

REVIEW ARTICLE**Epidemiology of Concussions among Pediatric Cheerleaders in the United States, 2009-2018****Authors**

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Abstract

Cheerleading is a popular activity in the United States with an estimated 4 million participants from Elementary school age to College. While cheerleading can be a safe activity, it can also result in injury ranging from minor sprains to serious neurological conditions and even death. One severe outcome of cheerleading is concussions. The purpose of this study is to review epidemiological data related to the descriptive factors and mechanisms of concussion as a result of cheerleading. Data was obtained from the Consumer Product Safety Commissions National Electronic Surveillance System for the years 2008 through 2019. The narrative portion of the data was used to identify mechanism of the concussion. Concussion injuries related to cheerleading activity has increased every year from 2009-2017. The majority of concussion (83%) occurred between the ages of 12 and 17 with 98% occurring to females. The mechanism most cited from the narrative for concussions were falls (52.2%) followed by having another cheerleader fall on the injured cheerleader (13.6%). Other common mechanisms included head to head collision, hit by elbow to the head and hit by knee to the head. More interesting findings identified the cheerleaders were in a 'pyramid' or 'formation' preceding the concussion. The conclusions identifies potential prevention strategies to address and reduce concussions among cheerleaders including reducing the height of cheerleading activities, providing protective equipment to the elbows and potential elimination of dangerous routines.

Introduction

Cheerleading is a popular activity among young adults. A recent report from the New York Post noted that the activity has over 4 million participants from elementary school level through College.¹ It was noted that U.S. participation rate rose to 11.7% in 2016 and is expected to increase more in the coming years. Cheerleading could also debut as an Olympic Sport in the future and is often headlined on major sports television networks for Cheerleading competitions. However, Cheerleading has also been highlighted as an activity that can result in injuries from minor scrapes and bruises to fractures and concussions.²⁻⁴ The use of stunts, formations and pyramids is common in cheerleading. Due to the nature of the formations, it can result in cheerleaders falling and if the activity or stunt is not done correctly could result in landing on the head or back and increasing injury or concussion risk. Several studies have highlighted the potential for serious neurological injuries and injuries to the neck and spine.⁵⁻⁹ from cheerleading activity. The literature has documented that concussion risk is a concerning and continuing health risk for cheerleaders.⁹ The purpose of this brief report is to describe concussion injuries and mechanisms for injuries from cheerleading related activity reported from Emergency Rooms in the United States for the years 2009-2018.

Methods

Data with a product code of 3254 (cheerleading-activity, apparel or equipment) was obtained from the National Electronic Surveillance System (NEISS) for years 2009-

2018.¹⁰ Injuries were initially treated at a hospital emergency department (ED) that was participating in the NEISS. 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 activity involved, anatomical location, descriptions of the ED visit, disposition; including hospitalization. For this study data was limited to the diagnosis code 52 for concussions. 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 three additional variables were created to indicate the mechanism of injury, multiple concussions occurring during the same workout or performance session and the identification of a pyramid formation. These three variables were not extracted from the NEISS database but developed by the researchers from the narrative of the NEISS database. The categories developed for the mechanism variable included falling, head hit by elbow, head hit by knee, kicked, head to head, other cheerleader falling on participant, or unknown.

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 injuries¹⁰⁻¹² 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

Results

The total number of concussions reported for the years 2009-2018 related to cheerleading activity was 793. The weighted estimated total number of concussions related to cheerleading activity during the study period in the United States was calculated at 21,924 (95% CI 16,370, 27,477). Further, results from the analysis indicate that concussions have been increasing in the emergency rooms from 2009-2017 with a

slight decrease noted for 2018 (Table 1). Age wise almost 83% of the concussions occurred between the ages of 12 through 17. Almost 8% were ages 18 and older and 8.6% being under the age of 12. Most of the concussions were among female cheerleaders (98%) and 51% of the cheerleaders were white with 32% having race listed as unknown and 10% identified as African American. The location of the injury mostly occurred at a place of recreation or school with 87.4% of the cases. As noted in Table 2, the most common injury mechanism for the concussion was due to a fall at 52.2% followed by another 13.6% due to another cheerleader falling on the concussed cheerleader. Additional mechanisms included the cheerleader being kicked at 11.4% and sustaining a concussion from being hit by an elbow or knee at 6.7%. Head to head concussions were identified as the mechanism among 4.4% of the cases. Finally, it was reported that the pyramid cheerleader formation was identified in over 5% of the incidents and there were multi-concussions identified in 2.3% of the cases.

Table 1

Total Number of Case by Year of Injury

2009—35
2010—55
2011—68
2012—78
2013—98
2014—98
2015—83
2016—99
2017—105
2018—70

Table 2

Mechanism of Injury	
Falls	52.2%
Another Cheerleader Falling on Participant	13.6%
Head to Head Collision	5.9%
Hit by Elbow	4.4%
Hit by Knee	2.3%
Kicked in Head	11.4%
Unknown	7.7%
Struck By Object (basketball, metal pipe, etc.)	2.2%

Discussion

The results confirm the concussion dangers related to cheerleading activity. Most injuries occurred to girls between the ages of 12-17 but there were also concussions occurring to girls as young as 3. As reported in previous literature²⁻⁴ falls were the cause of a majority of the concussions at 52%. The reasons for the falls vary with some participants falling from a tumbling routine, to falling from a stunt or cheerleader formation. The use of formations and pyramids could be a potential risk factor for concussions that warrants further study. It is possible that many more of the concussions were as a result of activities where cheerleaders were performing stunts with multiple individuals involved.

Another interesting finding is the number of concussions due to being hit by elbows or knees. Although only accounting for less than 10% it could be possible to decrease these concussions if protective knee or elbow padding was worn. The number of head to head collision is alarming as it contributed to 6% of the concussions and would impact more than one participant. It is unknown if the head to head concussions occurred during competition, regular performance or practice

but it could be recommended to wear protective head gear when practicing or performing high risk activities.

Making comparisons of the results of this study with previous related studies can be a challenge. This study concentrated on concussion injuries related to cheerleading activity whereas related studies considered all injuries. Secondly, previous studies may have considered other sports besides cheerleading that resulted in a concussion. Finally, previous studies focused on concussions that resulted in mortality and not morbidity. But a study by Currie et al³ noted that over half of all injuries to cheerleaders occurred during stunts (53.2%) and the most common cause of injury was due to concussion (31%). This presents indicates that concussions can be a result when performing stunts during cheerleading activity. In another study by Naiyer, Chounthirath, and Smith² found that the rate of concussions related to pediatric cheerleading-related activity increased by over 290% from 2001 to 2012 in the United States. This is in line with the rise in concussion injuries presented in our study. Finally, in a study by Jacobsen, Morawa and Bir¹³ found that the most common

mechanisms of injury from cheerleading were a collision between two or more cheerleaders (29.3%), stunting (19.8%), tumbling (11.3%), and tossing (2.5% overall). These were mechanisms for all injuries and not specific for concussions.

Conclusions

Based on the results of the study, cheerleading is a high-risk activity for injury, especially concussions. The use of formations and pyramids increases the concussion risk, especially when there is no

protective equipment used for the head or body. Recommendations would include the use of protective equipment for the knees, elbows and head at least during practice sessions along with the use of mats and soft landing surfaces. But a concussion could still occur with landing head or neck first on a soft-surface landing mat. To decrease the occurrence of concussions, the use of formations and pyramids that require cheerleaders to stand on each other's shoulders should be discouraged, especially among younger children 5-11 years of age.¹⁴

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