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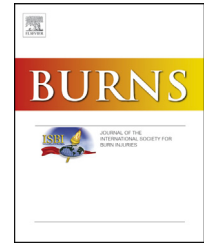
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## Genital burns in the United States: Disproportionate prevalence in the pediatric population

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### ABSTRACT

*Introduction and objectives:* To describe the epidemiology of genital burns in the U.S. and investigate the underlying etiology.

*Methods:* The National Electronic Injury Surveillance System database was queried for individuals who sustained genital burns from 2000 to 2016. We collected data on age, gender, injury diagnosis, disposition, and causative agents. Multivariate analysis was performed to determine predictors of hospitalization.

*Results:* We estimate 17,026 (95% CI 16,649–17,404) cases of genital burns presented to emergency departments nationally. Genital burns occurred more in males than females (12,295 vs 4,731). Scalding (57.9%) was the most common mechanism of injury and hot water (35.7%) the most common causative agent. Significant predictors of hospitalization on multivariate analysis were multi-surface (OR 4.4), scalding (OR 11.5) and thermal burns (OR 27.9).

Children ages 0–2 had the highest prevalence of genital burns, and children ages 0–12 comprised 37.1% of the study. For children <5 years of age, majority of the burns were caused by hot water in the bathroom. In age group 6–12, the most common causes of genital burns were cooking-related scalds due to hot foods and water.

*Conclusions:* Children sustain genital burns at a higher rate than adults and many appear to have a preventable mechanism. Improved product design for safety and educating caregivers about potential hazardous situations are needed.

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## 1. Introduction

Burns are an uncommon source of injury to the genitalia and perineum but can have debilitating physical, psychological

and reproductive consequences. Certain characteristics of male and female genitalia provide capacity to resist injuries. Anatomic location of the perineum as well as coverage by clothing make the exposure to the causative agents less probable [1–3].

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Burns to the genitalia and perineum are classified as major burns by the American Burn Association [4]. Single-institution studies have estimated the prevalence of genital burns (GB) between 1.7%–13% of burn hospital admissions [5–7]. Individuals with GBs are more likely to have higher total body surface area (TBSA) involvement; genitalia alone comprise 1% of TBSA and studies have demonstrated an average TBSA of 21%–56% for all patients with perineal burns [5]. They additionally have increased rates of mortality and hospital acquired infections [5,6]. Urinary tract infections and bacteremia are significantly more common in GB victims [6,8]. After controlling for age, ethnicity, TBSA, inhalation injury and burn depth, GBs remain a strong predictor of mortality [6].

Despite their importance, the medical literature on GBs is sparse. To our knowledge no descriptive epidemiological study on GBs have been published in the literature. The objective of the current study is to describe the epidemiology of GBs using a nationally representative sample of individuals presenting to emergency departments (ED) in the United States. Secondary aims are to investigate the underlying etiology and causative agents in order to promote prevention and influence care for these individuals in the future.

## 2. Methods

### 2.1. Study Population

The National Electronic Injury Surveillance System (NEISS) is collected from 100 EDs each year in the United States. Operated by the US Consumer Products Safety Commission, data collection and analysis is performed on a daily basis at NEISS ED hospitals by NEISS hospital coordinators. The data collected is a stratified probability sample used to produce national estimates of US ED patients. These ED hospitals are categorized based on five strata, four based on size and the fifth consisting of children's hospitals. The non-children's hospitals are stratified based on annual number of ED visits: small, medium, large and very large. Additionally, they consist of large inner-city hospitals with trauma centers, urban, suburban and rural hospitals. The data collected includes the individuals' age, gender, injury diagnosis, product codes and the affected body part. A brief narrative of the injury is included [9]. For the purpose of this study, the NEISS database was queried for individuals who sustained all cause diagnosis of burns to the pubic region, lower trunk, upper leg and all of body from the year 2000–2016 in order to capture all injuries that involved the genitalia. The coded data was read using the NEISS Coding Manual and Product Code Comparability Table issued in January of 2017 [10,11].

### 2.2. Variables

Burns were grouped into three categories: scalding, chemical and thermal (codes: 48, 49, 51). As defined by the NEISS coding manual, scalding is a burn caused by hot liquid or steam, chemical burns are caused by acids or alkalis, and thermal burns are caused by flames or hot surfaces [11]. Although defined as such by NEISS, thermal burns are formally defined as a tissue injury due to application of heat

in any form to the body surfaces. Scalding burns therefore are a subset of thermal burns and will be referred to as such in this paper. These three categories were then further split into twelve classifications to identify causative agents: hot water, hot beverages, chemical cleaners, hot food, fire, hot surfaces, flammable chemicals, unknown chemicals, battery/acid, fireworks, oils, and cigarettes. Each narrative was examined to see if injuries were isolated to the genitals alone or multiple regions of the body. Injuries were categorized by anatomic location of each sex: penis, scrotum, perianal and multiple areas for males and vulva/vagina, perianal and multiple areas for females. While anatomically distinct, vulva/vagina were used interchangeably in the narrative, which is why they were classified together. Age was categorized into the following groups: 0–1, 2–5, 6–12, 13–17, 18–30, 31–45, 46–65 and 66+. Disposition was defined as: treated and released, transferred, hospitalized, left against medical advice, held for observation, Dead on arrival/died in ER and unknown. Injury locations included: home, unknown, public, school, place of recreation or sport, street and mobile home.

### 2.3. Statistical analysis

All data was analyzed using Stata v.13 (StataCorp LP, College Station, TX, USA). We used descriptive statistics to summarize the study population from all years. We used the NEISS complex sample design to calculate projections of absolute number of GB cases. We then divided the estimated frequency of GB cases by the US census population totals to produce incidence per 1,000,000 [12]. We performed logistic regression analysis to determine predictors of hospitalization from GBs. In the analysis of predictors of hospitalization, hospitalized and transferred patients were combined together as they both demonstrate more severe injuries. All p-values (two-sided) less than 0.05 were considered statistically significant.

## 3. Results

### 3.1. Demographic characteristics

In the 17-year (2000–2016) study period, the weighted national frequency of all cause GBs was 17,026 (95% CI 16,649–17,404) with an average yearly incidence of 3.27 cases per million (Table 1). The demographic characteristics are summarized in Table 2. The mean age at the time of injury was 26.5 years (SD 21.7, range 1 month–96 years). The mean age of the pediatric and adult populations was 6.2 (SD 4.9) and 41.8 (SD 16.2). Fig. 1 presents the prevalence of GBs for each individual age. The prevalence of GBs for ages 0–2 are the highest and noticeably decline after the age of 70. Children ages 0–12 comprised 37.1% of the study population. GBs occurred more commonly in males than females (12,295 vs 4,731 respectively) but males were at decreased odds for hospitalization (OR 0.5, 95% CI 0.28–0.89,  $p=0.02$ ). Of those injured 66.5% were treated as an outpatient, 21.7% were transferred, and 9.1% were admitted. Most injuries occurred at home and involved multiple areas of the external genitalia.

**Table 1 – Weighted frequency of all cause diagnosis of genital burns from 2000-2016.**

Year	Total cases	Incidence per 1,000,000
2000	427	1.51
2001	957	3.36
2002	677	2.35
2003	1230	4.24
2004	1142	3.90
2005	572	1.94
2006	809	2.71
2007	954	3.17
2008	992	3.26
2009	781	2.54
2010	1190	3.83
2011	930	2.97
2012	687	2.18
2013	1437	4.53
2014	1640	5.13
2015	1139	3.54
2016	1461	4.51
Total	17026	3.27

**Table 2 – Demographics of genital burns throughout the study period from 2000-2016 (total estimated cases=17,026).**

Age, mean (sd)	26.5 (21.7)
Pediatric	6.2 (4.9)
Adult	41.8 (26.2)
Sex, n (%)	
Male	12,295 (72.2)
Female	4731 (27.8)
Type of injury, n (%)	
Scalding	9854 (57.9)
Chemical	3818 (22.4)
Thermal	3354 (19.7)
Disposition, n (%)	
Treated and released	11,317 (66.5)
Treated and transferred	3689 (21.7)
Hospitalized	1543 (9.1)
Died	208 (1.2)
Left against medical advice	104 (0.6)
Held for observation	101 (0.6)
Unknown	64 (0.4)
Injury location, n (%)	
Home	11,823 (69.4)
Unknown	3961 (23.3)
Other public property	596 (3.5)
School/daycare	438 (2.6)
Place of recreation/sports	108 (0.6)
Street/highway	86 (0.5)
Mobile/manufactured home	15 (0.09)

### 3.2. Causative agents and types of injury

The etiology and mechanism of burns are summarized in Fig. 1. Scalding was not only the overall most common cause of GBs, but was also the most common cause on a yearly basis from 2000 to 2016 (Fig.2). Among all causative agents in the population, hot water and hot beverages were the most common and cigarette burns were the least common. The most common cause of burns in both genders were hot water and hot beverages. Analyzing the differences between the

two genders with respect to causative burn agents yielded no statistical differences between males and females ( $p=0.26$ ). As hot water burns were the most prevalent, we further classified hot water burns into three categories based on location of burn: bathroom (45%), cooking related (21.6%) and unclassified (33.4%).

Fig. 3 presents the age groups corresponding with their most common causative agent. Hot water was the most common cause of GBs in all but 3 age groups. Bathrooms were the site of hot water injury in 93.3% of age group 0-1, 54% of age group 2-5 and 53.3% of age group 66+. For children age group 0-1, 36.7% of hot water bathroom scalds occurred when infants kicked the hot water on or cold water off. In age groups 0-5, majority of burns were caused by hot water in the bathroom, whereas in age groups 6-12, the most common causes of GBs were scalds that were cooking related due to hot foods or hot water.

GBs were further stratified based on extent of genital involvement. In males, multiple injuries and isolated penile burns were the most common at 44.6% and 33.7% respectively. In females, multiple injuries and isolated perianal burns were the most common at 43.1% and 33.8%. Burns to the penis and scrotum alone comprised 48.6% of male burns whereas burns to the vulva/vagina alone comprised 22.1% of female burns. Hot water was the most common cause of burns to every genital part in both males and females.

### 3.3. Predictors of hospitalization

Controlling for age, sex and year on multivariate analysis, multi-surface burns were statistically significantly associated with increased need for hospitalization compared to isolated burns (OR 4.4, 95% CI 2.6-7.4,  $p<0.001$ ). Additionally, scalding (OR 11.5, 95% CI 4.3-30.7,  $p<0.001$ ) and thermal burns (27.9, 95% CI 9.3-83.7,  $p<0.001$ ) when compared to chemical burns were statistically significantly associated with the need for hospitalization.

## 4. Discussion

To our knowledge, this is the first comprehensive study of the epidemiology of GBs. Through the data collected from NEISS, we found that GBs affect individuals of all age groups but with a disproportionate prevalence in the pediatric population. Children ages 0-2 suffered the highest prevalence of GBs out of all age groups and children ages 0-12 comprised 37.1% of the study population. Males were almost three times more likely to sustain GBs. Scalding burns were the most common mechanism of injury. These burns were most likely to occur at home with hot water, hot beverages, and chemical cleaners. Hot water affected various age groups differently: infants, toddlers and the geriatric population suffering from hot water burns were most commonly in the bathroom, whereas young children and adolescents suffered from cooking related hot water injuries more frequently.

The causative agents of most GBs in children ages 0-12 years were scalds caused by hot water and hot foods (of which soups and noodles were the most prevalent). In alignment with our study, a ten year (1991-2000) retrospective review of genital

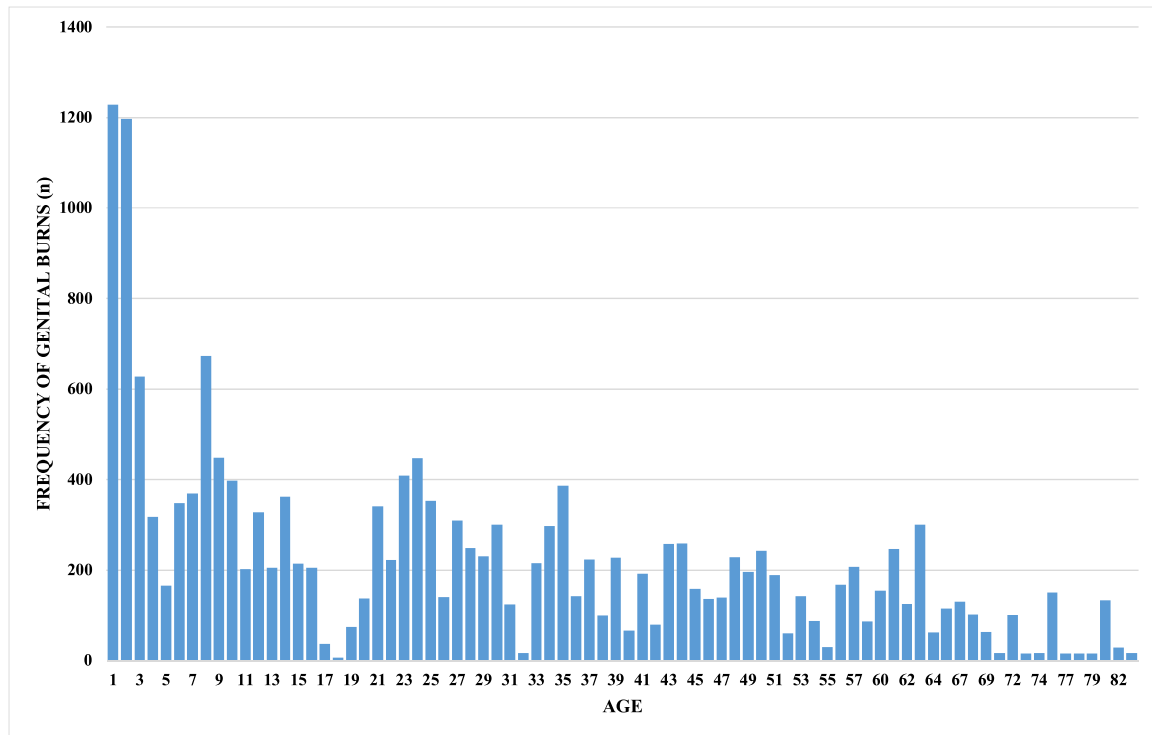


Fig. 1 – Frequency of genital burns stratified by age (2000-2016).

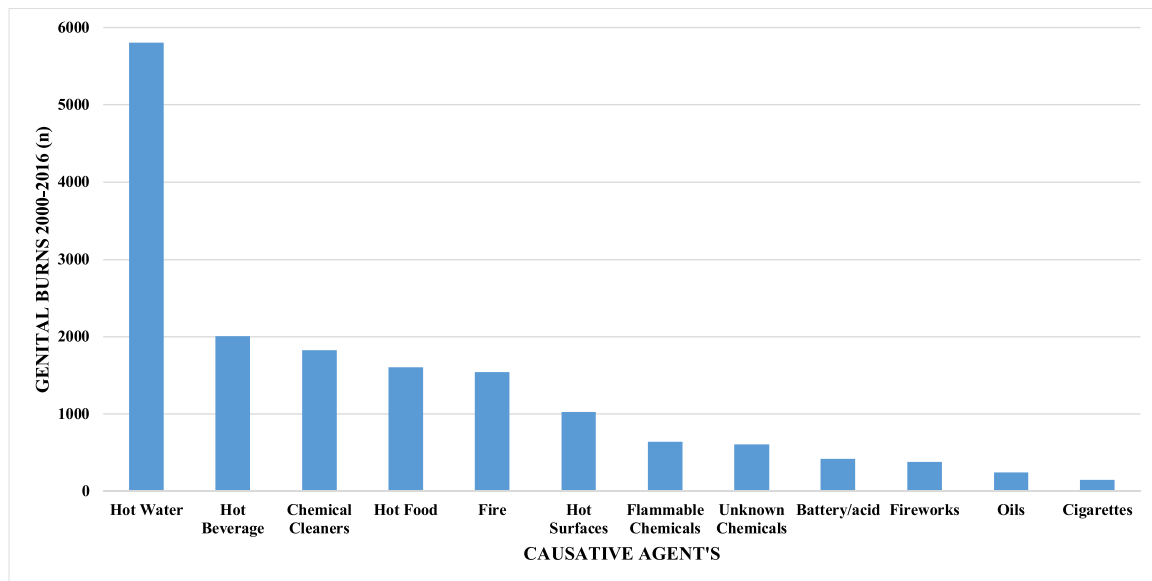


Fig. 2 – Causative agents associated with genital burns (2000-2016).

and perineal burns in children by Angel et al., found that 64% of GBs in children were caused by scalds [13]. Given the large number of burns disproportionately affecting the pediatric population, it is important to consider that a portion of these may come from non-accidental burns. The majority of burns for children ages 0-12 years presented in the NEISS dataset occurred due to scalds. Over a third of hot water burns in infants age 0-1 occurred according to the NEISS data due to the infant accidentally kicking the hot water on or cold water off.

Given the high prevalence and low likelihood of such a mechanism in this age group, it should prompt ED staff to explore non-accidental means of injury. Given the lack of dexterity in children and their increasing size, they are more prone to accidental spills when handling hot foods and are more capable of reaching kitchenware that were previously unattainable. Preventative strategies should be explored by industrial design to make products more safe for children. Education for parents could protect children from bathroom

RANK	0-1 YEARS	2-5 YEARS	6-12 YEARS	13-17 YEARS	18-30 YEARS	31-45 YEARS	46-65 YEARS	66+ YEARS
1	Hot Water (86.8%)	Hot Water (51.8%)	Hot Food (43.8%)	Chemical Cleaners (45.3%)	Hot Water (35.5%)	Hot Water (36.1%)	Hot Water (27.3%)	Hot Beverages (28.4%)
2	Hot Beverages (7.1%)	Chemical Cleaners (15.9%)	Hot Water (19.2%)	Hot Water (17.6%)	Hot Beverages (13.3%)	Hot Beverages (14.2%)	Fire (22.7%)	Fire (25.1%)
3	Chemical Cleaners (6.1%)	Hot Beverages (10.4%)	Hot Beverages (14.1%)	Fireworks (17.1%)	Hot Surfaces (13%)	Fire (10.9%)	Chemical Cleaners (13.1%)	Hot Surfaces (23.9%)
4	N/A	Hot Food (7.09%)	Fire (6.69%)	Fire (9.86%)	Unknown Chemicals (10.8%)	Flammable Chemicals (9.82%)	Hot Beverages (10.3%)	Hot Water (21%)
5	N/A	Hot Surfaces (5.03%)	Flammable Chemicals (5.39%)	Hot Food (2.89%)	Chemical Cleaners (7.63%)	Chemical Cleaners (8.14%)	Hot Food (9.15%)	Chemical Cleaners (1.7%)

**Fig. 3 – Percent of top 5 causative agents associated with genital burn injuries by age range.**

related burns and making cooking utensils more childproof/friendly could minimize injuries sustained during cooking or handling hot foods. Additionally, making physicians more aware of this can help in identifying cases of neglect and non-accidental injuries in the pediatric population.

A 2012 retrospective study by Abel et al. evaluated the outcomes of male and female GB victims during a 15-year period (1995-2009) among 393 patients. They found the most common cause of GBs were scalding injuries in both males (58.1%) and females (70.7%) with males comprising 64.4% of their study population [8]. This closely aligns with the findings of the current report with respect to the mechanism of injury and the prevalence of injuries in either gender. In our report, males were approximately three times more likely to be the victims of GBs. We hypothesize that this may be in part due to risk prone actions taken by males and/or the difference between external genital anatomy. The penis and scrotum create a larger surface area and are not protected with thigh folds making them likely more susceptible to burns compared to females. When comparing burns to the male and female genitalia, we found burns to the penis and scrotum alone comprise 48.6% of burns to the genitalia. For females however, burns to the vulva/vagina alone comprise only 22.1% of burns to the genitalia.

Patients who suffer GBs tend to be hospitalized more frequently and have longer hospital stays [14,15]. Additionally, we found that multi-organ burns including the genitalia were a stronger predictor for hospitalization than isolated GBs. Scalds and thermal burns were more commonly associated with hospitalization in comparison to chemical burns. This is likely due to the fact that scalds and thermal burns were of greater severity whereas the chemical burns tended to be more superficial. Abel et al. reported that scalds and thermal burns were associated with larger TBSA burns than chemical burns, had a higher percentage of serial debridement (scalds 24.4%, thermal 33.7% and chemical 11.1%) and of greater than 10-day length of hospital stay (scalds 56.5%, thermal 26.3%, chemical 2.2%) [7].

Our study has limitations. Given that this data is only acquired from emergency department visits, this likely has underestimated the number of cases that may have been treated in non-ED healthcare facilities. Additionally, this database does not compile information on cost, duration of

stay, burn degree, TBSA, and treatment. Thus, we cannot determine specific genital injury, which would benefit from further medical or surgical intervention. The lack of reporting on abuse by NEISS has limited our ability to analyze any subsequent non-accidental trauma evaluation. Our report provides a realistic estimate of the prevalence of these injuries and provides insight for future research in prevention and risk reduction especially among children.

## 5. Conclusion

Children sustain GBs at a higher rate than adults and many appear to have a preventable mechanism. Improved product design for safety and educating caregivers about potential hazardous situations are needed.

## Conflict of interest

We affirm that there was no source of extra-institutional funding, none of the authors has direct or indirect commercial financial incentive associating with publishing the article, and no funding agreement limits our ability to complete and publish the study. The authors do not have any conflict of interest. This manuscript or portions thereof are not under consideration by another journal or electronic publication and have not been previously published.

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