

Kickball and Its Underappreciated Pediatric Injury Burden

An 18-Year Retrospective Epidemiological Study

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Background: Kickball is a popular childhood game most frequently played during gym class or recess at schools throughout the United States (US). Despite this, the national health burden of injuries associated with kickball has never been explored in the US pediatric population.

Purpose: To report national estimates and demographic characteristics of pediatric patients presenting to US emergency departments between 2000 and 2017 with kickball-associated injuries.

Study Design: Descriptive epidemiology study.

Methods: This study retrospectively analyzed the National Electronic Injury Surveillance System (NEISS) database (2000-2017) to identify annual cases of injuries associated with playing kickball presenting to US emergency departments in the pediatric population (age ≤ 18 years).

Results: On average, 10,644 (95% CI, 8671-12,618) pediatric kickball-associated injuries presented to US emergency departments each year. There was no significant change in the number of injuries between the years 2000 ($n = 10,331$; 95% CI, 7781-12,881) and 2017 ($n = 9407$; 95% CI, 7233-11,582) ($P = .64$). Patients frequently sustained sprains, strains, or muscle tears (34.4%; 95% CI, 32.4%-36.5%) and fractures (24.8%; 95% CI, 23.1%-26.5%); these injuries most commonly affected the ankle (13.7%; 95% CI, 12.2%-15.2%) and the fingers of the hand (17.1%; 95% CI, 15.5%-18.7%). The greatest proportion of injuries occurred in male patients (60.7%; 95% CI, 58.7%-62.7%) who were 10 to 12 years of age (44.8%; 95% CI, 43.0%-46.6%), with over half of kickball-associated injuries occurring at school (54.1%; 95% CI, 50.7%-57.5%).

Conclusion: Despite kickball's ubiquity as a schoolyard game, its associated injuries remain largely underappreciated. This is particularly unjustified when considering that the annual pediatric injury burden associated with playing kickball surpasses that of other sports acknowledged as carrying a high injury risk, such as martial arts or tennis.

Keywords: kickball; school; epidemiology; NEISS; emergency department; pediatrics

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The benefits of physical activity in children and adolescents suggest that both recess and gym class may serve as potential conduits for healthful behavior in the pediatric population.¹⁶ In these settings, students may participate in both structured and unstructured activities ranging from organized sports to more individualized exercises.^{11,12} One ubiquitously favored activity is kickball. A simple schoolyard game, it is directly analogous to baseball, except that batters are replaced with kickers and a larger but bouncable rubber ball is kicked toward an outfield, where it is attempted to be caught by catchers.²¹ Although this game is still most popular in the United States (US), where it was first invented, it has since gained substantial international popularity; in both England and the Republic of Korea, for example, kickball is often first introduced in preschool and elementary school physical education classes, just as it is in the US.^{1,8,9}

Despite its widespread popularity, the national health burden of injuries associated with kickball has never been explored in the US pediatric population, by whom the game is most often played. In fact, only 1 report of an adult injury sustained while playing kickball has been published in recent years.¹⁵ This is particularly concerning, given the similarities between kickball and other sports with imposing injury burdens; pediatric injury risks from participation in baseball, dodgeball, and handball have all been well characterized and determined to be substantial, but kickball blends elements of all of these games without garnering the same attention.^{2,13,14,20} The obscure nature of kickball-associated injuries leaves much ambiguity with respect to the risks that it may impart on youth participants.

This study is, to the best of our knowledge, the first to evaluate the burden of kickball-associated injuries in the US pediatric population. The purpose of this analysis was to report weighted national estimates of pediatric injuries associated with playing kickball that presented to US emergency departments between 2000 and 2017. Furthermore, the demographic characteristics of this population were examined to identify those most at risk for sustaining kickball-associated injuries. We hypothesized that a significant majority of kickball-associated injuries would occur at school, given the sport's frequent choice as a gym class or recess activity, and secondarily, that the foot and ankle would be most commonly injured, given the objective of the game.

METHODS

Data Collection

A retrospective cross-sectional analysis was performed using registry data from the National Electronic Injury Surveillance System (NEISS) database of the US Consumer Product Safety Commission (CPSC) between 2000 and 2017. The data that we used were publicly available and deidentified, which exempted this study from institutional review board approval.

The US CPSC operates the NEISS database to oversee and capture product- or activity-related injuries presenting to hospital emergency departments in the US. The database is publicly available and published annually. Moreover, it is a nationally representative probability sample of about 100 designated hospital emergency departments stratified by both hospital size and geographic location, from which weighted national estimates and sampling errors for queried injuries may be derived. Specific data collection methodologies, quality control precautions, and other general information are available on the CPSC webpage (www.cpsc.gov/Research-Statistics/NEISS-Injury-Data).^{3,4,17}

Variables

Variables contained in the NEISS database include the date of treatment; the case record number; the age, sex, and

race/ethnicity of the patient; the injury diagnosis; the body part affected by the injury; disposition (treated and released, admitted, etc); the product involved (if any) in the injury; the location where the injury occurred; whether fire or motor vehicles were involved in the injury; whether the injury was work related; whether the injury was intentionally inflicted; and a short narrative of the incident and scenario leading to the injury.

Selection Criteria

In this study, each yearly sample in the NEISS database was queried between 2000 and 2017 for injuries associated with ball sports (product codes 3235: "OTHER BALL SPORTS (ACTIVITY, APPAREL OR EQUIPMENT)" and 3236: "BALL SPORTS (ACTIVITY, APPAREL OR EQUIPMENT), N.S."). This excluded sports with their own unique product codes such as baseball, football, or basketball from our analyses.³

A total of 27,940 unique cases were identified in the NEISS database during this period, which amounted to 958,930 weighted national estimates of injuries associated with otherwise unspecified ball sports. All weighted national estimates were calculated by using the *svyset* function in Stata/IC 15.1 statistical software (Stata-Corp).¹⁸ This *svyset* function uses the "PSU," "Weight," and "Stratum" columns intrinsically provided by the NEISS database as variable inputs for its primary sampling unit, sample weight, and strata fields, respectively, to output weighted national estimates for given queries, which can be summed across years for annualized results. Then, the narrative section of the database was individually analyzed to identify injuries specifically associated with playing kickball; 7525 such cases were observed in the database, yielding 248,350 national cases in this time period. Last, patients aged ≥ 19 years were excluded from the analysis, leaving a total of 6195 pediatric (aged 0-18 years) cases of kickball-associated injuries occurring between 2000 and 2017 in the database and an estimated 191,598 national kickball-associated injuries presenting to US emergency departments in the pediatric population during our study period.

Standard errors and 95% CIs were also derived using the *svyset* function in Stata/IC 15.1.¹⁸ The significance of trends in the total national estimates was determined using adjusted Wald tests. *P* values $< .05$ (2-sided) were considered significant.

RESULTS

The mean number of pediatric kickball-associated injuries presenting to US emergency departments per year was 10,644 (95% CI, 8671-12,618). The annual estimated national number of such injuries between 2000 and 2017 is demonstrated in Table 1. There was no significant change in the number of injuries between 2000 ($n = 10,331$; 95% CI, 7781-12,881) and 2017 ($n = 9407$; 95% CI, 7233-11,582) ($P = .64$). Therefore, no specific trend could be declared.

TABLE 1
Weighted National Estimates of Pediatric Kickball-Associated Injuries Presenting to US Emergency Departments, 2000–2017

Year	Cases in Survey Sample ^a	National Estimated Cases	SE	95% CI
2017	338	9407	1095	7233-11,582
2016	359	9972	1039	7909-12,035
2015	330	12,036	1320	9413-14,659
2014	336	10,624	1043	8553-12,695
2013	383	11,980	1101	9793-14,168
2012	425	13,420	1200	11,036-15,804
2011	377	11,482	929	9637-13,326
2010	403	11,492	993	9519-13,465
2009	336	9761	713	8344-11,177
2008	314	9828	929	7982-11,673
2007	348	10,150	1040	8085-12,215
2006	342	10,968	1040	8903-13,034
2005	289	8125	627	6880-9370
2004	333	9717	916	7897-11,537
2003	336	11,090	945	9213-12,968
2002	314	10,451	832	8799-12,103
2001	308	10,764	839	9099-12,430
2000	324	10,331	1284	7781-12,881
Annual average (2000-2017)	344	10,644	993	8671-12,618

^aGiven that raw survey sample cases have unique statistical weights, the National Electronic Injury Surveillance System (NEISS) explicitly states that these raw numbers should never be used for comparative purposes. Therefore, these are provided for reference purposes only and cannot be scaled to national estimates without first accounting for individual case strata, primary sampling units, and adjusted weights (ie, an individual case entry in a survey sample does not necessarily have the same weight, even for an identical activity, product, and year).^{3,4,17}

The types of injuries sustained and anatomic regions most commonly affected are described in Table 2. Over one-third of kickball-associated injuries presenting to emergency departments in the US were sprains, strains, or muscle tears (34.4%; 95% CI, 32.4%-36.5%), although nearly another quarter of patients sustained fractures (24.8%; 95% CI, 23.1%-26.5%). Contusions or abrasions (18.3%; 95% CI, 16.5%-20.1%) also presented frequently. The ankle (13.7%; 95% CI, 12.2%-15.2%) and fingers of the hand (17.1%; 95% CI, 15.5%-18.7%) were the body parts most often sustaining an injury. Table 3 combines the injury type and affected anatomic region to rank the top 10 most frequent kickball-associated injuries in our study population; these results similarly show that the ankle and fingers were most commonly affected.

Last, the demographic characteristics of pediatric patients sustaining kickball-associated injuries and presenting to US emergency departments are shown in Table 4. The bulk of injuries occurred in male patients (60.7%; 95% CI, 58.7%-62.7%) during the spring (38.6%; 95% CI, 36.5%-40.6%) and fall (26.5%; 95% CI, 24.7%-28.4%) seasons. The age distribution with the greatest proportion of injuries included patients aged

TABLE 2
Injury Diagnoses and Affected Regions for Overall Population of Pediatric Patients With Kickball-Associated Injuries Presenting to US Emergency Departments

Injury Variable	Percentage	SE	95% CI
Diagnosis			
Strain or sprain (including tear)	34.4	1.0	32.4-36.5
Fracture	24.8	0.9	23.1-26.5
Contusion (abrasion)	18.3	0.9	16.5-20.1
Laceration	5.5	0.4	4.6-6.4
Internal injury	4.1	0.5	3.1-5.1
Pain	3.4	0.5	2.5-4.4
Concussion	2.4	0.4	1.5-3.3
Dislocation	1.4	0.2	1.0-1.9
Other	5.6	0.8	4.1-7.2
Body part sustaining injury			
Ankle	13.7	0.8	12.2-15.2
Finger	17.1	0.8	15.5-18.7
Knee	9.9	0.5	8.9-11.0
Wrist	8.5	0.5	7.5-9.4
Head	8.3	0.6	7.0-9.5
Foot	8.3	0.5	7.4-9.3
Lower trunk	4.8	0.3	4.2-5.5
Face	4.1	0.4	3.4-4.8
Lower arm	3.7	0.3	3.0-4.4
Toe	3.7	0.3	3.1-4.4
Lower leg	3.2	0.3	2.6-3.8
Elbow	2.7	0.3	2.2-3.2
Hand	2.4	0.3	1.9-3.0
Shoulder	2.3	0.3	1.8-2.9
Upper trunk	2.0	0.3	1.4-2.6
Upper leg	1.6	0.2	1.1-2.1
Mouth	1.0	0.2	0.7-1.3
Neck	0.9	0.2	0.6-1.2
Other	1.6	0.2	1.2-2.1

10 to 12 years (44.8%; 95% CI, 43.0%-46.6%), although nearly one-quarter of patients were between 7 and 9 years of age (23.5%; 95% CI, 21.6%-25.4%), with just slightly fewer in the 13- to 15-year age group (19.1%; 95% CI, 17.7%-20.5%). Regarding patient disposition status, nearly all patients were treated and subsequently released from the hospital (98.4%; 95% CI, 98.1%-98.8%). Patient race was most often reported to be white (49.6%; 95% CI, 42.1%-57.0%) or black (15.5%; 95% CI, 10.8%-20.3%), although roughly one-quarter was not specified (26.6%; 95% CI, 19.8%-33.4%). Over half of kickball-associated injuries occurred at school (54.1%; 95% CI, 50.7%-57.5%), with another 13.9% (95% CI, 10.6%-17.1%) reported to have occurred during participation in sports at unspecified settings.

DISCUSSION

Our study reveals a largely underappreciated and previously undescribed pediatric injury burden associated with the game of kickball. This is despite the fact that for nearly 2 decades, kickball-associated injuries have, on average,

TABLE 3

Top 10 Most Common Combined Kickball-Associated Injury Diagnoses and Affected Regions for Pediatric Patients Presenting to US Emergency Departments

Rank	Combined Injury Diagnosis and Affected Region	Percentage	SE	95% CI
1	Ankle strain or sprain	10.9	0.7	9.4-12.4
2	Finger fracture	8.9	0.6	7.8-10.0
3	Finger strain or sprain	5.3	0.4	4.4-6.1
4	Knee strain or sprain	4.5	0.4	3.7-5.3
5	Internal head injury	4.1	0.5	3.1-5.1
6	Wrist strain or sprain	3.9	0.3	3.3-4.5
7	Wrist fracture	3.4	0.4	2.7-4.2
8	Foot strain or sprain	2.9	0.3	2.3-3.6
9	Lower arm fracture	2.5	0.3	2.0-3.1
10	Concussion (head)	2.4	0.4	1.5-3.3

sent over 10,000 children per year to emergency departments nationwide, with no significant decreases in these estimates over time. Moreover, the types of injuries endured were demonstrated to be moderate to severe in nature: sprains, strains, and fractures constituted more than half of all injuries. The data also supported our primary hypothesis that the majority of injuries occurred in a school setting, in keeping with the notion that kickball has been a generational cornerstone of physical education and recess activities. Similarly, they supported our secondary hypothesis that the ankle would be one of the leading anatomic locations affected. The fact that the fingers of the hand and ankle were commonly injured makes sense: in kickball, the 2 principal points of contact with the ball occur during the kicking phase and catching phase, during which higher relative energies are transferred through these points of contact.

The sheer volume of kickball-associated injuries per year is most striking when compared with the incidence of injuries reported with other activities. For example, Yard et al²² previously found that there are about 9000 pediatric martial arts injuries per year that present to US emergency departments. Thus, even though participation in martial arts may involve combat and is widely recognized as having a substantial injury risk, its estimated burden on pediatric injuries is still about 10% less than that of kickball. Even pediatric injuries sustained while playing tennis, which employs high-velocity ball movements, frequent swinging of a rigid racket, and rapid directional changes that can lead to ankle injuries, have only been estimated to total about 6500 emergency department admissions per year in the US.^{5,6} Evidently, the health burden associated with kickball rivals that of other sports and activities, which already garner significantly more public attention toward and awareness of the injury risk.

Importantly, our results indicate that these injuries mainly affected elementary and middle school students at school. The fact that injury rates were highest in the fall and spring may reflect physical education teachers more

TABLE 4

Demographics for Overall Population of Pediatric Patients With Kickball-Associated Injuries Presenting to US Emergency Departments

Demographic Variable	Percentage	SE	95% CI
Season			
Summer	19.5	0.9	17.6-21.3
Winter	15.4	0.9	13.6-17.2
Fall	26.5	0.9	24.7-28.4
Spring	38.6	1.0	36.5-40.6
Age, y			
0-3 ^a	0.5		
4-6	3.7	0.3	3.0-4.4
7-9	23.5	1.0	21.6-25.4
10-12	44.8	0.9	43.0-46.6
13-15	19.1	0.7	17.7-20.5
16-18	8.4	0.6	7.1-9.6
Sex			
Male	60.7	1.0	58.7-62.7
Female	39.3	1.0	37.3-41.3
Race			
White	49.6	3.8	42.1-57.0
Black	15.5	2.4	10.8-20.3
Other ^a	1.8		
Asian ^a	0.4		
Hispanic	6.0	1.6	2.7-9.2
Not specified	26.6	3.4	19.8-33.4
Disposition			
Treated and released	98.4	0.2	98.1-98.8
Treated and admitted	0.8	0.1	0.6-1.1
Location			
Unknown	20.2	1.6	17.1-23.3
Home	9.4	1.1	7.1-11.6
Street	0.7	0.1	0.4-1.0
Public	1.8	0.4	0.9-2.6
School	54.1	1.7	50.7-57.5
Sports	13.9	1.6	10.6-17.1

^aThe estimate is considered to be potentially unstable because of the number of unweighted cases from the sample frame totaling <20, the weighted national estimate totaling <1200, or coefficient of variation >33%. Therefore, no SEs or 95% CIs are provided; the unstable percentage estimate is provided for reference purposes only. Variable results with sample frame totals <20 cases or percentages <0.1% were omitted from this table, resulting in percentage totals not necessarily summing to 100%.

frequently electing to have their classes play kickball outside when the weather is more temperate. Overall, this health burden is especially troubling because kickball-associated injuries occur in spite of adult supervision and at institutions intended to minimize risks to students. In part, the game of dodgeball faced scrutiny for similar reasons; it was banned in schools across the nation because it involved striking other students with dense rubber balls and could lead to needless harm.^{10,19} In many ways, kickball can be comparably injurious: rubber balls are kicked at even higher velocities than can be thrown, playing outside exposes children to the risk of falling onto hard concrete or hidden stones, and the kicker can be eliminated from play by being struck with the ball as well. Despite these

parallels, kickball has largely avoided scrutiny and remained a playground staple.

Of course, banning any school activity carrying an injury risk is impractical at best; every activity carries with it some intrinsic, unavoidable risk of harm. Instead, steps should be taken to minimize known risks and make activities as safe as possible for participants. In the case of kickball, we propose that physical education teachers consider existing, alternative versions of the game that are fundamentally safer for players. This is best illustrated in the case of “matball,” a more contemporary version of kickball with several rule and equipment changes that still preserve the stylistic integrity and overall objectives of its predecessor but is a markedly safer game overall.⁷ First, it is played indoors rather than outdoors so that large, soft gym mats can serve as bases. Second, a foam ball replaces the traditional and dense rubber ball. This foam substitute cannot be kicked as far or as fast and is much less likely to cause injuries to fielders attempting catches. As a result of these slight but noteworthy changes, matball preserves most aspects of the game while reducing the overall injury risk.

The study has several limitations because of the nature of the NEISS database and its data collection methodologies. For example, kickball does not have a specific product code within the database; the free-text narrative section had to be individually analyzed to identify cases of kickball-associated injuries. However, this depended on the accuracy of the narrative section, which inherently demonstrates reporting bias. Consequently, it cannot be ruled out that for some events, the narrative may have failed to correctly identify kickball as the activity associated with an injury. Even so, a strength of this research is the straightforwardness of the methodology, making it a reliable, reproducible, and verifiable study overall. We therefore believe that because the bias of the database tends to result in underreporting, our findings most likely represent a conservative, best-case scenario of the minimal possible injury burden of kickball-associated injuries.

Additionally, the database lacks several clinically relevant details. For instance, there is no distinction made between open and closed fracture types, whether muscular injuries were simple strains or more complex tears, or the eventual treatment plan. Moreover, although hospital admissions to the emergency department are included in the database, there are no data available on whether surgical interventions were pursued. Coupled with the fact that there are no cost variables included in the database sample, it was not possible to accurately estimate the economic burden of kickball-associated injuries in a given time period. Even the implementation of averaged cost multipliers would have led to erroneous calculations, given the range in both the frequency and severity of diagnoses as well as the variability in the anatomic regions affected. We therefore focused solely on investigating the health burden of kickball-associated injuries in this study.

CONCLUSION

Kickball endures as a childhood pastime in part because its simplicity makes for an inclusive game that students of all different skill sets and abilities can enjoy together. Regardless, the game is associated with a substantial health burden that merits actionable improvements in the way that it is played, especially at elementary and middle schools throughout the US, where the majority of injuries are sustained. Thoughtful changes to the rules and equipment used during games, such as those employed in the version of kickball known as matball, will help make kickball safer for participants. Doing so will ultimately serve the dual purpose of reducing the national injury burden associated with kickball while ensuring that the game remains a viable tradition on the playground in both the US and abroad as this game continues to garner international popularity.

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