

Epidemiology of exercise-related injuries among children

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ABSTRACT

The objective of this study was to describe the epidemiology of injuries from exercise not involving equipment among children 18 and under. Methods included a retrospective review of data for children birth to 18 years old from the National Electronic Injury Surveillance (NEISS) system of the US consumer Product Safety Commission for the years 2005-2009. A total of 5093 cases were identified and would result in an estimated 175,000 injuries in the US. The most common type of injury was a sprain/strain to the ankle (20%). Four out of five injuries were among children between 10 and 18. Injuries occurring at school accounted for 40% of the injuries. Exercise-related injuries are common among older children and often occur in schools or recreational environments but are usually minor. School officials and athletic personnel should make efforts to provide proper instruction on exercise activities and have resources to provide emergency care for injuries.

Keywords: Exercise; Children; Adolescents; Running

1. INTRODUCTION

It is common knowledge that exercise is beneficial and should be required for children for the promotion of health and development. As children grow, exercise becomes more important and can develop into specific activities involving individual or team sports. Exercise at a young age can create a positive habit that can transfer into adulthood. Exercise can take the form of several activities, thereby providing a buffer from disease development and promotion of a higher quality of life. The focus of this study will be on exercise that does not involve equipment. Examples include running or jogging, stretching, calisthenics; physical activities included as a

part of school activities, and other general exercise not requiring the use of equipment.

A negative consequence of any activity is the risk for injury and eventual disability. Previous research has noted the epidemiology of running injuries to pediatric populations [1,2] as well as various sports-related injuries [3-6]. Studies have also investigated injury occurrence related to exercise equipment [7-10] and playground equipment [11]. However, population-based studies on exercise-related injury among children in general are scant and those that have been conducted usually consider the use or involvement of exercise equipment. Injuries related to exercise among children without the use of equipment is the focus of this study.

The purpose of this brief report was to investigate and describe the epidemiology of exercise-related injuries that did not involve the use of equipment that required emergency department treatment to children birth to 18 years of age in the United States from 2005 through 2009. Results could aid in identifying the potential environmental hazards of exercise-related injuries to children and suggest appropriate measures to prevent and treat such injuries.

2. METHODS AND MATERIALS

Data were obtained from an emergency department (ED) sample of all children birth to 18 years of age reporting injuries from January 1, 2005 through December 31, 2009 for product code 3299 (non-equipment exercise). Injuries were initially treated at a hospital (ED that was participating in the National Electronic Injury Surveillance System (NEISS) from 2005 through 2009.

Information extracted by NEISS includes the product or products related to the injury; descriptions of the injury, which includes primary diagnosis, causes of injuries and type of exercise involved, anatomical location, the severity of the injury, descriptions of the ED visit, disposition; including hospitalization. General demographic characteristics of the injured person, and a brief comment/narrative of the injury incident were also reviewed.

The location of the injury was also analyzed. The locations listed in the NEISS database include home, ranch, street or highway, other public property, mobile home, industrial place, school, place of recreation or sports, or not recorded. The narratives for all records reported for this study were reviewed and two additional variables were created to indicate the possible contributor of the injury and the type of exercise equipment involved. These variables were not extracted from the NEISS database but developed by the researcher from the narrative of the NEISS database. Information on fatalities was obtained from the NEISS death certificate database for the same period.

Anatomical location of injury was categorized into seven different body regions: the head, upper trunk, lower trunk, hand, foot, arm, and leg. The head region consisted of the head, eyes, ears, forehead, face, mouth, and neck. The upper trunk consisted of the shoulder and upper trunk. The lower trunk consisted of the lower trunk and pubic region. The hand included the wrist and fingers. The foot included the ankle and toes. The arms included the upper and lower arms. The legs consisted of the upper and lower legs and the knees.

The injury diagnosis was also categorized into groups for this study except for amputations, which were not categorized due to the seriousness of the diagnosis. Soft tissue injuries included the NEISS categories of contusions, abrasions, hematomas, and strains or sprains. Lacerations included lacerations, punctures, and avulsions. Fractures, dislocations, and crushing injuries were combined for analysis. Concussions and internal organ injury were combined due to the serious nature of those injuries. The "other injury" category included, dental injuries, foreign bodies, nerve damage, burns, dermatitis or conjunctivitis, and other injuries.

From a sample of 100 records of the comment/narrative section of the NEISS, we obtained information concerning possible contributors towards injury and the specific types of exercise involved in the injury. From the data it was not possible to determine if the injury was from overuse or overtraining. Information on intentionality and adult supervision were also not available from every report and were therefore not categorized for analysis.

NEISS receives and collects data reports from a probability sample of hospital emergency departments in the United States and uses the information to estimate national patterns of product-related injuries [12,13] Some of the emergency departments are located in children's hospitals. Each emergency department participating in NEISS carries a statistical weight that determines how it represents all US emergency departments. We used the NEISS data and weightings to calculate injury estimates. Calculation of a 95% confidence interval (CI) for the

estimated number of injuries was based on the generalized estimated sampling error for NEISS data provided by the CPSC [12]. Sampling errors for estimates below 1200 injuries were not calculated. US Census estimates for 1994-2001 were used to calculate injury incidence rates [13]. To account for the change in the NEISS sampling frame in 1999, the weights were adjusted by computed ratio adjustments developed by the CPSC [14].

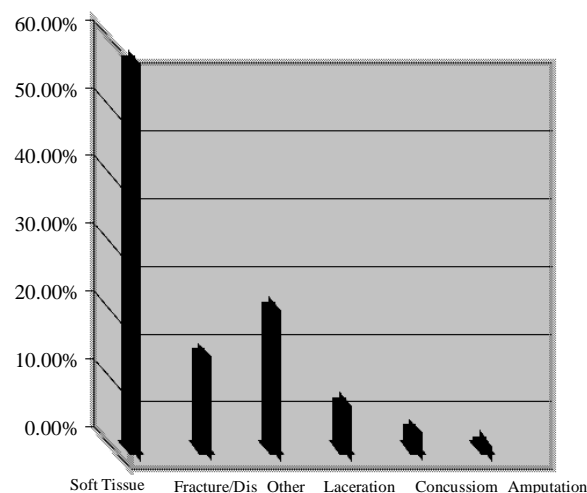
3. RESULTS AND DISCUSSION

A total of 5093 cases of exercise-related injuries not involving equipment were identified for the years 2005 through 2009 among children birth to 18 years of age. The estimated weighted total of injuries in the US was calculated at 173,544. The majority of injuries reported occurred to males (53%), children ages 9 - 18 (90.5%), and white (51.4%). The three most common types of injury diagnosis were soft tissue (57%), fractures and dislocations (14%), and lacerations (6%) (**Table 1**).

The most common body parts involved in the injury were ankle (22%), knee (13%), and head and neck region (10.5%) (**Table 2**). The most common type of injury was a sprain or strain to the ankle (20%). Most injuries were

Table 1. Estimated injuries related to exercise.

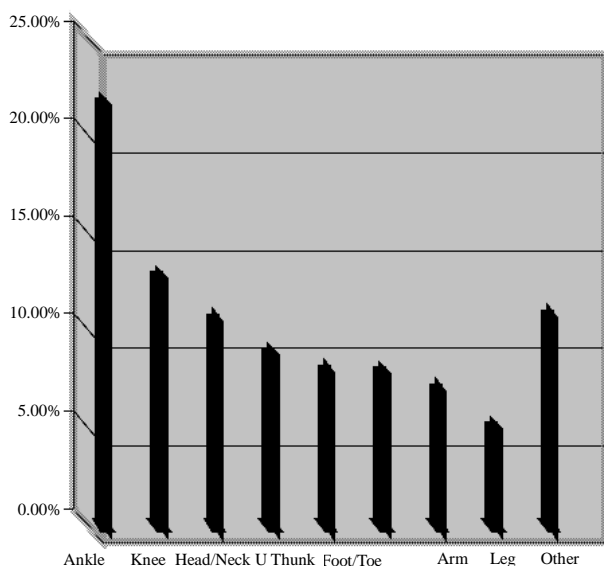
| | N | % |
|----------------------------------|-------|--------|
| Soft tissue* | 98688 | 56.9% |
| Fracture/dislocation/crushing | 23837 | 13.7% |
| Lacerations/avulsion/puncture | 11150 | 6.4% |
| Other† | 35522 | 20.5% |
| Concussion/Internal organ injury | 4342 | 2.5% |
| Amputation | 5 | >0.01% |



*Soft tissue includes contusion, abrasions, strains, and sprains; †Other includes dental injuries, foreign body, nerve damage, burns, dermatitis or conjunctivitis, other injury and not stated.

Table 2. Body part involved in injury.

| | N | % |
|---------------------------------------|-------|--------|
| Ankle | 37819 | 21.6% |
| Knee | 22253 | 12.7% |
| Head/neck region | 18162 | 10.5% |
| Upper trunk/shoulder | 15219 | 8.8% |
| Foot/toe | 13874 | 8% |
| Lower trunk/pubic region | 13693 | 7.9% |
| Hand/wrist/finger | 13502 | 7.8% |
| Arm/elbow | 11898 | 6.9% |
| Leg region (excluding ankle and knee) | 8505 | 5% |
| Internal | 31 | <0.01% |
| Other/not stated | 18588 | 10.7% |



minor (99%) and didn't require hospitalization. The location of injury was most common at the school (32%) and recreational (19%) settings. The home was the location for 15% of the injuries.

The type of exercise that was most common during the injury was running/jogging (59%) and 10% of injuries were from general exercising or stretching. The remaining injuries were due to other factors or not recorded.

4. CONCLUSIONS

Findings indicated that injuries occurring to children during exercise are usually minor and do not require hospitalization. Children most at risk are those involved with exercise activities in the upper grade levels of elementary school and high school. There was minimal data to suggest if the injuries were related to sports or phys-

cal education programs in the schools. Another important consideration that could not be determined was injury due to overtraining or overuse. Research has found this to be an important factor in exercise-related injury [15]. Other limitations of this study were the lack of specific information on cause and contributing factors. Additionally, there was no data to note the difference between unintentional or intentional injuries.

The injuries noted in this study provide indication that the school and recreational locations are the areas for most concern. The results do provide support that schools need to have staff trained in dealing with exercise injuries as well as resources for the care and treatment of injuries. Having trained staff on duty may also limit the number of children referred to ED's for minor injuries, thereby lessening associated health care costs. Furthermore, exercise-related injuries occurring to children at young ages need to be treated appropriately to prevent further damage and disability. The result of not taking appropriate care and treatment of injuries could lead to more serious injuries in later years as well as limiting the activity of the individual. Even though most exercise-related injuries to children are minor, the lack of proper care could impact the exercise behavior of individuals in adulthood and possibly lead to an increase for negative lifestyle behaviors and diseases such as obesity.

REFERENCES

- [1] Mehl, A.J., Nelson, N.G. and McKenzie, L.B. (2011) Running-related injuries in school-age children and adolescents treated in emergency departments from 1994 through 2007. *Clinical Pediatrics*, **50**, 126-132. doi:10.1177/0009922810384719
- [2] Seto, C.K., Statuta, S.M. and Solari, I.L. (2010) Pediatric running injuries. *Clinics in Sports Medicine*, **29**, 499-511. doi:10.1016/j.csm.2010.03.005
- [3] Singh, S., Smith, G.A., Fields, S.K. and McKenzie, L.B. (2008) Gymnastics-related injuries to children treated in emergency departments in the United States, 1990-2005. *Pediatrics*, **121**, e954-e60. doi:10.1542/peds.2007-0767
- [4] Shields, B.J. and Smith, G.A. (2006) Cheerleading-related injuries to children 5 to 18 years of age: United States, 1990-2002. *Pediatrics*, **117**, 122-129. doi:10.1542/peds.2005-1139
- [5] Lawson, B.R., Comstock, R.D. and Smith, G.A. (2009) Baseball-related injuries to children treated in hospital emergency departments in the United States, 1994-2006. *Pediatrics*, **123**, e1028-e1034. doi:10.1542/peds.2007-3796
- [6] Day, C., Stolz, U., Mehan, T.J., Smith, G.A. and McKenzie, L.B. (2008) Diving-related injuries in children <20 years old treated in emergency departments in the United States: 1990-2006. *Pediatrics*, **122**, e388-e394. doi:10.1542/peds.2008-0024
- [7] Jones, C.S., Freeman, J. and Penhollow, T.M. (2006)

- Epidemiology of exercise equipment-related injuries to young children. *Pediatric Emergency Care*, **22**, 160-163. [doi:10.1097/01.pec.0000202451.96365.7e](https://doi.org/10.1097/01.pec.0000202451.96365.7e)
- [8] Jones, C. (2004) Epidemiology of weight-training equipment-related injuries to young children. *Journal of Children's Health*, **2**, 125-131.
- [9] Martinez, A., Snyder, A.J. and Smith, G.A. (2011) Home exercise equipment-related injuries among children in the United States. *Clinical Pediatrics*, **50**, 553-558. [doi:10.1177/0009922810396547](https://doi.org/10.1177/0009922810396547)
- [10] Juang, D., Fike, F.B., Laituri, C.A., Mortellaro, V.E. and St. Peter, S.D. (2011) Treadmill injuries in the pediatric population. *Journal of Surgical Research*, **165**, 340. [doi:10.1016/j.jss.2010.11.128](https://doi.org/10.1016/j.jss.2010.11.128)
- [11] Vollman, D., Witsaman, R., Comstock, R.D. and Smith, G.A. (2008) Epidemiology of playground equipment-related injuries to children in the United States, 1996-2005. *Clinical Pediatrics*, **48**, 66-71. [doi:10.1177/0009922808321898](https://doi.org/10.1177/0009922808321898)
- [12] US Consumer Product Safety Commission (1998) National Electronic Injury Surveillance System estimated generalized relative sampling errors. US Consumer Product Safety Commission, Washington DC.
- [13] US Consumer Product Safety Commission (2001) The National Electronic Injury Surveillance System (NEISS) sample (design and implementation) 1997-Present. US Consumer Product Safety Commission, Washington DC.
- [14] US Consumer Product Safety Commission (2003) Consumer product safety review. US Consumer Product Safety Commission, Washington DC.
- [15] Winsley, R. and Matos, N. (2011) Overtraining and elite young athletes. *Medicine and Sport Science*, **56**, 97-105. [doi:10.1159/000320636](https://doi.org/10.1159/000320636)