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Children treated for lawn mower-related injuries in US emergency departments, 1990–2014☆

Karen S. Ren, BS [a,b], Thiphalak Chounthirath, MS [a], Jingzhen Yang, PhD, MPH [a,b], Laura Friedenberg, MA [a], Gary A. Smith, MD, DrPH [a,b,c,*]

[a] Center for Injury Research and Policy, The Research Institute of Nationwide Children's Hospital, Columbus, OH, United States
[b] The Ohio State University College of Medicine, Columbus, OH, United States
[c] Child Injury Prevention Alliance, Columbus, OH, United States

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ABSTRACT

Objective: Investigate the epidemiology of lawn mower-related injuries to children in the US.
Methods: A retrospective analysis was conducted of children younger than 18 years of age treated in US emergency departments for a lawn mower-related injury from 1990 through 2014 using data from the National Electronic Injury Surveillance System.
Results: An estimated 212,258 children <18 years of age received emergency treatment for lawn mower-related injuries from 1990 through 2014, equaling an average annual rate of 11.9 injuries per 100,000 US children. The annual injury rate decreased by 59.9% during the 25-year study period. The leading diagnosis was a laceration (38.5%) and the most common body region injured was the hand/finger (30.7%). Struck by (21.2%), cut by (19.9%), and contact with a hot surface (14.1%) were the leading mechanisms of injury. Patients <5 years old were more likely (RR 7.01; 95% CI: 5.69–8.64) to be injured from contact with a hot surface than older patients. A projectile was associated with 49.8% of all injuries among patients injured as bystanders. Patients injured as passengers or bystanders were more likely (RR 3.77; 95% CI: 2.74–5.19) to be admitted to the hospital than lawnmower operators.
Conclusions: Lawn mower-related injuries continue to be a cause of serious morbidity among children. Although the annual injury rate decreased significantly over the study period, the number of injuries is still substantial, indicating the need for additional prevention efforts. In addition to educational approaches, opportunities exist for improvements in mower design and lawn mower safety standards.

1. Introduction

Despite stricter safety specifications and product design changes, lawn mowers continue to be an important source of serious pediatric morbidity in the United States (US) [1-18]. Between 1990 and 2004, an estimated 140,700 children under 20 years of age were treated in US emergency departments (EDs) for lawn mower-related injuries [12]. Initial treatment of pediatric lawn mower-related injuries costs about $90 million annually [19]. The long-term physical, psychological, and financial effects of these traumatic injuries can be devastating for those injured and for their families [8,17,19-22].

Lawn mower-related injuries have previously been described, but many studies were published years ago [1-3,6,9,19,23,24]. Previous studies using data from the National Electronic Injury Surveillance System (NEISS) examined fewer years and conducted less comprehensive analyses than the current study [8,10,13,14,17]. Most did not evaluate the case narratives included in the NEISS database to investigate mechanism of injury and other variables regarding the circumstances of the injury. Other studies were limited in focus, analyzing data from a single hospital system [3,4,9,11] or about a type of mower [14].

This study comprehensively analyzes data over a 25-year period using a nationally representative database to evaluate the

Abbreviations: ANSI, American National Standards Institute; CI, Confidence Interval; CPSC, United States Consumer Product Safety Commission; ED, Emergency Department; NEISS, National Electronic Injury Surveillance System; NMIR, No-mow-in-reverse; OPEI, Outdoor Power Equipment Institute; RR, Relative risk; US, United States.

☆ Address Where Work was Done:Center for Injury Research and Policy, The Research Institute at Nationwide Children's Hospital; 700 Children's Drive; Columbus, OH 43205

* Corresponding author at: Center for Injury Research and Policy, The Research Institute at Nationwide Children's Hospital, 700 Children's Drive, Columbus, OH 43205, United States.
E-mail address: gary.smith@nationwidechildrens.org (G.A. Smith).

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epidemiologic characteristics, including mechanism of injury, of lawn mower-related injuries to children in the US. It also provides a discussion of relevant injury prevention strategies.

2. Methods

2.1. Data sources and case selection criteria

This study analyzed data for lawn mower-related injuries among children younger than 18 years old treated in EDs from January 1, 1990 through December 31, 2014. Data were obtained from the National Electronic Injury Surveillance System (NEISS), which is operated by the US Consumer Product Safety Commission (CPSC) to monitor consumer product-related and sports and recreation-related injuries treated in US EDs. NEISS collects data daily from a sample of approximately 100 EDs, which represent a stratified probability sample of the >5300 hospitals with a 24-hour ED with 6 or more beds in the US and its territories [25]. The NEISS database contains information on patient age, gender, locale of injury, injury diagnosis, injured body region, disposition from the ED, product(s) involved, and a brief narrative of the circumstances of the injury incident.

Data regarding lawn mower-related injuries (product codes 1401, 1402, 1422, 1439, and 1448) reported to the NEISS were obtained for the 25-year study period. The narrative for each case was reviewed to identify miscoding and to create new variables describing injury circumstances. Cases were excluded from analysis if the outcome was fatal (2 cases) or if the injury was unrelated to a lawn mower. The US Census Bureau's July 1 intercensal and postcensal residential population estimates were used to calculate injury rates in this study [26].

2.2. Study variables

NEISS case narratives were used to code for mechanism of injury, user type (operator, passenger, bystander, other), and mower part or object associated with the injury (projectile, mower blade, or other). Case coding definitions were refined through an iterative process comparing coding agreement among authors to achieve consistent assignment of categories.

The NEISS codes for locale of incident were regrouped into: home (included the NEISS categories of home, farm, and manufactured/mobile home), and non-home (included school, sports/recreation place, street/highway, industrial place, and other public place).

Mechanism of injury categories consisted of: 1) fell and struck/struck on (included tripped and fell), 2) struck by, 3) fell off, 4) run over, 5) backed over, 6) cut by, 7) caught/entrapped, 8) contacted a hot surface, 9) tip-over/roll-over, and 10) other (included mower malfunction, overextension, and other specified mechanisms). The "backed over" category included cases in which the patient was backed over by a ride-on mower. A case was coded as "cut by" if the narrative specified that the patient was struck or hit by the blade, if a body part went under the mower deck with the blades, if the patient stepped on something while mowing, or if the narrative indicated an unspecified laceration or amputation. For cases with more than one mechanism mentioned, such as "patient fell off mower and then was run over," rules for assigning a mechanism were established as followed: 1) being backed over took precedence over falling off the mower; 2) falling off took precedence over striking on/falling and striking/tripping and falling, being run over, and being caught/trapped in the mower; 3) being run over took precedence over being caught/entrapped; and 4) striking on/falling and striking/tripping and falling took precedence over contact with a hot surface.

The NEISS injury diagnoses were grouped into: 1) laceration (included the NEISS categories of laceration, puncture, and avulsion), 2) burn (included thermal, chemical, scald, radiation, and electrical burn, and burns not specified), and 3) soft tissue injury (included contusion/abrasion, crushing, and hematoma). Fracture, amputation, foreign body, and sprain/strain were each kept as separate categories without regrouping. All remaining NEISS codes for injury diagnosis were grouped into "other."

For body part injured, NEISS categories were grouped into: 1) head/neck (included head, ear, face, mouth, and neck), 2) trunk (included upper trunk, lower trunk, and pubic region), 3) upper extremity (included shoulder, upper arm, elbow, lower arm, and wrist), 4) lower extremity (included upper leg, knee, lower leg, and ankle), 5) hand/finger, 6) foot/toe, 7) globe of eye, and 8) other (included all remaining NEISS codes).

Disposition from ED categories were grouped into three categories: 1) admitted (including NEISS categories: treated and transferred to another hospital, treated and admitted for hospitalization, and held for observation), 2) treated and released, and 3) left against medical advice.

2.3. Data analysis

Data were analyzed using IBM SPSS Statistics for Windows, Version 19.0 (IBM Corp., Armonk, NY) and SAS Enterprise Guide 7.11 HF3 (SAS Institute Inc., Cary, NC) statistical software. Complex survey procedures, which accounted for the NEISS sampling design, were used to calculate national estimates and the Taylor series linearization method was used to calculate the variance of the estimates. All estimates reported in this study are stable estimates unless stated otherwise. An estimate is deemed potentially unstable if the estimate is <1200 cases, the sample size is <20 cases, or the coefficient of variation is >33% [27]. Trend analyses were performed using weighted linear regression with weights equal to the inverse of the variance of the estimated statistics. The estimated annual rate of change from the regression model, denoted by "m," was reported along with the p-value associated with the t-test used to test for its statistical significance. Other statistical analyses included Rao–Scott χ^2 test for association and calculation of relative risks (RRs) with 95% confidence intervals (CIs). Statistical significance was determined at the level $\alpha = 0.05$. This study was approved by the Institutional Review Board of the authors' institution.

3. Theory

This study provides a comprehensive epidemiological analysis of nationally representative emergency department data covering a 25-year period regarding an important source of ongoing pediatric injury morbidity. In addition, within the context of study findings, it describes relevant injury prevention strategies.

4. Results

An estimated 212,258 (95% CI: 176,130–248,386) children <18 years of age were treated for lawn mower-related injuries in US EDs from 1990 through 2014 (Table 1). This equaled an average of 8490 (95% CI: 7045–9935) injuries annually or 11.9 (95% CI: 9.8–13.9) injuries per 100,000 US children. The number of injuries per year decreased significantly by 53.9% ($m = -191.8$; $p < 0.001$) from 10,420 (95% CI: 6960–13,880) in 1990 to 4808 (95% CI: 2985–6631) in 2014 (Fig. 1). The annual injury rate per 100,000 children <18 years of age decreased significantly by 59.9% ($m = -0.32$; $p < 0.001$) from 16.2 (95% CI: 10.8–21.6) in 1990 to 6.5 (95% CI: 4.1–9.0) in 2014. The mean and median age of injured patients was 9.9 years (standard deviation: 0.12) and 10.6 years (interquartile range: 4.2 to 14.2), respectively. The age distributions of the injured patients were bimodal with peaks at 2 and 15 years of age (Fig. 2).

The majority of children injured by a lawn mower were boys (77.2%) and 42.1% were 13–17 years of age (Table 1). Of the 73.2% of cases with a known locale of injury, 97.1% occurred at home. Mechanism of injury was specified in 96.3% of cases, and among these, "struck by" (21.2%) was the most common mechanism of injury, followed by "cut by" (19.9%) and "contact with hot surface" (14.1%). "Back-over" incidents

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