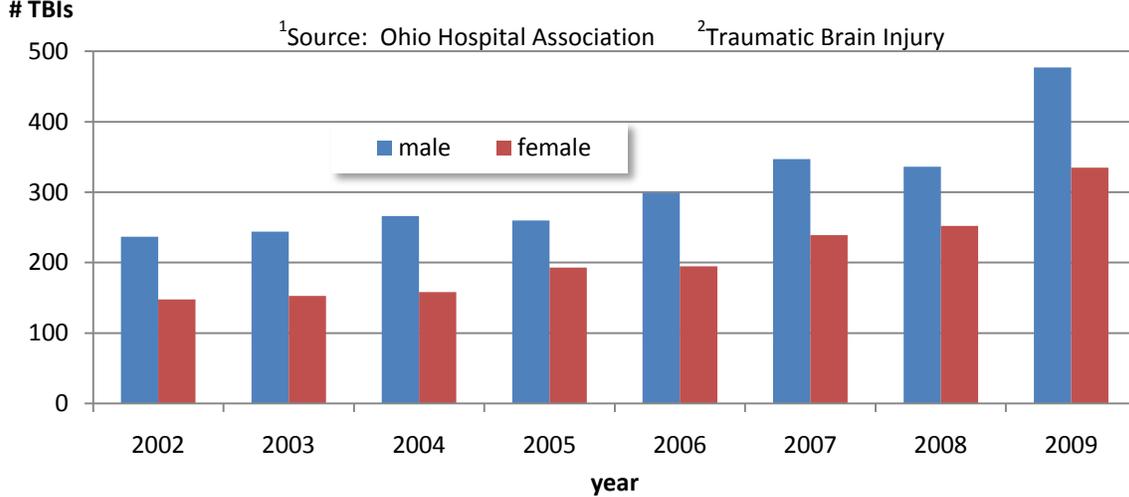
**Figure 13. ED treatment rates<sup>1,2</sup> for traffic-related pedal cycle TBIs<sup>3</sup> among 18 years old and younger, by sex/age groups, county urbanality, Ohio, 2002-09**



## ED VISITS FOR RECREATION, NO MENTION OF WHEELS-RELATED TBIS

ED visits for recreation, no mention of wheels TBIs primarily involved falls from playground equipment (78 percent) or from snowboards (14 percent) (Appendix 5). Overall, the number of such injuries increased 110 percent from 2002 to 2009 (386 to 812) (Table 1) with rapid increases found for both males and females (Figure 14).

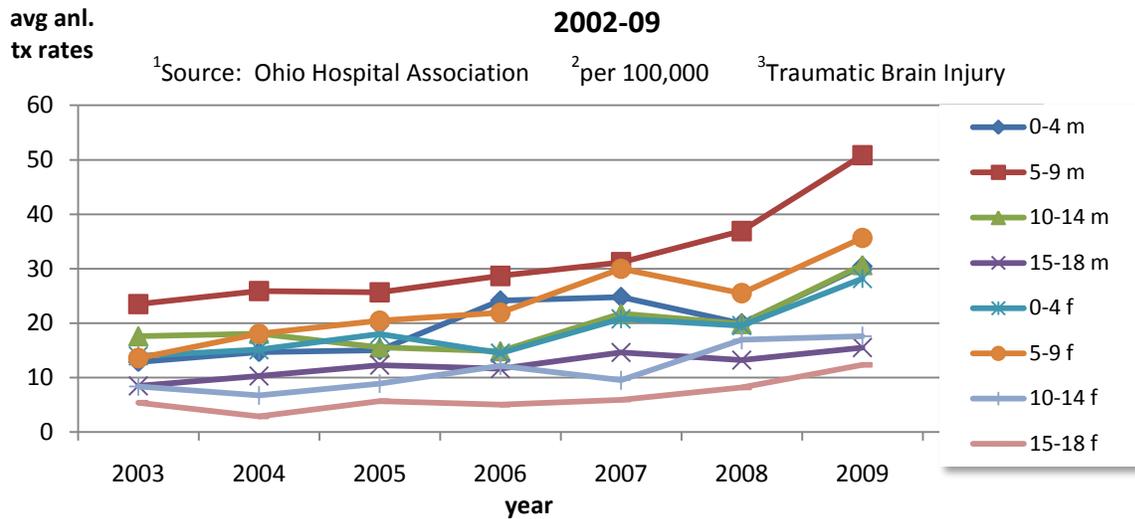
**Figure 14. Number of ED visits<sup>1</sup> for recreation, no mention of wheels TBIs<sup>2</sup> among 18 years old and younger, by sex, year, Ohio, 2002-09**



Five to 9 year olds were at particular risk of incurring a TBI from these types of activities, with males demonstrating a peak rate in 2009 of 51 per 100,000 and females a rate of 36 per 100,000, (Figure 15).

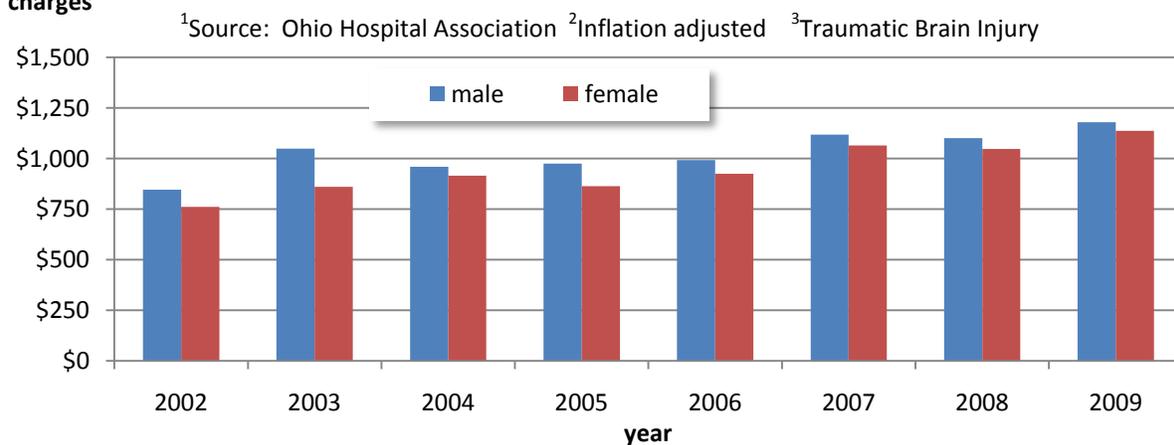


**Figure 15. ED treatment rates<sup>1,2</sup> for recreation, no mention of wheels TBIs<sup>3</sup>, among 18 years old and younger, by sex/age groups, year, Ohio, 2002-09**



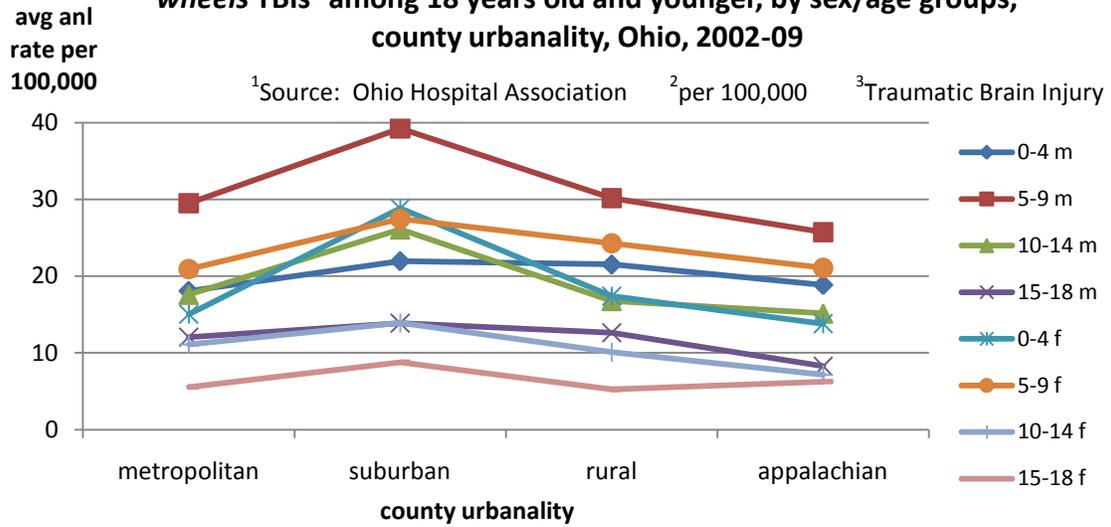
Males consistently incurred greater treatment charges than females for *recreation, no mention of wheels* TBIs (Figure 16). For both sexes combined, after inflation adjustment, average treatment charges increased 43 percent from 2002 (\$813) to 2009 (\$1,162), (data not shown). As shown in Figure 5, youths incurring TBIs from this class of S/R-related activities accumulated the lowest treatment charges.

**Figure 16. Average ED treatment charges<sup>1,2</sup>, for recreation, no mention of wheels-related TBIs<sup>3</sup> among 18 years old and younger, by sex, year, Ohio, 2002-09**



ED treatment rates for *recreation, no mention of wheels* were highest in suburban counties for most age/sex groups (Figure 17). Five to 9 year old males that reside in such counties had an average annual ED-treated TBI rate of 39 per 100,000 for the entire study period.

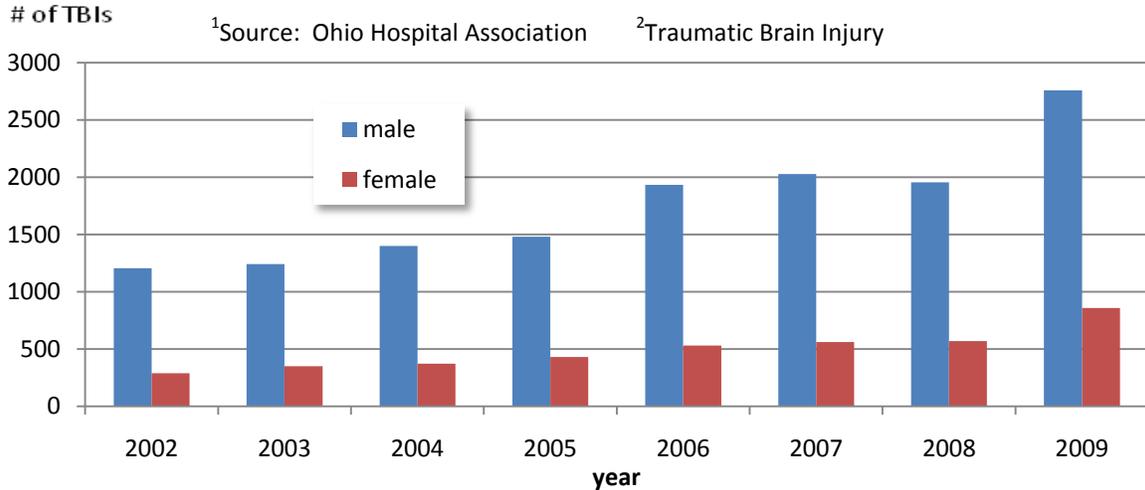
**Figure 17. ED treatment rates<sup>1,2</sup> for recreation, no mention of wheels TBIs<sup>3</sup> among 18 years old and younger, by sex/age groups, county urbanality, Ohio, 2002-09**



## ED VISITS FOR SPORTS, NO MENTION OF WHEELS TBIS

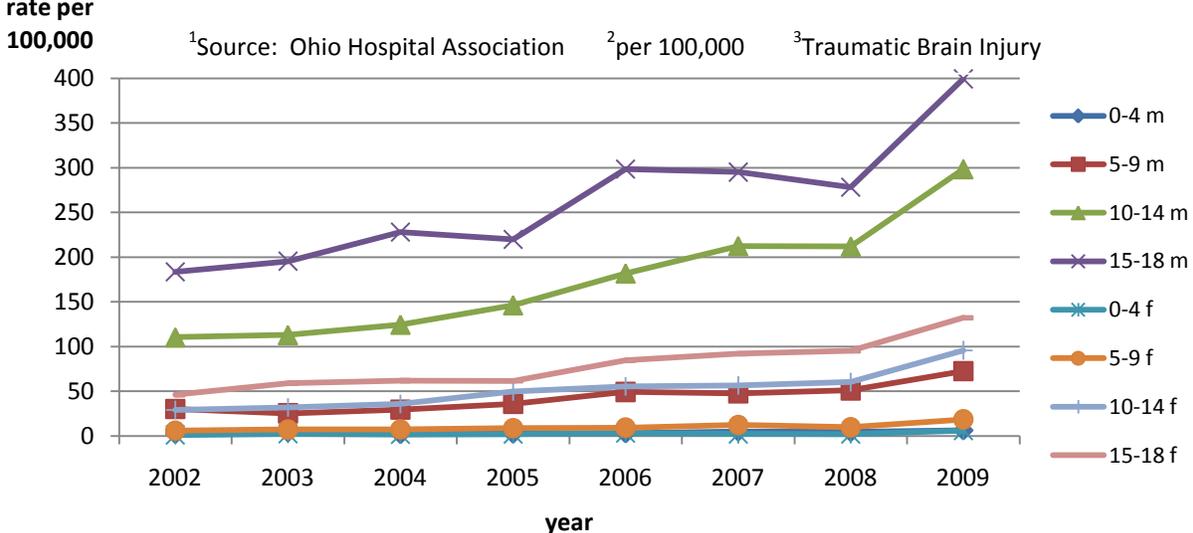
Of the youths treated for a TBI after a *sports, no mention of wheels* injury, 78 percent were male, (Figure 18). The number of such injuries increased 142 percent from 2002 (1,495) to 2009 (3,617).

**Figure 18. Number of ED visits<sup>1</sup> for *sports, no mention of wheels* TBIs<sup>2</sup> among 18 years old and younger, by sex, year, Ohio, 2002-09**



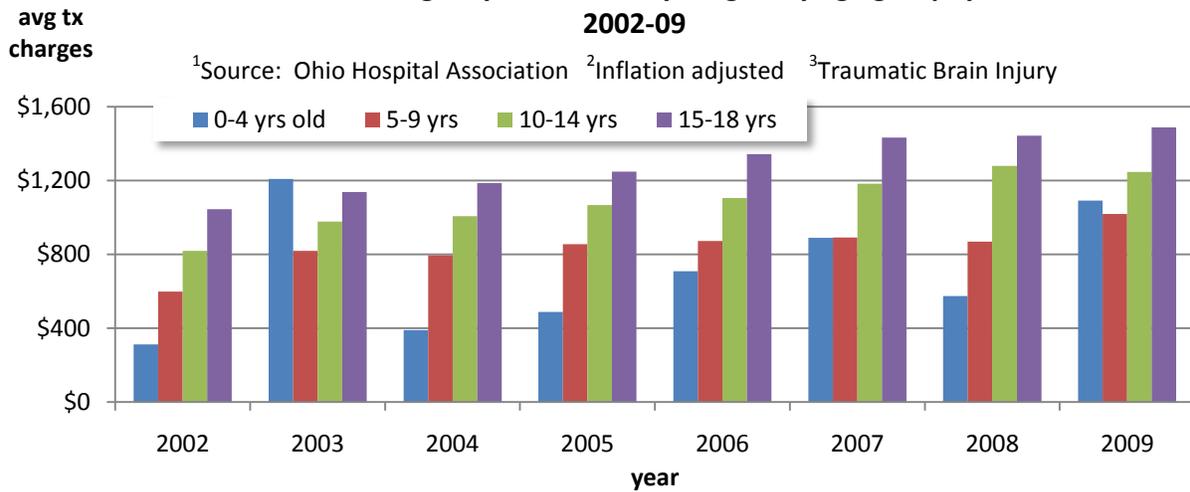
Older males were by far the most likely to endure a TBI from a *sports, no mention of wheels* injury. Fifteen to 18 year olds had a treatment rate of 399 per 100,000 in 2009, while 10-14 year olds had a rate of 298 per 100,000. (Figure 19). Fifteen to 18 year old females, the next highest rate (132 per 100,000) in 2009, was 56 percent as high as males 10-14 years.

**Figure 19. ED treatment rates<sup>1,2</sup> for *sports, no mention of wheels* TBIs<sup>3</sup>, among 18 years old and younger, by sex/age groups, year, Ohio, 2002-09**



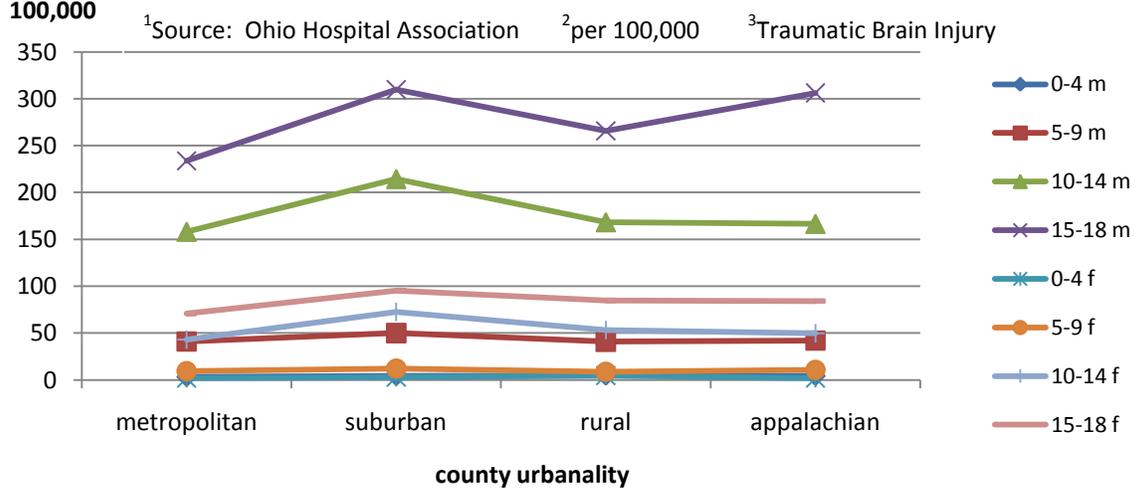
Except for 2003, when charges among 0-4 year olds soared, *sports, no mention of wheels* TBIs were most expensive to treat among 15-18 year olds (Figure 20). For this oldest age group, mean charges increased 42 percent from 2002 (\$1,045) to 2009 (\$1,487). Overall, treatment charges ranged from \$23 to \$14,515.

**Figure 20. Average ED treatment charges<sup>1,2</sup>, for *sports, no mention of wheels*, TBIs<sup>3</sup> among 18 years old and younger, by age group, year, Ohio 2002-09**



The highest ED treatment rates were found in suburban counties for most sex and age groups (Figure 21). Males between the ages of birth to 4 years old had ED treatment rates so low as to render them immaterial.

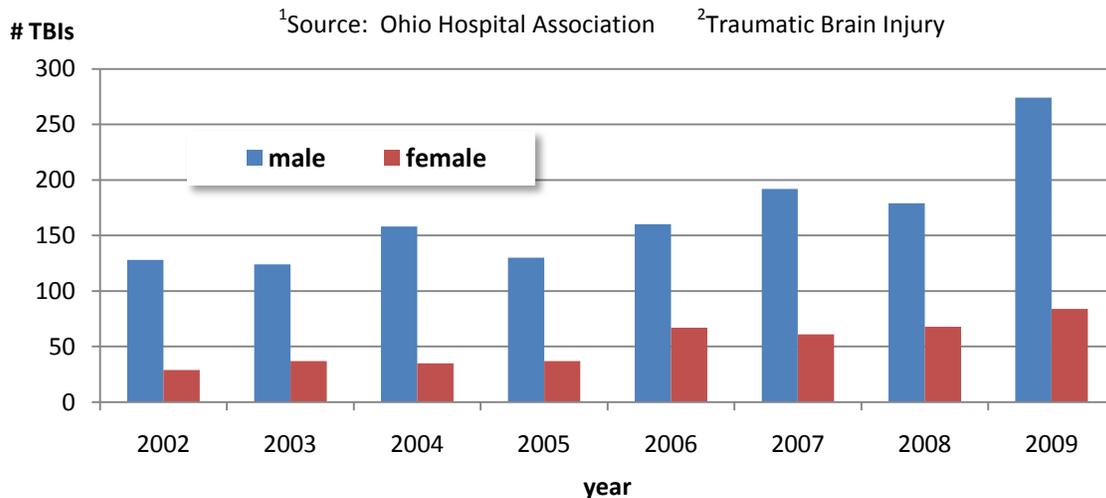
**Figure 21. ED treatment rates<sup>1,2</sup> for *sports, no mention of wheels* TBIs<sup>3</sup> among 18 years old and younger, by sex/age groups, county urbanality, Ohio 2002-09**



## ED VISITS FOR WHEELED RECREATION TBIs

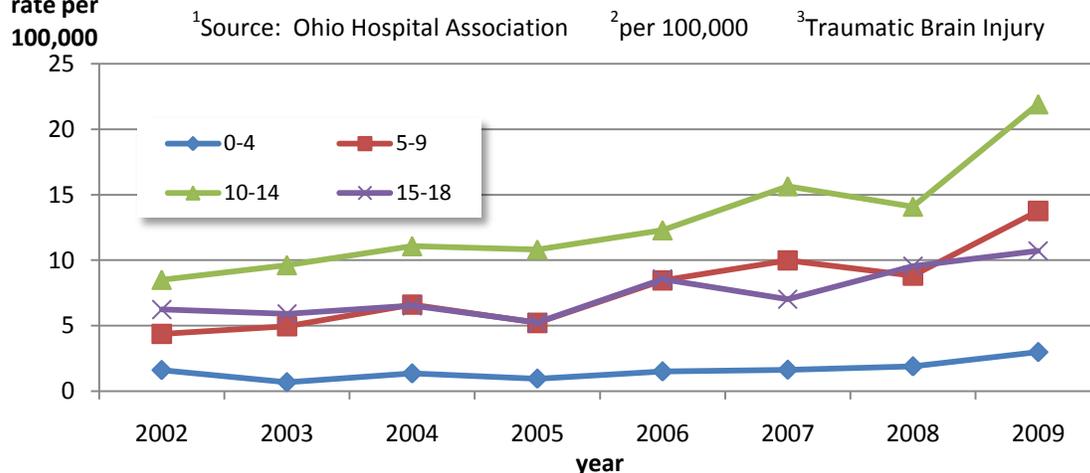
From 2002-09, there were 1,764 ED-treated TBIs associated with *wheeled recreation*, Figure 22. All of these resulted from mishaps involving skates (28 percent), skateboards (53 percent), or non-motorized scooters (19 percent) (data not shown). Seventy-six percent of such TBIs occurred in males.

**Figure 22. Number of ED-treated<sup>1</sup>, wheeled recreation-related TBIs<sup>2</sup> among 18 years old and younger, by sex, year, Ohio, 2002-09**



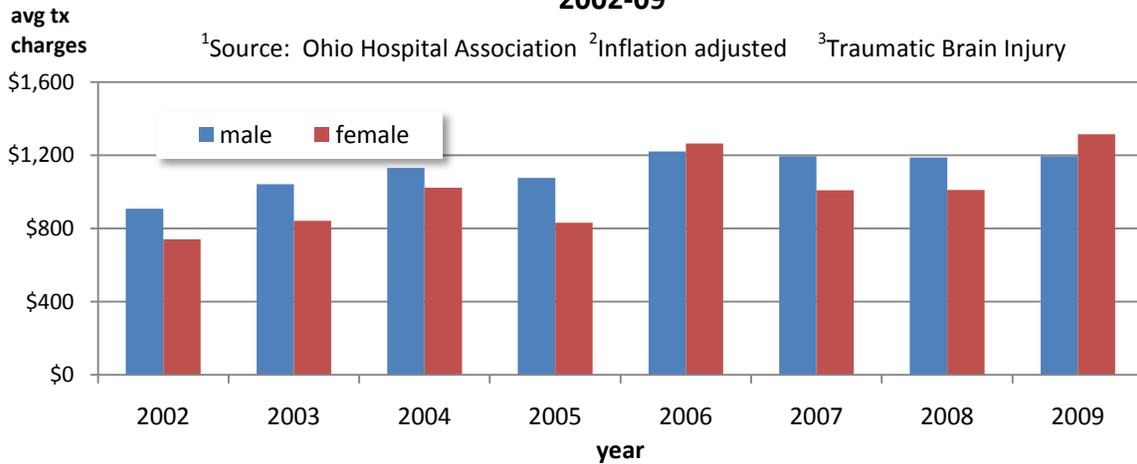
ED treatment rates for *wheeled recreation-related TBIs* increased for children and youth 5 years of age or older with the largest increase occurring among 10 to 14 year olds (Figure 23). The number of ED-treated *wheeled recreation-related TBIs* increased 128 percent from 2002 (157) to 2009 (358) for 10 to 14 year olds. Children in this age group were at the greatest risk for *wheeled recreation-related TBI* during each year from 2002 to 2009.

**Figure 23. ED treatment rates<sup>1,2</sup> for wheeled recreation-related TBIs<sup>3</sup> among 18 years old and younger, by age group, Ohio, 2002-09**



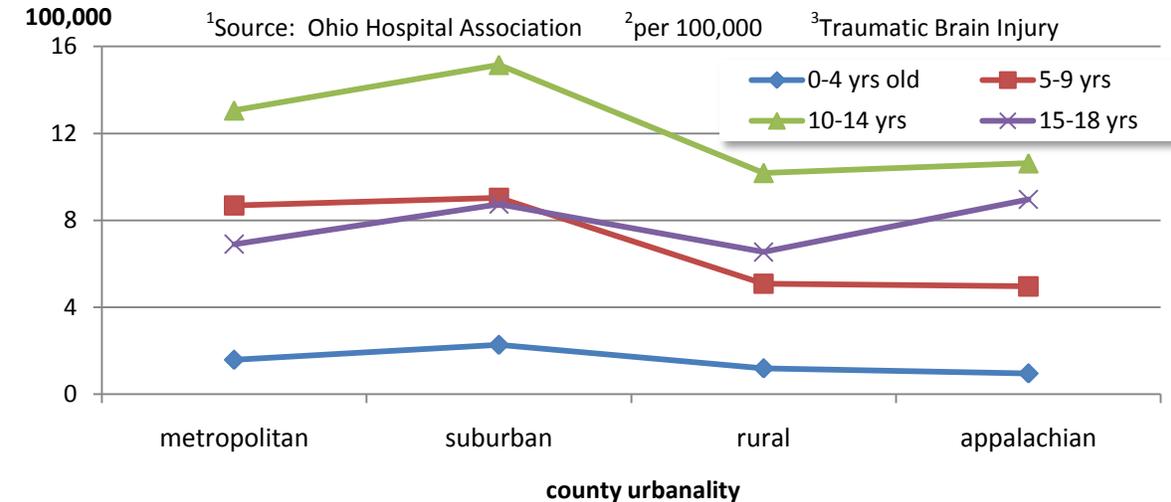
On average, males who incur a *wheeled recreation* TBI cost about \$70 more to treat than similarly injured females during the study period. However, treatment charges increased more rapidly for females (77 percent) compared to males (32 percent) with average treatment charges for females surpassing males in 2006 and 2009 (Figure 24).

**Figure 24. Average ED treatment charges<sup>1,2</sup>, for *wheeled recreation*-related TBIs<sup>3</sup> among 18 years old and younger, by sex, year, Ohio, 2002-09**



Suburban county youth appear to be at slightly greater risk of *wheeled-recreation* TBIs, likely due to more opportunities for such activities. Ten to 14 year old males incurred such injuries at a rate of 15 per 100,000 annually (Figure 25).

**Figure 25. ED treatment rates<sup>1,2</sup> for *wheeled recreation*-related TBIs<sup>3</sup> among 18 years old and younger, by age group, county urbanality, Ohio, 2002-09**



## SECTION 3:

### SPORTS AND RECREATION-RELATED TBI HOSPITALIZATIONS



From 2002 through 2009, about 11 percent of TBIs in Ohioans 18 or younger were associated with sports or recreation activities (as best they could be defined, taking into account the inherent limitations of using (ICD-9-CM) codes (Appendix 2 and 4)).

On average, nearly 148 youths were hospitalized for sports/recreation-related traumatic brain injuries each year, with a range of 136 in 2005 to 169 in 2006 (Table 2).

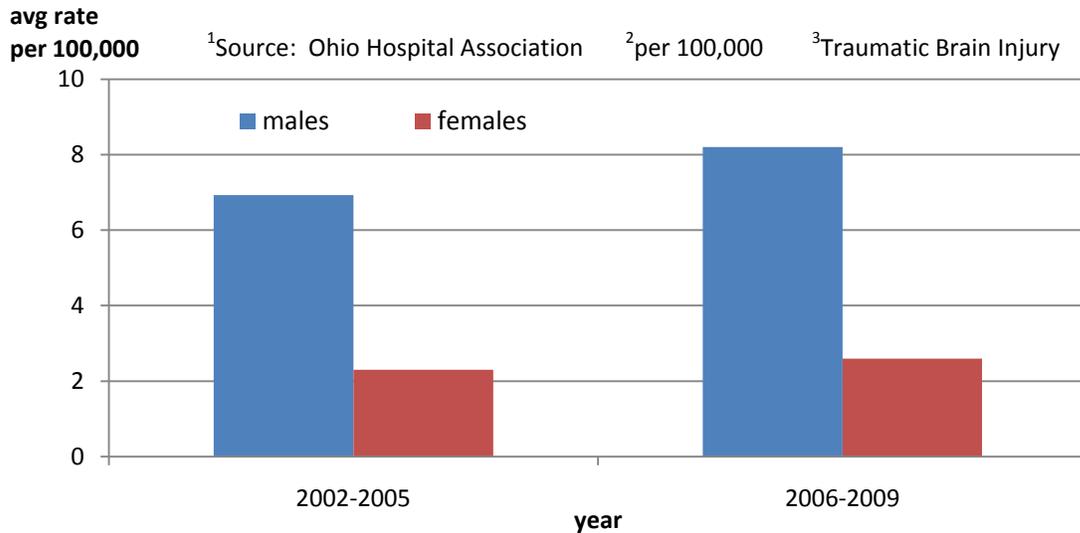
For the purposes of this analysis, five ‘how injured’ categories were developed to capture all sports/recreation injuries. The most common categories were *non-traffic pedal cycle* (439), *non-wheeled sports* (350), and *traffic related pedal cycle* injuries (213) which accounted for 85 percent of hospitalizations.

**Table 2. Number of hospitalizations for sport/recreation-related TBIs<sup>1</sup> among 18 years old and younger, by how injured, year, Ohio, 2002-09<sup>2</sup>**

<sup>1</sup> Traumatic brain injuries <sup>2</sup> Source: Ohio Hospital Association									
<i>How Injured Category</i>	<b>Year of Hospitalization</b>								<b>Total</b>
	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	
<b>non-traffic pedal cycle</b>	51	38	48	61	60	65	57	59	<b>439</b>
<b>traffic-related pedal cycle</b>	26	30	24	20	29	26	34	24	<b>213</b>
<b>recreation, no mention of wheels</b>	10	14	18	15	16	12	14	16	<b>115</b>
<b>sports, no mention of wheels</b>	43	46	44	30	55	47	43	42	<b>350</b>
<b>wheeled recreation</b>	9	12	6	10	9	10	10	5	<b>71</b>
<b>Total</b>	<b>139</b>	<b>140</b>	<b>140</b>	<b>136</b>	<b>169</b>	<b>160</b>	<b>159</b>	<b>146</b>	<b>1,188</b>

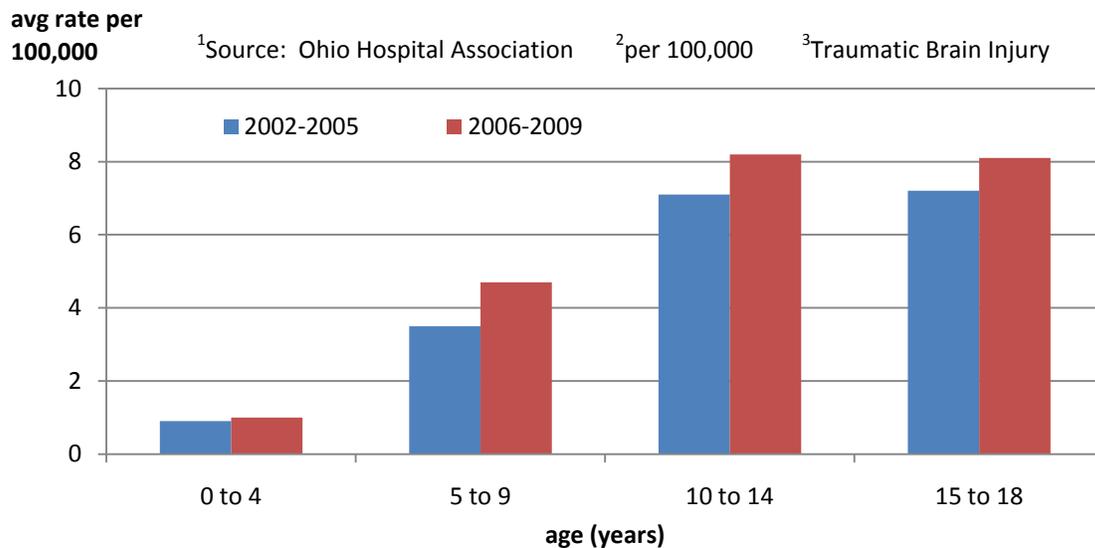
Hospitalization rates were higher for males compared to females. The gap between males and females increased during the study period. Rates increased from 6.9 per 100,000 in 2002-2005 to 8.2 per 100,000 in 2006-2009 for males while rates remained the same for females between 2002-2005 and 2006-2009 (Figure 26).

**Figure 26. Hospitalization rates<sup>1,2</sup> of sports/recreation related TBIs<sup>3</sup> among 18 & younger, by sex, time period, Ohio, 2002-05 vs 2006-09**



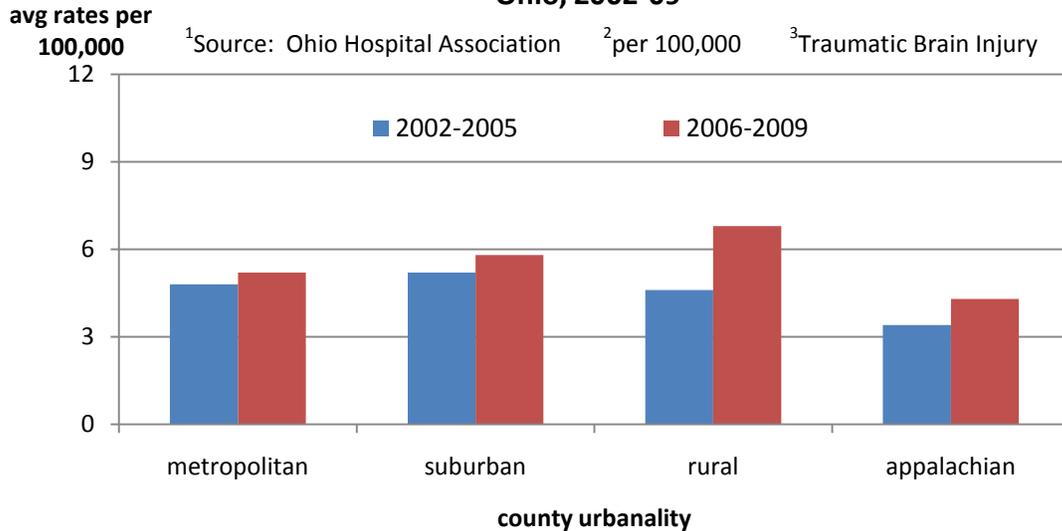
Children ages 10-14 and 15-18 were more likely to be hospitalized than younger children ages birth to 4 and 5-9. Trends in hospitalization rates differed by age group. Hospitalization rates increased from 2002-2005 to 2006-2009 among the 5-9, 10-14, and 15-18 age groups and remained the same for children birth through 4 (Figure 27).

**Figure 27. Hospitalization rates<sup>1,2</sup> of sports/recreation related TBIs<sup>3</sup> among 18 years old and younger, by age and year, Ohio, 2002-09**



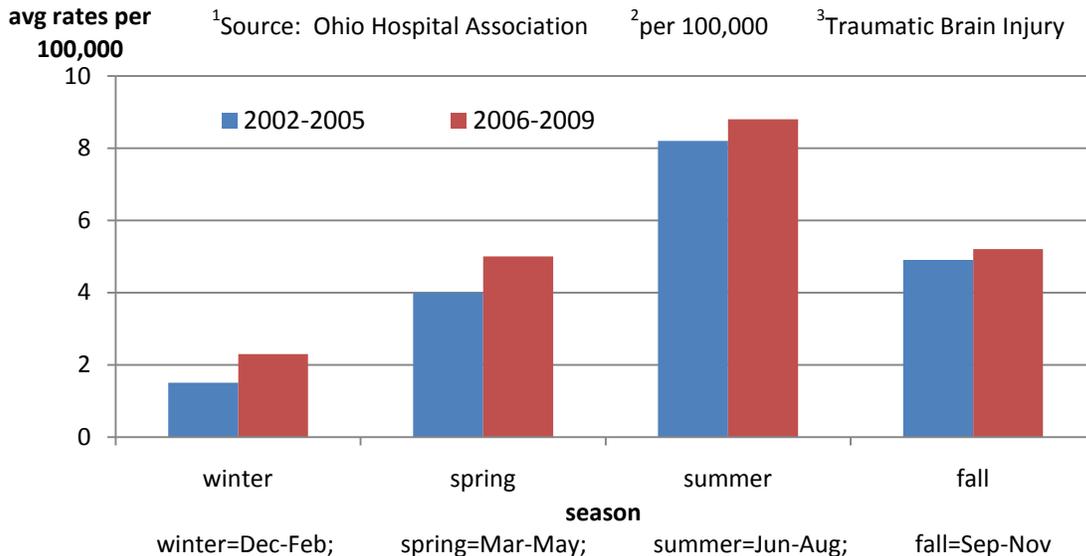
Hospitalization rates were higher in metropolitan, suburban, and rural counties compared to Appalachian counties. Rates increased across all county urbanity classifications from 2002-2005 to 2006-2009. The largest increase was found in rural counties (Figure 28).

**Figure 28. Hospitalization rates<sup>1,2</sup> of sports/recreation related TBIs<sup>3</sup> among 18 years old and younger, by county urbanity and year, Ohio, 2002-09**



For the study period, summer was the most common season of the year for hospitalizations followed by fall and spring. Between 2002-2005 and 2006-2009, hospitalization rates increased for each season (Figure 29).

**Figure 29. Hospitalization rates<sup>1,2</sup> of sports/recreation related TBIs<sup>3</sup> among 18 years old and younger, by season<sup>4</sup> and year, Ohio, 2002-09**

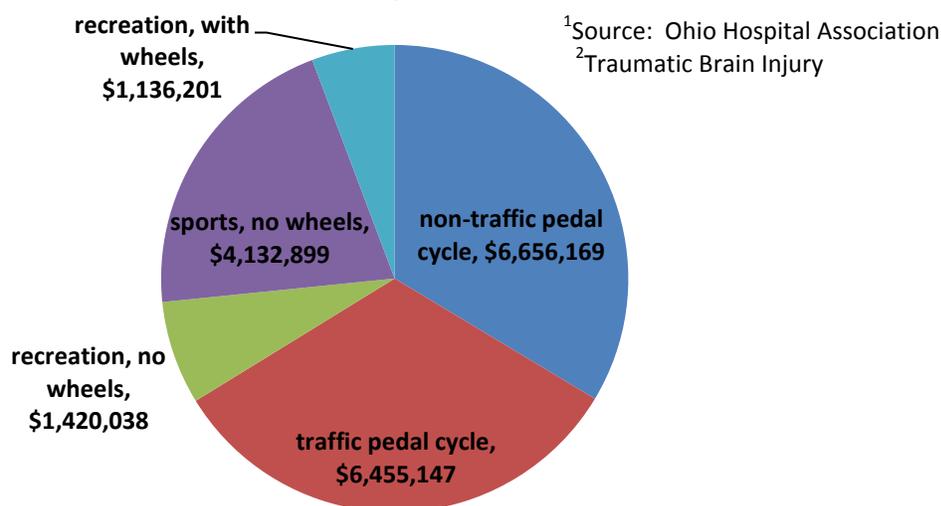


Most (95%) children and youth were discharged home from the hospital. The percentage of home discharges did not vary by mechanism of injury or year (data not shown).

S/R-related TBI hospitalizations were associated with \$19.8 million in total treatment charges during the study period (table 3). Average charges increased from \$2.1 million in 2002-2005 to an annual average of \$2.8 million in 2006-2009. *Non-traffic* and *traffic pedal cycle* TBIs incurred the largest total charges at nearly \$6.7 million and \$6.5 million respectively (Figure 30).

<b>Table 3. Total charges (\$) for sport/recreation-related TBIs<sup>1</sup> among 18 years old and younger, by how injured, year, Ohio, 2002-09<sup>2</sup></b>									
<sup>1</sup> Traumatic brain injuries <sup>2</sup> Source: Ohio Hospital Association									
<i>How Injured</i>	Year of Hospitalization								Total
	2002	2003	2004	2005	2006	2007	2008	2009	
<b>non-traffic pedal cycle (\$)</b>	577,316	459,239	638,221	869,274	1.0 million	1.1 million	955,999	1.0 million	<b>6.7 million</b>
<b>traffic-related pedal cycle (\$)</b>	804,719	820,569	630,513	546,345	703,271	1.1 million	755,102	1.1 million	<b>6.5 million</b>
<b>recreation, no mention of wheels (\$)</b>	126,427	90,518	181,277	179,474	247,998	147,315	91,270	355,759	<b>1.4 million</b>
<b>sports, no mention of wheels (\$)</b>	399,215	459,724	500,682	451,343	829,735	443,972	539,961	508,267	<b>4.1 million</b>
<b>wheeled recreation (\$)</b>	103,874	142,758	64,209	308,586	161,050	175,533	82,765	97,425	<b>1.1 million</b>
<b>Total (\$)</b>	<b>2.0 million</b>	<b>1.9 million</b>	<b>2.0 million</b>	<b>2.4 million</b>	<b>3.0 million</b>	<b>3.0 million</b>	<b>2.4 million</b>	<b>3.1 million</b>	<b>19.8 million</b>

**Figure 30. Total charges<sup>1</sup> for sports/recreation related TBI<sup>2</sup> hospitalizations among 18 years old and younger, by how injured, Ohio, 2002-09**



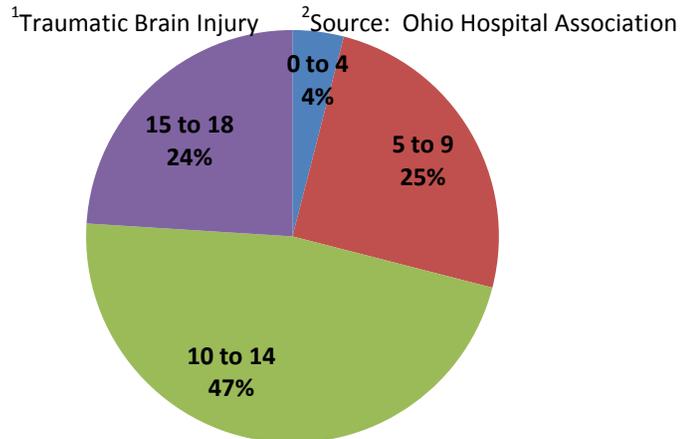
## NON-TRAFFIC PEDAL CYCLE INJURIES



Thirty seven percent (439) of S/R-related TBI hospitalizations were associated with *non-traffic pedal cycle* injuries, (Table 2). Nearly all *non-traffic pedal cycle* injuries (98 percent) were caused by a collision between pedal cyclist and non-motorized object (Appendix 6).

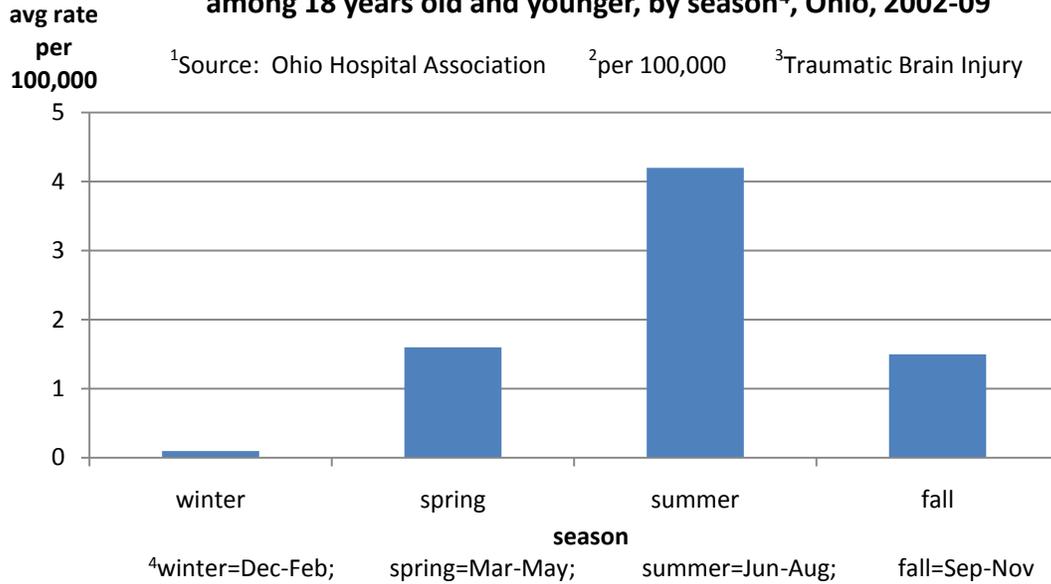
The overall *non-traffic related pedal cycle* TBI hospitalization rate was 1.9 per 100,000, with males at more than twice the risk of females: (2.6 versus 1.1 per 100,000). Approximately one-half (47 percent) of the hospitalizations occurred among youth ages 10-14 while one-quarter of the hospitalizations were among children ages 5-9 years and youth 15-18 years respectively (Figure 31).

**Figure 31. Percentage of non-traffic pedal cycle TBI<sup>1</sup> hospitalizations<sup>2</sup> among 18 years old and younger, by age group, Ohio, 2002-09<sup>2</sup>**



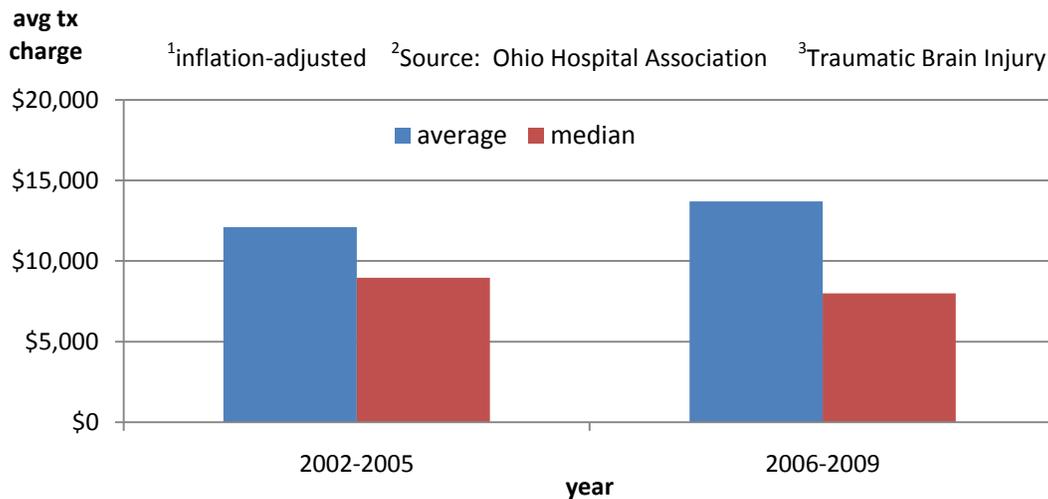
Rates of *non-traffic pedal cycle* related TBI hospitalizations did not differ by county urbanity (data not shown). However, differences in hospitalization rates were found by season. Hospitalizations were most likely to occur in summer (4.2 per 100,000) followed by spring (1.6 per 100,000) and fall (1.5 per 100,000) (Figure 32).

**Figure 32. Hospitalization rates<sup>1,2</sup> of non-traffic pedal cycle TBIs<sup>3</sup> among 18 years old and younger, by season<sup>4</sup>, Ohio, 2002-09**



Non traffic-related pedal cycle TBIs were associated with \$6.7 million in hospitalization charges (Figure 30). Between 2002-2005 and 2006-2009, the average adjusted charge increased slightly from \$12,093 to \$13,705 while the median adjusted charge decreased from \$8,968 to \$7,992 (Figure 33). The divergent trends in the average and median costs are attributed to treating a higher proportion of patients with extremely high charges in 2006-2009.

**Figure 33. Average and median charges<sup>1</sup> of hospitalizations<sup>2</sup> of non-traffic pedal cycle TBIs<sup>2</sup> among 18 years old and younger, by year, Ohio, 2002-09**

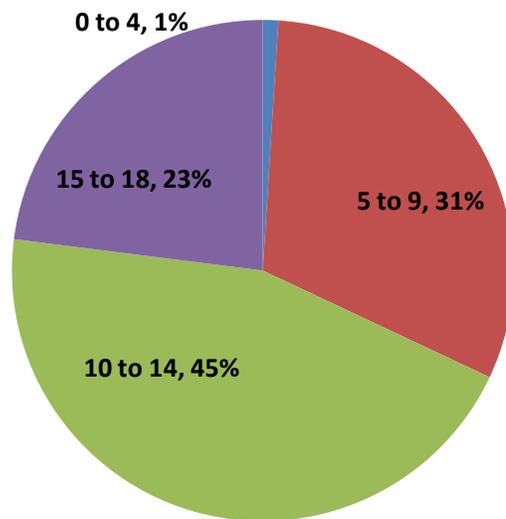


## TRAFFIC-RELATED PEDAL CYCLE INJURIES

Two hundred thirteen (18 percent) of sports and recreation hospitalizations were associated with traffic-related pedal cycle injuries (Table 2). Most *traffic-related pedal cycle* injuries were caused by a collision between a pedal cyclist and a motor vehicle (79 percent) or collision involving a pedal cyclist, pedestrian, and motor vehicle (14 percent) (Appendix 6).

The overall rate of *traffic related pedal cycle* TBI hospitalizations was 0.9 per 100,000. Males were nearly 4 times more likely to be hospitalized than females (1.4 versus 0.4 per 100,000). Nearly half of hospitalizations occurred among children ages 10 to 14 followed by 5 to 9 year olds (31 percent) and 15 to 18 year olds (23 percent) (Figure 34).

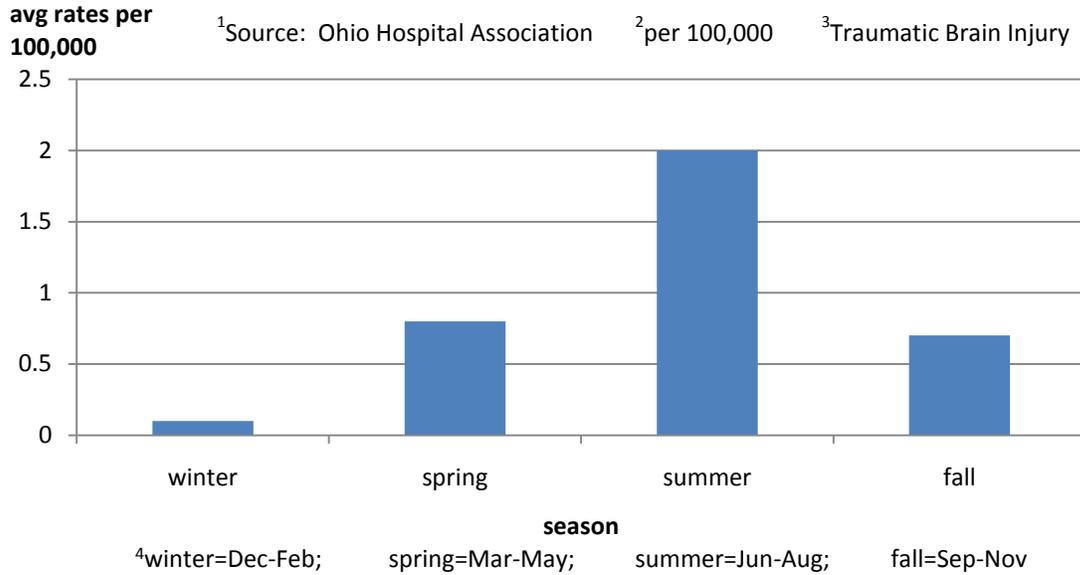
**Figure 34. Percentage of hospitalizations<sup>1</sup> for traffic-related pedal cycle TBIs<sup>2</sup> among 18 years old and younger, by age, Ohio, 2002-09**



<sup>1</sup>Source: Ohio Hospital Association    <sup>2</sup>Traumatic Brain Injury

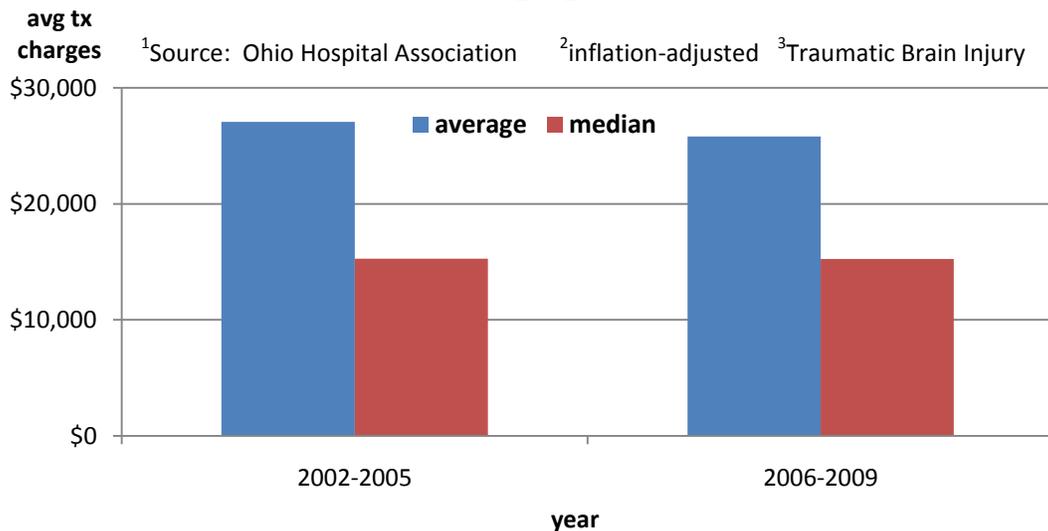
Rates of *traffic related pedal cycle* TBI hospitalizations were lower in Appalachian counties (0.4 per 100,000) compared to metropolitan, suburban, and rural counties (0.9-1.1 per 100,000) (data not shown). Differences in hospitalization rates were also found by season. Hospitalizations were most likely to occur in summer (2.0 per 100,000) followed by spring (0.8 per 100,000) and fall (0.7 per 100,000) (Figure 35).

**Figure 35. Hospitalization rates<sup>1,2</sup> of traffic-related pedal cycle TBIs<sup>3</sup> among 18 years old and younger, by season<sup>4</sup>, Ohio, 2002-09**



Traffic-related pedal cycle TBIs were associated with \$6.5 million in charges (Figure 30). Between 2002-2005 and 2006-2009, the average adjusted charge decreased from \$27,075 to \$25,817 and the median adjusted charge slightly decreased from \$15,278 to \$15,253 (Figure 36).

**Figure 36. Average and median hospitalization<sup>1</sup> charges<sup>2</sup> for traffic pedal cycle TBIs<sup>3</sup> among 18 years old and younger, by year, Ohio, 2002-09**



## RECREATION, NO MENTION OF WHEELS INJURIES

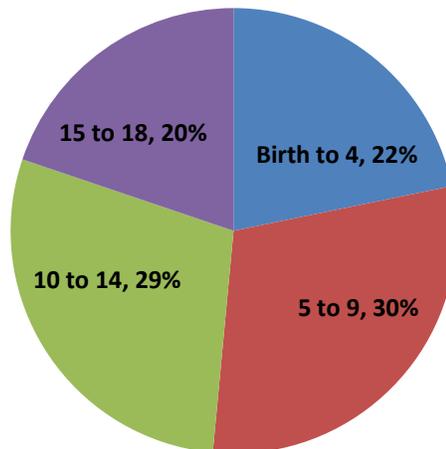
One hundred fifteen (10 percent) of sports and recreation hospitalizations were associated with *non-wheeled recreation* injuries (Table 2). Falls from playground equipment (59 percent), falls from snowboards (18 percent) and air gun incidents (10 percent) were the most common *non-wheeled recreation* injuries (Appendix 6).

The overall rate of *non-wheeled recreation* related TBI hospitalizations was 0.5 per 100,000. Males were twice as likely to be hospitalized than females (0.7 versus 0.3 per 100,000). Hospitalizations were evenly distributed across the age groups (Figure 37).



**Figure 37. Percentage of hospitalizations<sup>1</sup> for non-wheeled recreation related TBIs<sup>2</sup> among 18 years old and younger, by age group, Ohio, 2002-09**

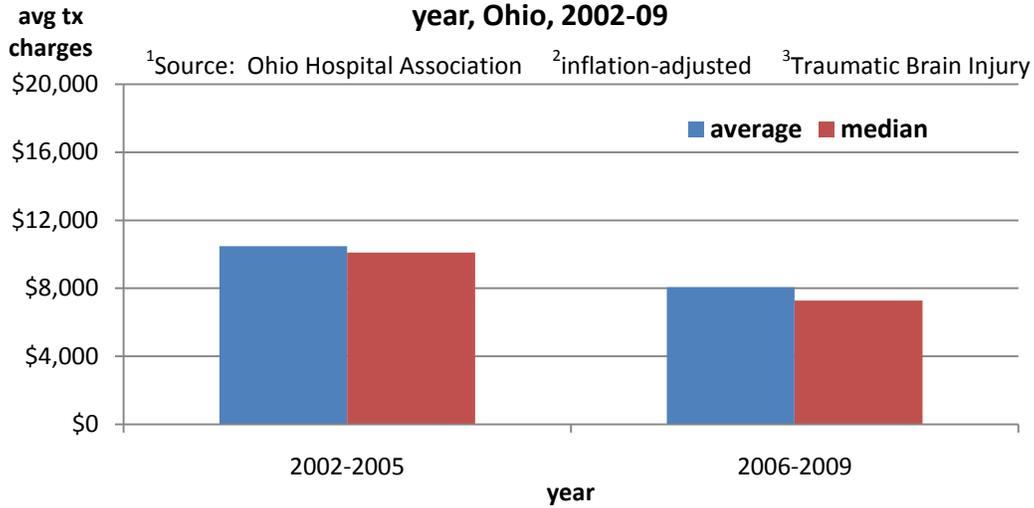
<sup>1</sup>Source: Ohio Hospital Association    <sup>2</sup>Traumatic Brain Injury



Rates of *non-wheeled recreation* related TBI hospitalizations were slightly lower in Appalachian and metropolitan counties compared to suburban and rural counties (data not shown). Differences in hospitalization rates were also found by season. Hospitalizations were more likely to occur in summer (0.7 per 100,000) and winter (0.6 per 100,000) than in the spring (0.3 per 100,000) and fall (0.4 per 100,000) (data not shown).

*Non-wheeled recreation* TBIs were associated with \$1.4 million in hospitalization charges (Figure 30). Between 2002-2005 and 2006-2009, the average adjusted charge increased from \$9,664 to \$11,800 and the median adjusted charge increased from \$5,802 to \$7,569 (Figure 38).

**Figure 38. Average and median hospital<sup>1</sup> charges<sup>2</sup> of non-wheeled recreation TBIs<sup>3</sup> among 18 years old and younger, by year, Ohio, 2002-09**

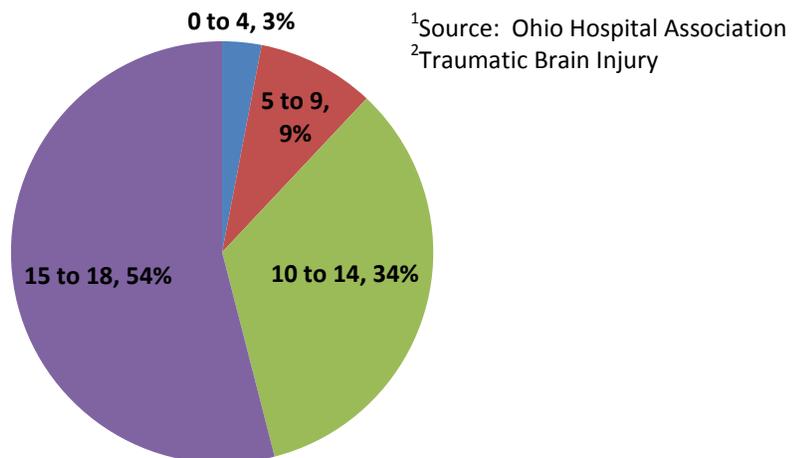


## SPORTS, NO MENTION OF WHEELS INJURIES

Three hundred fifty one (30 percent) of sports and recreation hospitalizations were associated with *non-wheeled sports* injuries (Table 2). Being struck by/against without a subsequent fall was the most common *non-wheeled sports* injury (62 percent) followed by being struck by/against with a subsequent fall (28 percent) and falls on the same level caused by a collision, pushing, or shoving (10 percent) (Appendix 6).

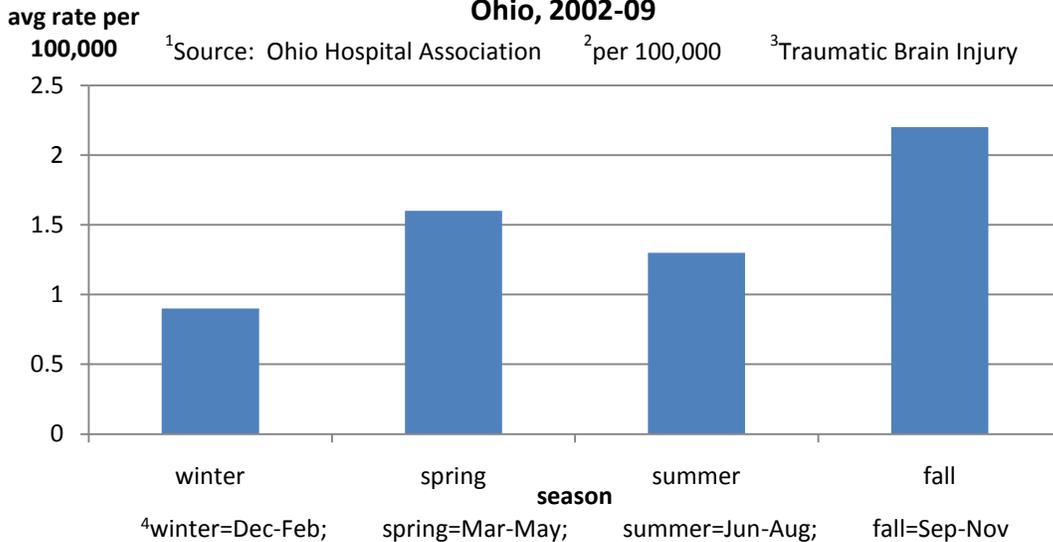
The overall rate of non-wheeled sports related TBI hospitalizations was 1.5 per 100,000. Males were nearly four times more likely to be hospitalized than females (2.3 versus 0.6 per 100,000). Most of the hospitalizations occurred among youth 15-18 and 10-14 years of age (Figure 38).

**Figure 38. Percentage of hospitalizations<sup>1</sup> for non-wheeled sports-related TBIs<sup>2</sup> among 18 years old and younger, by age group, Ohio, 2002-09**



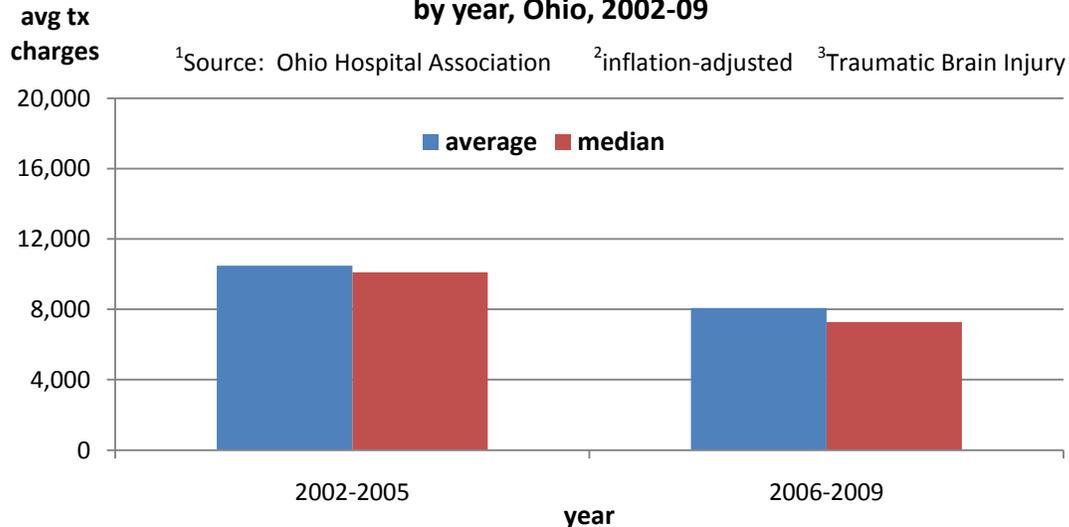
Some variation was found in *non-wheeled sports* related hospitalization rates by county urbanality classifications. The highest rate occurred in metropolitan counties (1.9 per 100,000) followed by suburban (1.7 per 100,000), rural (1.4 per 100,000) and Appalachian (1.1 per 100,000) counties (data not shown). Hospitalization rates varied by season with the highest rate in fall (2.2 per 100,000) and the lowest rate in winter (0.9 per 100,000) (Figure 39).

**Figure 40. Hospitalization rates<sup>1,2</sup> of traffic related non-wheeled sports TBIs<sup>3</sup> among 18 years old and younger, by season<sup>4</sup>, Ohio, 2002-09**



*Non-wheeled sports* TBIs were associated with \$4.1 million in charges (Table 3). Between 2002-2005 and 2006-2009, the average charge decreased from \$10,484 to \$10,095 and the median decreased from \$8,070 to \$7,281 (Figure 40).

**Figure 40. Average and median hospitalization<sup>1</sup> charges<sup>2</sup> of non-wheeled sports-related TBIs<sup>3</sup> among 18 years old and younger, by year, Ohio, 2002-09**



## RECREATION, WHEELED INJURIES

Seventy-one (6 percent) of sports and recreation hospitalizations were associated with wheeled *recreation* injuries (Table 2). Unintentional falls from skateboards were the most common wheeled recreation injuries (76 percent) followed by falls on/from non-motorized scooters (13 percent) and falls from roller and inline skates (11 percent) (Appendix 6).

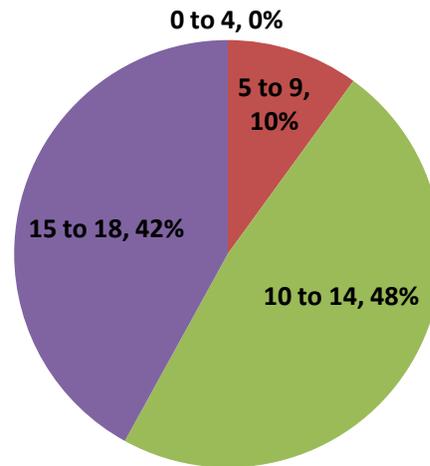
The overall rate of *wheeled recreation* related TBI hospitalizations was 0.3 per 100,000. Males were nearly five times more likely to be hospitalized than females (0.5 versus 0.1 per 100,000). Nearly all hospitalizations occurred among youth 10-14 and 15-18 years of age (Figure 41).



**Figure 41. Percentage of hospitalizations<sup>1</sup> for wheeled recreation related TBIs<sup>2</sup> hospitalizations among 18 years old and younger, by age group, Ohio, 2002-09**

<sup>1</sup>Source: Ohio Hospital Association

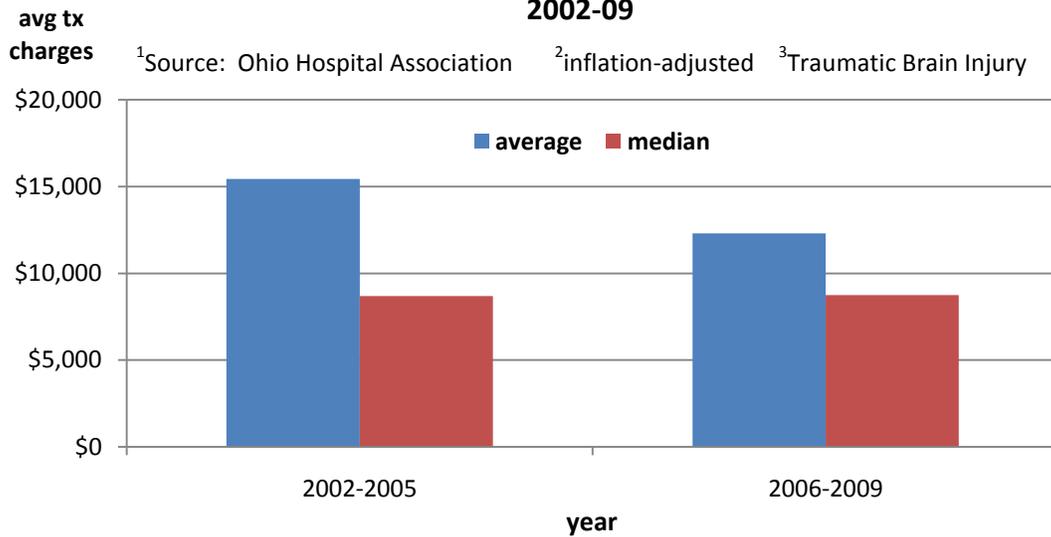
<sup>2</sup>Traumatic Brain Injury



Differences in the rates of *wheeled recreation*-related TBI hospitalizations were associated with degree of county urbanality. Hospitalizations rates ranged from a high of 0.4 per 100,000 in rural counties to a low of 0.2 per 100,000 in suburban counties (data not shown). Differences in hospitalization rates were found by season as well. The peak hospitalization rate occurred in summer (0.5 per 100,000) while the lowest rate was found winter and fall (0.2 per 100,000) (data not shown).

*Wheeled recreation* related TBIs were associated with \$1.1 million in hospitalization charges (Figure 30). Between 2002-2005 and 2006-2009, the average adjusted charge decreased from \$15,447 to \$12,309 and the median adjusted charge increased from \$8,693 to \$8,739 (Figure 42). The divergent trends in average and median charges can be attributed to treating a higher proportion of patients with extremely high charges in 2002-2005.

**Figure 42. Average and median hospitalization<sup>1</sup> charges<sup>2</sup> of wheeled recreation TBIs<sup>3</sup> among 18 years old and younger, by year, Ohio, 2002-09**



## SECTION 4: DEATHS FROM SPORTS AND RECREATION-RELATED TBI

During the study, eleven TBI fatalities in Ohioans 18 or younger were associated with sports or recreation activities (as best they could be defined, taking into account the inherent limitations of utilizing International Classification of Disease Revision 10 (ICD10) codes (Appendices 3 and 7)).

All of these fatalities resulted from a *traffic related pedal cycle* injury. Most pedal cycle TBI fatalities were caused by a collision between a pedal cyclist and a moving motor vehicle (Appendix 8). *Pedal cycle TBI fatalities* were most common among males, youth ages 10 or older, residents of Metropolitan counties, and cycling during summer (Table 4).

<b>Table 4. Number and percent of deaths<sup>1</sup> from traffic-related, pedal cycle TBIs<sup>2</sup> among 18 years old and younger, 2002-2009</b>		
	<b>Number</b>	<b>Percent</b>
<b>Overall</b>	11	-
<b>Sex</b>		
Males	8	72.7
Females	3	27.3
<b>Age (years)</b>		
0 to 4	1	9.1
5 to 9	2	18.2
10 to 14	4	36.4
15 to 18	4	36.4
<b>Season</b>		
Winter ( <i>Dec- Feb</i> )	0	0.0
Spring ( <i>Mar – May</i> )	1	9.1
Summer ( <i>Jun- Aug</i> )	7	63.6
Fall ( <i>Sept – Nov</i> )	3	27.3
<b>County Urbanality</b>		
Metropolitan	6	54.5
Suburban	2	18.2
Rural	0	0.0
Appalachian	3	27.3

<sup>1</sup>Source: ODH Office of Vital Statistics    <sup>2</sup>Traumatic Brain Injury

## SECTION 5: APPENDICES



## **APPENDIX 1: METHODS AND LIMITATIONS**

### **DATA SOURCES**

This report uses data from Ohio hospital discharge records and death certificates to study traumatic brain injury (TBI) related to sports and recreation activities among Ohio residents aged 18 years and younger for 2002 through 2009.

#### ***Hospital Discharge Records***

Hospital discharge records are collected and maintained by the Ohio Hospital Association (OHA) from information provided by member hospitals. Both injuries and their external causes were classified according to the 9th Revision of the International Classification of Diseases, Clinical Modification (ICD-9-CM). For this report, a case was defined as an Ohio resident treated in an ED or a hospital, who had listed among his diagnostic fields, both a traumatic brain injury-related code (See Appendix 2 for a list of codes) and an external-cause of injury code related to sports or recreation (See Appendix 4 for a list of codes).

#### ***Death Records***

Death records are maintained by ODH's Office of Vital Statistics. Both injuries and their external causes were classified according to the 10th Revision of the International Classification of Diseases (ICD-10). For this report, a case was defined as an Ohio resident who had listed in any field of the multiple cause of death file both a traumatic brain injury-related code (See Appendix 3 for a list of codes) and an external cause of injury code related to sports or recreation (See Appendix 7 for a list of codes).

### **DATA ANALYSIS**

This analysis was limited to descriptive statistics, which were generated through the use of Statistical Analysis System (SAS) Version 9.1, Cary, N.C.

- ICD-9-CM and ICD-10 codes were used to identify sports/recreation-related TBIs (see *Appendices 2-4 and 7*), as best they could, taking into account inherent limitations (see below) of using administrative data for injury surveillance.
- For the purposes of this analysis, five 'how injured' categories (traffic-related pedal cycle; non traffic pedal cycle; recreation, no mention of wheels; sports, no mention of wheels; and wheeled recreation) were developed to capture all sports/recreation injuries. Lists of ICD-9-CM and ICD-10 codes used to define 'how injured' categories are available in *Appendices 4 and 7*, respectively.
- Persons who are treated at an ED and later admitted to a hospital are removed from the ED dataset and added to the inpatient dataset, and therefore are not included in any analysis of ED data.
- Treatment charges incurred through ED visits and hospitalization stays were adjusted for inflation based on the Consumer Price Index and reported in 2002 dollars.

## **LIMITATIONS OF INJURY SURVEILLANCE USING HOSPITAL DISCHARGE DATA**

Interpretation of these results is subject to the usual constraints inherent in research based on administrative data.

- In each year of the study period, at least 30 percent of hospitalized injury cases were not assigned an external cause code (E-code). This most likely resulted in an underestimate of total costs and incidence rates, because not all TBIs resulting from sports- and recreation-related activities could be identified and included.
- Of the non-fatally injured, only those who sought medical care were captured for this analysis.
- Discharges, not individuals, were the unit of measurement, thereby resulting in duplication when readmissions for the same initial event occurred.
- Race and ethnicity are not available in the hospital discharge data.
- Ohio residents treated in out-of-state hospitals are not consistently included, thereby affecting rates, particularly of border counties.
- Medical charges are based on billing data and not actual costs.
- Severity of injury is assumed based on type of medical treatment received (i.e., inpatient treatment is for more severe injuries than ED visits).

<b>APPENDIX 2: ICD-9-CM Codes for TBI-Related Emergency Department Visits and Hospitalizations</b>	
<b>Description</b>	<b>ICD-9-CM (ED Visits and Hospitalizations)</b>
Fracture of the vault or base of the skull	800.0-801.9
Other and unqualified multiple fractures of the skull	803.0-804.9
Intracranial injury, including concussion, contusion, laceration, and hemorrhage	850.0-854.1
Injury to optic nerve and pathways	950.1-950.3
Shaken baby syndrome	995.55
Head injury, unspecified	959.01

<b>APPENDIX 3: ICD-10 Codes for TBI-related Deaths</b>	
<b>Description</b>	<b>ICD-10 (Deaths)</b>
Open wound of the head	S01.1-S01.9
Fracture of the skull and facial bones	S02.0, S02.1, S02.3, S02.7-S02.9
Injury to optic nerve and pathways	S04.0
Intracranial injury	S06.0-S06.9
Crushing injury of head	S07.0, S07.1, S07.8, S07.9
Other unspecified injuries of head	S09.7-S09.9
Open wounds involving head with neck	T01.0
Fractures involving head with neck	T02.0
Crushing injuries involving head with neck	T04.0
Injuries of brain and cranial nerves with injuries of nerves and spinal cord at neck level	T06.0
Sequelae of injuries of head	T90.1, T90.2, T90.4, T.90.5, T90.8, T90.9

<b>APPENDIX 4: ICD-9-CM external cause codes used to define 'sports/recreation'-related TBIs in ED visits and hospitalizations</b>	
<b><u>E-code</u></b>	<b><u>Definition</u></b>
<b>Non-traffic pedal cycle</b>	
<b>E801.3</b>	non-traffic accident involving railway and pedal cycle
<b>E802.3</b>	non-traffic accident involving railway derailment and pedal cycle
<b>E803.3</b>	non-traffic accident railway explosion and pedal cycle
<b>E804.3</b>	non-traffic accident involving railway fall and pedal cycle
<b>E805.3</b>	non-traffic accident involving rolling stock and pedal cycle
<b>E806.3</b>	non-traffic accident involving other specified railway and pedal cycle
<b>E807.3</b>	non-traffic accident involving other unspecified railway and pedal cycle
<b>E820.6</b>	accidents involving motor vehicles being used in recreational or sporting activities off the highway collision and non-collision motor vehicle accidents occurring entirely off the highway
<b>E821.6</b>	non-traffic accident involving other off-road motor vehicle
<b>E822.6</b>	other motor vehicle non-traffic accident involving collision with moving object
<b>E823.6</b>	other motor vehicle non-traffic accident involving collision with stationary object
<b>E824.6</b>	other motor vehicle non-traffic accident while boarding and alighting
<b>E825.6</b>	accidents involving motor vehicles being used in recreational or sporting activities off the highway collision and non-collision motor vehicle accidents occurring entirely off the highway
<b>E826.1</b>	accidents involving other road vehicles being used in recreational or sporting activities
<b>E827.1</b>	non-traffic collision between pedal cycle and animal drawn vehicle
<b>E828.1</b>	non-traffic collision between pedal cycle and ridden animal
<b>E829.1</b>	non-traffic collision between pedal cycle and other road vehicle
<b>Traffic-related pedal cycle</b>	
<b>E810.6</b>	traffic accident involving collision with train
<b>E811.6</b>	traffic accident involving re-entrant collision with pedal cycle
<b>E812.6</b>	collision with another motor vehicle parked, stopped, stalled, disabled, or abandoned on the highway and motor vehicle collision not otherwise specified
<b>E813.6</b>	motor vehicle traffic accident involving collision with pedal cycle
<b>E814.6</b>	traffic accident involving collision with pedestrian and pedal cycle
<b>E815.6</b>	collision (due to loss of control) (on highway) between motor vehicle, any kind, and pedal cycle
<b>E816.6</b>	motor vehicle traffic accident due to loss of control, without collision on the highway
<b>E817.6</b>	non-collision motor vehicle traffic accident while boarding or alighting pedal cycle
<b>E818.6</b>	other non-collision motor vehicle traffic accident
<b>E819.6</b>	motor vehicle traffic accident of unspecified nature

**Sports/Recreation-related Traumatic Brain Injuries among Ohio's Youth**

Ohio Violence and Injury Prevention Program, Ohio Department of Health

<b>Recreation, no mention of wheels</b>	
<b>E849.4</b>	occurred in place for recreation and sport <i>(not an actual injury, merely where injury occurred)</i>
<b>E883.0</b>	accident from diving or jumping into water [swimming pool]
<b>E884.0</b>	fall from playground equipment
<b>E885.3</b>	fall from skis
<b>E885.4</b>	fall from snowboard
<b>E902.2</b>	due to diving
<b>E910.0</b>	drowning/submersion, while water-skiing
<b>E910.1</b>	drowning/submersion, while engaged in other sport or recreational activity with diving equipment
<b>E910.2</b>	drowning/submersion, while engaged in other sport or recreational activity without diving equipment
<b>E922.2</b>	accident caused by hunting rifle
<b>E922.4</b>	accident caused by air gun
<b>E922.5</b>	accident caused by paintball gun
<b>E987.2</b>	undetermined fall from a Natural site
<b>Sports, no mention of wheels</b>	
<b>E886.0</b>	fall on same level from collision, pushing, or shoving, by or with other person (in sports)
<b>E917.0</b>	striking against etc, in sports without subsequent fall
<b>E917.5</b>	striking against etc, object in sports with subsequent fall
<b>Wheeled recreation</b>	
<b>E885.0</b>	fall from non-motorized scooter
<b>E885.1</b>	fall from roller skates
<b>E885.2</b>	fall from skateboard

*Sports/Recreation-related Traumatic Brain Injuries among Ohio's Youth*

Ohio Violence and Injury Prevention Program, Ohio Department of Health

<b>APPENDIX 5: ED visits for sport/recreation-related TBIs, by 'how injured' category and specific-injury involved, year, Ohio, 2002-09</b>				
<b>Non-traffic pedal cycle</b>				
<b>Specific injury</b>	<b>Frequency</b>	<b>Percent</b>	<b>Cumulative Frequency</b>	<b>Cumulative Percent</b>
E821.6 accidents involving other road vehicles being used in recreational or sporting activities	15	0.2	15	0.2
E822.6 other motor vehicle non-traffic accident involving collision with moving object	7	0.1	22	0.3
E823.6 other motor vehicle non-traffic accident involving collision with stationary object	1	<0.1	23	0.3
E824.6 other motor vehicle non-traffic accident while boarding and alighting	1	<0.1	24	0.3
E825.6 accidents involving motor vehicles being used in recreational or sporting activities off the highway collision and non-collision motor vehicle accidents occurring entirely off the highway	4	0.1	28	0.4
E826.1 accidents involving other road vehicles being used in recreational or sporting activities	6,992	99.6	7,020	100.0
<b>Traffic-related pedal cycle</b>				
<b>Specific injury</b>	<b>Frequency</b>	<b>Percent</b>	<b>Cumulative Frequency</b>	<b>Cumulative Percent</b>
E812.6 collision with another motor vehicle parked, stopped, stalled, disabled, or abandoned on the highway and motor vehicle collision not otherwise specified	38	6.3	38	6.3
E813.6 motor vehicle traffic accident involving collision with pedal cycle	351	58.6	389	64.9
E814.6 traffic accident involving collision with pedestrian and pedal cycle	165	27.6	554	92.5
E815.6 collision (due to loss of control) (on highway) between motor vehicle, any kind, and pedal cycle	6	1.0	560	93.5
E816.6 motor vehicle traffic accident due to loss of control, without collision on the highway	4	0.7	564	94.2
E818.6 other non-collision motor vehicle traffic accident	2	0.3	566	94.5
E819.6 motor vehicle traffic accident of unspecified nature	33	5.5	599	100.0

*Sports/Recreation-related Traumatic Brain Injuries among Ohio's Youth*

Ohio Violence and Injury Prevention Program, Ohio Department of Health

<b>Recreation, no mention of wheels</b>				
<b>Specific injury</b>	<b>Frequency</b>	<b>Percent</b>	<b>Cumulative Frequency</b>	<b>Cumulative Percent</b>
E883.0 accident from diving or jumping into water [swimming pool]	138	3.3	138	3.3
E884.0 fall from playground equipment	3,212	77.6	3,350	80.9
E885.3 fall from skis	191	4.6	3,541	85.5
E885.4 fall from snowboard	564	13.6	4,105	99.2
E910.0 drowning/submersion, while water-skiing	4	0.1	4,109	99.3
E910.2 drowning/submersion, while engaged in other sport or recreational activity w/o diving equipment	7	0.1	4,116	99.4
E922.4 air gun	20	0.5	4,136	99.9
E922.5 paintball gun	4	0.1	4,140	100.0
<b>Sports, no mention of wheels</b>				
<b>Specific injury</b>	<b>Frequency</b>	<b>Percent</b>	<b>Cumulative Frequency</b>	<b>Cumulative Percent</b>
E886.0 fall on same level from collision, pushing, or shoving, by/with other person (in sports)	1,948	10.9	1,948	10.9
E917.0 striking against etc, in sports without subsequent fall	13,137	73.1	15,085	84.0
E917.5 striking against etc, object in sports with subsequent fall	2,876	16.0	17,961	100.0
<b>Wheeled recreation</b>				
<b>Specific injury</b>	<b>Frequency</b>	<b>Percent</b>	<b>Cumulative Frequency</b>	<b>Cumulative Percent</b>
E885.0 fall from non-motorized scooter	333	18.9	333	18.9
E885.1 fall from roller skates	488	27.7	821	46.5
E885.2 fall from skateboard	943	53.5	1,764	100

*Sports/Recreation-related Traumatic Brain Injuries among Ohio's Youth*

Ohio Violence and Injury Prevention Program, Ohio Department of Health

<b>APPENDIX 6: Hospitalizations for sport/recreation-related TBIs, by 'how injured' category and specific-injury involved, Ohio, 2002-09</b>				
<b>Non-traffic pedal cycle</b>				
<b>Specific injury</b>	<b>Frequency</b>	<b>Percent</b>	<b>Cumulative Frequency</b>	<b>Cumulative Percent</b>
E804.3 railway fall/pedal cycle	1	0.2	1	0.2
E821.6 other off-road/pedal cycle	2	0.5	3	0.7
E822.6 other mv nontraffic collision w/moving pedal cycle	1	0.2	4	0.9
E823.6 other mv nontraffic collision w/stationary pedal cycle	1	0.2	5	1.1
E824.6 other mv nontraffic alighting/pedal cycle	1	0.2	6	1.4
E825.6 other mv nontraf unspecfd/pedal cycle	2	0.5	8	1.8
E826.1 pedal cyclist and non-motorized object	431	98.2	439	100.0
<b>Traffic-related pedal cycle</b>				
<b>Specific injury</b>	<b>Frequency</b>	<b>Percent</b>	<b>Cumulative Frequency</b>	<b>Cumulative Percent</b>
E812.6 parked or stopped motor veh/pedal cycle	8	3.8	8	3.8
E813.6 collision motor veh/pedal cycle	169	79.3	177	83.1
E814.6 collision motor veh/pedestrian/pedal cycle	30	14.1	207	97.2
E815.6 other collision motor veh/pedal cycle	1	0.5	208	97.7
E816.6 collision motor veh/pedal cycle, off hwy	2	0.9	210	98.6
E818.6 other non-collision motor veh/pedal cycle	1	0.5	211	99.1
E819.6 unspecified motor veh/pedal cycle	2	0.9	213	100.0
<b>Recreation, no mention of wheels</b>				
<b>Specific injury</b>	<b>Frequency</b>	<b>Percent</b>	<b>Cumulative Frequency</b>	<b>Cumulative Percent</b>
E883.0 accident from diving or jumping into water [swimming pool]	7	6.1	7	6.1
E884.0 fall from playground equipment	68	59.1	75	65.2
E885.3 fall from skis	4	3.5	79	68.7
E885.4 fall from snowboard	21	18.3	100	87.0
E910.2 drowning/submersion, while engaged in other sport or recreational activity w/o diving equipment	2	1.7	102	88.7
E922.2 hunting rifle	1	0.9	103	89.6
E922.4 air gun	11	9.6	114	99.1
E987.2 undetermined fall from a natural site	1	0.9	115	100.0

*Sports/Recreation-related Traumatic Brain Injuries among Ohio's Youth*

Ohio Violence and Injury Prevention Program, Ohio Department of Health

<b>Sports, no mention of wheels</b>				
<b>specific injury</b>	<b>Frequency</b>	<b>Percent</b>	<b>Cumulative Frequency</b>	<b>Cumulative Percent</b>
E886.0 fall on same level from collision, pushing, or shoving, by/with other person (in sports)	34	9.7	34	9.7
E917.0 striking against etc, in sports without subsequent fall	217	62.0	251	71.7
E917.5 striking against etc, object in sports with subsequent fall	99	28.3	350	100.0
<b>Wheeled recreation</b>				
<b>specific injury</b>	<b>Frequency</b>	<b>Percent</b>	<b>Cumulative Frequency</b>	<b>Cumulative Percent</b>
E885.0 fall from non-motorized scooter	9	12.7	9	12.7
E885.1 fall from roller skates	8	11.2	17	23.9
E885.2 fall from skateboard	54	76.1	71	100.0

<b>APPENDIX 7:</b>	
<b>ICD-10 codes used to define fatal 'sports/recreation' traumatic brain injuries</b>	
<u><b>E-code</b></u>	<u><b>Definition</b></u>
<b>Non-traffic-related Pedal Cycle</b>	
V15.0, V15.1, and V15.2	non-traffic collision between pedal cycle and railway
v12.0, V12.1, V12.2;	non-traffic collision between other pedal cycle and off-road vehicle
V17.0, V17.1, V17.2	non-traffic collision between pedal cycle and stationary pedal cycle
V10.3, V11.3, V12.3, V13.3, V14.3, V15.3, V16.3, 17.3, V19.3	non-traffic collision with other motor vehicle non-traffic alighting pedal cycle
V19.00, V19.10, and V19.20	non-traffic collision with other motor vehicle non-traffic unspecified
V11.0, V11.1, and V11.2	pedal cyclist
V10.0, V10.1, and V10.2; V16.0, V16.1, and V16.2	non-traffic collision between pedal cycle and animal drawn vehicle
<b>Traffic-related pedal Cycle</b>	
V11.4, V11.5, and V11.9 (pedal cycle) V12.4, V12.5, and V12.9 (2 or 3 wheeled veh) V13.4, V13.5, and 13.9 (car) V14.4, V14.4, V14.9 (bus), V15.4-V15.5, and V15.9 (rail) V16.4, V16.5, V16.9 (street car);	traffic related collision between a pedal cycle and motor vehicles, rail, street car, or other pedal cycle.
V17.4, V17.5, V17.9	traffic related collision between pedal cycle and parked or stopped motor vehicle
V19.49, V19.59, V19.69	other traffic related collision between pedal cycle and motor vehicle
V18.4, V18.5	other traffic related non-collision between pedal cycle and motor vehicle
V18.9	unspecified non-collision between pedal cycle and motor vehicle
<b>Recreation, no mention of wheels</b>	
W09.0, W09.1, W09.2, and W09.8	fall from playground equipment
V00.32	fall from skis
V00.31	fall from snowboard
W33.02, W33.12	hunting rifle
W34.010, W34.110	air gun
W34.011, W34.111	paintball gun
W16.111, W16.112, W16.121, W16.122, W16.611, W16.131, W16.132	undetermined fall from a Natural site
W16.711, W16.721, W16.511, W16.521, W16.531, W16.91, W16.611, W16.621, W16.811, W16.821, W16.831	due to diving, includes accident from diving or jumping into swimming pools

**Sports/Recreation-related Traumatic Brain Injuries among Ohio's Youth**

Ohio Violence and Injury Prevention Program, Ohio Department of Health

<b>Sports, no mention of wheels</b>	
Y92.3	place for sport: stadium, field, court
W21.0, W21.1, W21.2, W21.3, W21.4, W21.8, W21.9; Y08.09;	striking against etc, in sports without subsequent fall
W18.01	striking against etc, object in sports with subsequent fall
<b>Wheeled sports</b>	
V00.141, W05.1	fall from non-motorized scooter
V00.121, V00.111	fall from roller skates and inline skates
V00.131	fall from skateboard

<b>APPENDIX 8: Fatal sport/recreation-related TBIs, by 'how injured' category and specific-injury involved, Ohio, 2002-09</b>				
<b>Traffic pedal cycle</b>				
<b>specific injury</b>	<b>Frequency</b>	<b>Percent</b>	<b>Cumulative Frequency</b>	<b>Cumulative Percent</b>
<b>Collision between moving motor vehicle and pedal cyclist</b> V11.4, V11.5, and V11.9 (pedal cycle) V12.4, V12.5, and V12.9 (2 or 3 wheeled veh) V13.4, V13.5, and 13.9 (car) V14.4, V14.4, V14.9 (bus), V15.4-V15.5, and V15.9 (rail) V16.4, V16.5, V16.9 (street car);	9	81.8	9	81.8
<b>Collision between non-moving motor vehicle and pedal cyclist: V17.4, V17.5 and V17.9</b>	1	9.1	10	90.9
<b>Other non-collision between motor vehicle and pedal cyclist: V18.4 and V18.5</b>	1	9.1	11	100.0

<b>APPENDIX 9:</b>			
<b>URBANALITY CLASSIFICATION FOR OHIO COUNTIES</b>			
<b>Metropolitan</b>	<b>Suburban</b>	<b>Rural</b>	<b>Appalachian</b>
ALLEN	AUGLAIZE	ASHLAND	ADAMS
BUTLER	CLARK	ASHTABULA	ATHENS
CUYAHOGA	DELAWARE	CHAMPAIGN	BELMONT
FRANKLIN	FAIRFIELD	CLINTON	BROWN
HAMILTON	FULTON	CRAWFORD	CARROLL
LORAIN	GEAUGA	DARKE	CLERMONT
LUCAS	GREENE	DEFIANCE	COLUMBIANA
MAHONING	LAKE	ERIE	COSHOCTON
MONTGOMERY	LICKING	FAYETTE	GALLIA
RICHLAND	MADISON	HANCOCK	GUERNSEY
STARK	MEDINA	HARDIN	HARRISON
SUMMIT	MIAMI	HENRY	HIGHLAND
	PICKAWAY	HURON	HOCKING
	PORTAGE	KNOX	HOLMES
	TRUMBULL	LOGAN	JACKSON
	UNION	MARION	JEFFERSON
	WOOD	MERCER	LAWRENCE
		MORROW	MEIGS
		OTTAWA	MONROE
		PAULDING	MORGAN
		PREBLE	MUSKINGUM
		PUTNAM	NOBLE
		SANDUSKY	PERRY
		SENECA	PIKE
		SHELBY	ROSS
		VAN WERT	SCIOTO
		WARREN	TUSCARAWAS
		WAYNE	VINTON
		WILLIAMS	WASHINGTON
		WYANDOT	

## **APPENDIX 10: Resources and References:**

### **Centers for Disease Control and Prevention (CDC)**

*Traumatic Brain Injury in the United States: Emergency Department Visits, Hospitalizations and Deaths, 2002-06.* US Department of Health and Human Services, Centers for Disease Control and Prevention. [www.cdc.gov/traumaticbraininjury](http://www.cdc.gov/traumaticbraininjury)

Heads-Up Concussion in Youth Sports Campaign and Training Materials  
<http://www.cdc.gov/concussion/headsup/index.html>

### **Ohio Violence and Injury Prevention Program**

Sports/Recreation-related Traumatic Brain Injury Prevention  
<http://www.healthyohioprogram.org/vipp/child/tbi.aspx>