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Homemade zipline and playground track ride injuries in children ☆

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ABSTRACT

Background/Purpose: Playground track ride and homemade zipline-related injuries are increasingly common in the emergency department, with serious injuries and even deaths reported.
Methods: Retrospective review of the National Electronic Injury Surveillance System (NEISS) database (2009–2015), followed by review of our academic pediatric trauma center's prospectively-maintained database (2005–2013). We included children ages 0–17 years of age with zipline-related injuries. We recorded annual incidence of zipline-related injury, zipline type (homemade or playground), injuries and mechanism.
Results: In the NEISS database, 9397 (95%CI 6728–12,065) total zipline-related injuries were reported (45.9% homemade, 54.1% playground). Homemade but not playground injuries increased over time. Common injuries were fracture (49.8%), contusion/laceration (21.2%) and head injury (12.7%). Fall was predominant mechanism (83%). Age 5–9 was most frequently affected (59%). Our center database (n = 35, 40% homemade, 1 fatality) revealed characteristics concordant with NEISS data. Head injury was related to fall height > 5 ft and impact with another structure.
Conclusions: Homemade zipline injuries are increasing. Children ages 5–9 are at particular risk and should be carefully supervised. Despite protective surfaces, playground ziplines cause significant head injury, extremity fracture and high rates of hospital admission. Playground surface standards should be reviewed and revised as needed.
Level of evidence: Prognosis Study, Level III.

Outdoor play is a means to foster the physical and social development of our youth; however, injuries are common with 218,000 accidental playground incidents sending children to the emergency department each year [1]. Approximately 50,000 of these occur on home equipment [2] and more than 80% occur when children fall to the ground [3]. Track rides, where the child grabs a handle above her head and propels herself from one platform to another parallel platform, are most commonly seen in playground areas (Fig. 1). Homemade ziplines may be of this same variety, however many products have a seat/bar/stand where riders can support themselves as they glide down a gradient on a pulley between two fixed objects. Ziplines are increasingly popular in both public and private recreational areas; however, with new forms of recreation may come unintended consequences, or increased rates of injury.

One recent study of emergency department visits from 1997 to 2012 indicates that injuries because of ziplining are on the rise [4] in both children and adults, though this study omits playground injuries that represent a significant morbidity in children. While zipline devices clearly pose a safety risk to children, there are limited descriptions of zipline-related injuries in a pediatric population [5]; specific risk factors and potential mitigating factors for zipline injuries are not well characterized.

We hypothesize that public and privately owned zipline-associated injuries are increasing in prevalence and are a source of morbidity in a pediatric population. Our objective is to evaluate trends using a national sample followed by a more granular evaluation of our single-center cohort of zipline injury patients to better characterize the injury patterns and associated risk factors. We also aim to identify potential areas for intervention and recommend measures to promote safer play.

1. Materials and methods

1.1. National Electronic Injury Surveillance System (NEISS) database

We performed a 7-year retrospective review of the most current data available in the NEISS database (2009–2015) [6]. This publically-available data maintained by the United States Consumer Product Safety Commission (CPSC) is a stratified probability sample of approximately 100 hospitals in the United States. Data points include age, sex, race,

☆ Conflicts of Interest: None.

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Fig. 1. Playground zipline or "track ride".

diagnosis, body part injured, location of injury, post-ED disposition, and a brief narrative [7]. The narrative often contains additional information about the specific location, mechanism and circumstances around the injury event. Variables generated from these data included zipline type (playground or homemade), injuries (closed head injury, fracture, contusion/laceration, sprain/dislocation and miscellaneous), injury mechanism (fall, impact with another structure, equipment failure, second user), disposition (admission or discharge), and age category (0–4 years, 5–9 years, 10–14 years, 15–17 years). All NEISS entries were complete cases.

1.1.1. Subject selection

Subjects were included if age 0–17 years, NEISS injury code 3219 "Other playground equipment" and narrative text that specified a zipline injury. The code has been consistent in the database for the duration of the study period and is the recommended code for a zipline injury [8]. Patients were excluded if cause of injury not attributable to zipline or if cause of injury could not be established from the narrative. Subjects were also excluded if injury occurred on commercial zipline, as there were very few subjects and estimates too unstable to perform statistical analysis.

1.1.2. Statistical analysis

Hospital weights are provided by the CPSC and are determined by the inverse of the probability of selection with adjustments for nonresponse, merged hospitals and changes in the sampling frame [9]. Confidence intervals (CI) were calculated using the coefficient of variation (CV), which is obtained based on the NEISS sample design and calculated from the square root of the variance divided by the estimate. CPSC considers estimates to be unstable and potentially unreliable if the estimate is less than 1200, the number of records used is less than 20, or the CV exceeds 33% [10]. These estimates were included with notation as indicated in tables and figures. All statistical analyses were performed with Stata 13.0 statistical software (StataCorp, College Station, TX). Survey commands were utilized to calculate incidence, proportions, and associations between variables. Tests of association included the Pearson chi-square with second-order Rao and Scott correction as well as logistic regression.

1.2. Benedum pediatric trauma center database

We then performed an 8-year retrospective review of patients presenting to our single academic pediatric trauma center between 1/1/2006 and 12/31/2013. Children's Hospital of Pittsburgh of UPMC is a 300 bed pediatric-only facility that provides care to more than 1700 trauma admissions annually. As the region's only level 1 pediatric trauma center, it is the definitive care provider for injured children in Western Pennsylvania as well as parts of West Virginia and Ohio. Our institutional trauma registry, the Benedum Pediatric Trauma Center Database, is prospectively maintained by designated pediatric trauma registrars and trained data abstractors. This database was queried for all trauma patients age 0–17 with zipline-related injury based on e-codes and free text documentation of injury mechanism. There were no changes in local zipline regulations or documentation across the two time periods. Variables of interest included standard patient demographics, type of zipline (homemade or playground), injury mechanism, injuries, cause of injury (e.g. why did the subject fall), fall height, presence/absence of supervision, injury severity score (ISS), surgical procedures, hospital length of stay (LOS) and disposition. Data not available in our trauma database were obtained directly from the electronic health record. All research procedures and analyses conducted for this study were approved by the local institutional review board.

1.2.1. Statistical analysis

Data were summarized as mean (SD), median (interquartile range), or percentage. Univariate analysis was conducted to determine association between selected variables and the primary outcome of interest, mortality. Student's t-test was used for normally distributed continuous data, Wilcoxon rank-sum testing for skewed continuous data, and chi-square or Fisher exact test were used for categorical data. Youden index (J), which maximizes sensitivity and specificity (vertical distance on the ROC curve) across various cutoff points, was utilized to determine the optimum cutoff point for fall height in predicting head injury [11]. The Youden index was calculated using the formula [J = sensitivity + specificity – 1]. Sample size was insufficient to support adequately-powered multivariate analyses. Differences were considered significant for $p < 0.05$.

2. Results

2.1. National Electronic Injury Surveillance System (NEISS) database

The total estimated zipline injuries resulting in ED visits was 9397 (95% CI 6728–12,065) for the 2009–2015 time interval (Table 1). Overall, 45.9% of injuries occurred on homemade ziplines and 54.1% occurred on playground ziplines. Injury type was 49.8% fracture, 21.2% contusion/laceration, 12.7% head injury, 10.4% sprain/dislocation and 5.1% other. Fall as a mechanism of injury was by far the most frequent (83%), with impact against another structure (11%), equipment failure (3.8%) and second user on the line (2.3%) representing less common causes. Regarding disposition, 11% required admission and 89% were discharged or left from the emergency department. Sex was evenly distributed with 49.7% female and 50.3% male. Median (IQR) age was 8 (6–11), with age categories as follows: 0–4 years = 4.3%, 5–9 years = 59.0%, 10–14 years = 25.5%, 15–17 years = 11.2%. Both height of fall and parental supervision were inconsistently documented, and the amount of missing data precluded analysis of these variables.

In a comparison of playground versus homemade injuries (Table 1), there was no difference in sex between groups (p = NS). As expected, younger children (age ≤ 9) were more likely to be injured on playground equipment and older children and adolescents (age > 9) were more likely to be injured on homemade devices, likely because of the difference in usage rates of each type. There were significantly more fractures in the playground group and more contusions/lacerations in the homemade group ($p < 0.001$). Surprisingly, the amount of head injury was the same between groups as was the rate of hospital admission (p = NS). The trend over time revealed an increase in the overall prevalence of zipline injuries. Interestingly, increases in homemade ziplines accounted for this phenomenon, with the number of playground injuries remaining relatively consistent across the time period (Fig. 2).