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Variations in U.S. Pediatric Burn Injury Hospitalizations Using the National Burn Repository Data

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Abstract

An understanding of population-specific variation in pediatric burn injuries is essential to the development of effective prevention strategies. The purpose of this study was to examine the etiology of pediatric burn injury considering age and race categories using the National Burn Repository. The authors reviewed the records of all pediatric patients (age <18 years) in the American Burn Association's National Burn Registry injured between 1995 and 2007. The authors compared patient and injury characteristics across race, age, etiology, and payor status. A total of 46,582 patients were included in this study. The etiology of burn injury varied by both age and race. Populations of color were younger, constituting 53.8% of patients younger than 5 years, whereas 53.9% of the total study population identified as Caucasian. Scald etiology was disproportionately less common in patients identifying as Caucasian (39.9 vs 61.4%, $P < .001$), and scald was a common etiology in older children identifying as African American, Asian, and Hispanic. Inhalation injuries were also higher in patients identifying as Native American (5.4%), Hispanic (4.2%), and African American (3.7%). Pediatric burn injury etiology varies with age and race. These data should encourage careful consideration of race, age, and other differences in formulating the most effective, population-specific prevention and outreach strategies.

An understanding of population-specific variations in pediatric burn injuries is essential to the development of effective prevention strategies. Interventions over the past two decades, such as hot water default settings, smoke detector requirements, banning of fireworks, and child-resistant lighters, have successfully reduced the incidence and severity of pediatric burn injury.^{1,2} However, these interventions are applied to children as a homogenous group. More effective and targeted prevention strategies require identifying the population most at risk for a particular injury etiology.

Current literature on the epidemiology of pediatric burn injuries shows consistent variation in incidence and etiology with age, detailing changing risks across developmental stages.^{3,4} A number of studies examine further variation across race, reporting increased risk of burn injury among populations of color, but these findings are based on single center studies with small sample sizes and, often, focus on single etiologies such as house fires.^{4–15} Two recent studies using national data cite higher rates of burns treated in populations of color

compared with patients identifying as white. Fagenholz et al¹⁵ reviewed emergency department visits for burns in all age categories and found a 62% increase in emergency department visits in patients identifying as black. Shields et al⁴ examined hospitalizations for pediatric injuries and found that children younger than 2 years were more likely to identify as nonwhite compared with children aged 3 to 17 years. However, these national studies do not use burn-specific databases, limiting their capacity to detail injury characteristics, such as etiology, burn size, and inhalation injury.

The purpose of this study was to use the National Burn Repository—the largest burn injury specific database in the United States—to examine variations in injury across age, race, and payor status to provide guidance for the development of population-specific burn prevention strategies.

Methods

Data Source and Study Population

Patients were identified from the American Burn Association's (ABA) National Burn Registry (NBR), version 4. The NBR is the largest data source dedicated to burn injury and currently contains data on more than 300,000 burn patients treated at U.S. and Canadian burn centers.¹⁶ We reviewed the NBR records of all pediatric patients (age <18 years) admitted for burn injury to one of the 73 U.S. hospitals between 1995 and 2007. We obtained the data from the ABA and approval for the analysis from our Institutional Review Board. We excluded all admissions for nonburns or skin diseases. We also excluded cases with unknown gender (n = 479), race (n = 5128), or intensive care unit stays longer than total hospital stay (n = 25).

Race was entered into the database by each center based on the center's methodology and a single-race category: African American, Asian, Caucasian, Hispanic, Native American, and Other. Therefore, these are the race categorizations used for the remainder of this article. The etiology of burn injury was determined by one of three NBR variables—entry coder categorization, listed e-code, or written as free text. The e-code categories were as follows: fire/flame (890–899.0, 923.0–923.9), scald (924.0–924.5, 924.7, 988.2), contact with a hot object (924.8), and electrical (925.0–925.9). Intentional injury was categorized based on e-codes (849.0–849.9, 904.0, 950.7, 958.1, 967.0–967.9, 968.0, 968.3–968.4, and 968.8). We categorized the free text only when explicit for one of these mechanisms.

Payor status was categorized as commercial, Shriners Hospital, Medicaid, and uninsured. The commercial category included other fully covered sources, including auto insurance and veterans' healthcare.

Data Analysis

Univariate and multivariate analyses were used to compare patient and injury characteristics across race, age, sex, etiology, and payor status. We used χ^2 for dichotomous and categorical variables and *t*-test for continuous variables. Comparisons were made between the majority race category (Caucasian) and all other race categories combined and individually, where indicated. To more precisely examine age-related variation, age was categorized in 5-year intervals. However, we divided the 0 to 4 years age category (0–1 and 2–4 years) because mechanism of injury typically varies with child development during these years. Finally, we used Medicaid or uninsured payor status as a surrogate for lower socioeconomic status for comparison to those with established medical coverage independent of household income level. All data analyses were performed using STATA 9.2 (Stata Corporation, College Station, TX).

Results

During the study period, a total of 228,105 burn admission records were contained in NBR, and a total of 46,582 subjects met study eligibility criteria. Of these patients, 53.9% identified as Caucasian, 21.4% as African American, 17.5% as Hispanic, 2.9% as Asian, and 0.8% as Native American. Patient characteristics (age, sex, and payor status) and injury characteristics (injury etiology, burn size, and inhalation injury) are stratified by race category in Table 1.

Over half of the patients (51.8%) were younger than 5 years, with 32.0% of patients younger than 2 years (Table 1). Patients identifying as African American, Asian, Hispanic, and Native American had significantly lower mean ages (all $P < .001$, Table 1) than patients identifying as Caucasian. Populations of color collectively comprised 53.8% of patients younger than 5 years and 46.1% of pediatric patients overall.

Payor status varied widely across each race category (Table 1). We combined all patients with Medicaid and uninsured status into a single group (representing lower socioeconomic status) and compared this group to those with commercial status. Medicaid/uninsured payor status was highest in patients identifying as Native American (71.9%), Hispanic (68.4%), and African American (65.6%), whereas Caucasian was lowest (35.9%). The Medicaid/uninsured group was significantly younger (5.8 ± 5.4 vs 8.2 ± 6.1 , $P < .001$) than the patients with commercial status.

Injury Characteristics

Injury etiology varied with age. Figure 1 demonstrates the general trends in proportion of patients with etiologies of scald, fire/flame, and contact burns by age. Scald (50.5%) and fire/flame (30.8%) represent >80% of all known etiologies, and these injuries switched in predominance at the age of 5 years. Contact burn was the second most common etiology in the younger age categories, representing 23.4% of burns for children younger than 2 years. Electrical, chemical, and other burns comprised 3.4% of all known etiologies and varied slightly.

Injury etiologies at a given age varied by race (Table 2). Scald etiology remained predominant or nearly equal to fire/flame in older age categories for patients identifying as African American, Asian, and Hispanic. The Medicaid/uninsured payor group had more scald injuries compared with the commercial payor group (55.6 vs 47.9%, $P < .001$), and only those patients identifying as Caucasian had a significant difference when disaggregating payor groups by race (43.4 vs 37.7%, $P < .001$).

Intentional injuries were reported in 4.5% of patients. This etiology was three times more frequent in children younger than 5 years, when compared with the oldest age category (6.6 vs 2.3%). Intentional etiology was also disproportionately higher in the patients identifying as African American, Hispanic, and Native American when compared with those identifying as Caucasian ($P < .001$, Table 1). Children in the Medicaid/uninsured group were more likely to have intentional etiology than those with commercial coverage (7.0 vs 2.7%, $P < .001$), and this disproportion remained upon disaggregation by race for patients identifying as Caucasian (5.3 vs 1.8%, $P < .001$), African American (10.1 vs 5.9%, $P < .001$), or Asian (8.7 vs 2.1%, $P < .001$). To control for payor status in examining the association between race and intentional injury etiology, we performed a multivariate logistic regression analysis (Table 3). When adjusting for socioeconomic status, African American, Asian, and Hispanic race categories had higher odds of intentional injury compared with the Caucasian race category.

Overall burn size and full-thickness burn size varied widely across races (Table 1). Although mean total burn size was larger among children identifying as Hispanic (11.1%, $P < .001$) than among those identifying as Caucasian (9.1%), it was smaller for those identifying as Asian (8.2%, $P = .01$). Inhalation injuries were more common for patients identifying as African American (3.7%, $P < .001$), Hispanic (4.2%, $P < .001$), and Native American (5.4%, $P < .001$) than for patients identifying as Caucasian (3.1%).

Discussion

In this analysis, U.S. pediatric burn injury admissions varied significantly with age and race, showing that populations of color were disproportionately younger, more likely to have scald etiology even in older age categories, and had more severe burns when compared with patients identifying as Caucasian. However, each race had distinct variation in injury etiology and severity. These results use a large, burn injury-specific dataset to show major differences when disaggregating data by population variables, confirming what has been shown in smaller regional studies, and expanding on larger national studies without access to very specific burn injury characteristics. These differences emphasize the need to understand the patients and their injuries for designing population-specific intervention strategies.

Children younger than 5 years comprised >50% of subjects of this study, and this age group is reported nationally to have the highest incidence of hospitalization for burn injury of all age categories.¹⁷ The patients in this study population identifying as African American, Asian, Hispanic, and Native American were disproportionately younger, and some race categories may have been additionally overrepresented by children with burn injuries when compared with the overall U.S. census racial distribution (Table 4). However, these national averages fail to account for variation in population mix by region and differences in the definition of race categorization between the census and NBR—discussed further as a limitation below.

The results of this study also highlight differences in burn etiology across race. Those patients identifying as African American, Asian, and Hispanic had a higher proportion of scald etiology that continues to affect even older children. These results challenge the general paradigm, characterizing scald injury as high only in children younger than 5 years. Correspondingly, those identifying as African American, Asian, and Hispanic had lower proportions of fire/flame injuries in addition to a higher proportion of inhalation injury in those identifying as African American, Hispanic, and Native American. Inhalation injury was associated with fire/flame etiology (97.9%) and is typically the result of prolonged exposure to the products of combustion. Results demonstrating a higher proportion of inhalation injuries despite a lower rate of fire/flame may be attributable to lack of smoke detectors as well as a delay in escape and fire rescue.^{2,18}

The variations in etiology across age and race that are highlighted in Table 2 reflect a national sample and may vary based on geographic location. Therefore, although they can be used to guide national prevention strategies, smaller, local programs may require further background research to define geographically specific age and race variations. Geographic models¹⁹ can be developed that incorporate patient data with community variations to pinpoint high impact areas for intervention, and qualitative techniques can reveal discrepancies within focus groups and patient-family interviews.²⁰ Rimmer et al²⁰ provide an example that combines both quantitative and qualitative methods to inform prevention strategies that target lower-income Hispanic families in Arizona to reduce scald injury in children younger than 5 years. This strategy benefits from community input, and all strategies should consider additional resources through collaborations with health care

settings, government agencies, universities, and interest groups. Strategies currently being implemented can further benefit from evaluations that include multiple social and economic factors to assess their impact and opportunities to reach underserved areas; future and more effective prevention requires multistrategy (passive and active) and multifocused (targeted across risks) tactics that are sustained and updated throughout childhood.^{21,22} Resources and tactics on population-specific injury prevention are reviewed by Atiyeh et al and Parks and Kreuter.^{22,23}

There remain several caveats that need to be considered when studying race as a variable. The limitations of race as a variable for inconsistencies in reporting and documentation are well described.^{24,25} Further, there is clearly a need to not examine race in isolation but rather to consider other social variables such as household wealth, level of education, ethnicity, and housing situation that may impact injury risk, unrelated to race.^{25,26} Unfortunately, these important variables are not available in the NBR. We did examine the relationship between socioeconomic status and etiology, because payor status data were available for the majority of patients. In this instance, we set commercial insurance status as the baseline for comparison. Populations of color had higher proportions of scald etiology independent of payor status; but intentional injuries varied highly between each population based on their payor status. However, it is important to note that the patients for whom payor status was available disproportionately identify as Caucasian and were older, which in and of themselves are associated with decreases in both scald and intentional etiologies. Thus, these results are inconclusive but further emphasize the need for controlling for multiple social and economic variables to find the population most at risk.

The use of the National Burn Repository for this study has many strengths as well as limitations that warrant consideration. The NBR is the largest administrative dataset designed specifically for burn injury and, accordingly, contains more burn-specific data fields than any other large administrative database. In addition, the NBR contains data collected by 79 burn centers over the 13 years analyzed, which overcomes many of the limitations of single center studies. However, the NBR contains data only on inpatients and not those patients treated and discharged from the emergency department; therefore, in this study, there is a bias toward more severe burn injuries. For example, children with minor injuries (which typically result from scalding) may be underrepresented in this study. The NBR's focus on burn centers, and not all hospitals, may potentially bias patient characteristics, such as race and payor mix. In addition, there are no standard definitions for diagnosing inhalation injury,²⁷ and etiologies were broadly categorized, making additional details on burn source unavailable. Contributing centers may not consistently document race by patients' self-report or a standardized categorization. Other variables have missing observations potentially biasing the populations by omitting these patients for analysis—eg, % TBSA missing for 13,083 patients (28.1%); payor status for 14,276 (30.6%); and etiology for 10,027 (21.5%).

Conclusion

In conclusion, pediatric burn injuries vary across age and race. The data show more injuries in the youngest of children and a higher risk of scald in populations of color. Future prevention strategies should be designed to reach those most at risk in the community of interest. These data should encourage careful consideration of age, race, and other social variables in formulating the most effective prevention and outreach strategies.

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Figure 1.
Percent with known etiologies across age categories.

Table 1

Patient and injury characteristics across racial categories

	Caucasian	African American	Asian	Hispanic	Native American	Other
Total, N (%)	25116 (53.9)	9978 (21.4)	1334 (2.9)	8152 (17.5)	374 (0.8)	1628 (3.5)
Age, yr, mean (SD)	7.8 (6.0)	6.0* (5.5)	4.4* (4.8)	5.2* (5.2)	6.1* (5.1)	5.6* (5.4)
Categorical age, yr (%)						
0–1	26.3	36.4*	47.5*	39.9*	30.5*	40.9*
2–4	18.1	20.5*	22.1*	23.6*	23.0*	20.7*
5–9	16.3	17.9*	16.3	16.3	21.4*	14.6
10–14	19.9	13.5*	6.8*	10.9*	15.2*	12.9*
15–17	19.5	11.7*	7.4*	9.5*	9.9*	10.9*
Female (%)	33.0	39.1*	42.4*	37.3*	40.6*	38.0*
Payor status (%)						
Commercial	57.7	32.5*	51.5*	30.2*	27.6*	53.3 [†]
Medicaid	26.6	54.8*	35.7*	55.3*	67.0*	37.8*
Shiners	10.0	5.6*	7.3 [†]	4.4*	1.7*	1.9*
Uninsured	5.7	7.1*	5.5	10.2*	3.7	7.1
Etiology (%)						
Scald	29.3	51.9*	67.7*	50.3*	40.6 [†]	48.0*
Fire/flame	28.8	17.5*	10.8*	20.7*	32.4	16.8*
Contact	12.7	11.7*	7.8*	10.9*	11.0 [†]	16.2 [†]
Chemical	0.9	0.9	0.7	1.0	0.8	0.7
Electrical	1.4	1.3	0.5*	2.4*	2.4	1.0
Radiation	0.4	0.0*	0.0 [†]	0.04*	0.0	0.6
Unknown/other	26.5	16.8*	12.6*	14.8*	12.8*	16.7*
Intentional burn etiology (%)	3.1	8.7*	4.3 [†]	4.2*	5.7*	2.6
% TBSA, mean (SD)	9.1 (12.2)	9.0 (11.8)	8.2 [†] (9.7)	11.1* (14.5)	10.3 (13.3)	6.8* (10.3)
% TBSA full thickness, mean (SD)	2.9 (9.7)	2.6 (9.5)	1.8* (7.2)	4.7* (13.4)	3.3 (11.3)	2.0* (8.5)

	Caucasian	African American	Asian	Hispanic	Native American	Other
Inhalation (%)	3.1	3.7*	2.5	4.2*	5.4*	2.1 [†]

* $P < .01$,

[†] $P < .05$, comparison between individual race vs Caucasian.

Table 2

Predominant injury etiology by age and race categories

Age	Caucasian	African American	Asian	Hispanic	Native American	Other
0-1	Scald (63%)	Scald (71%)*	Scald (85%)*	Scald (73%)*	Scald (68%)	Scald (69%)*
2-4	Scald (47%)	Scald (70%)*	Scald (79%)*	Scald (67%)*	Scald (69%)*	Scald (57%)*
5-9	Fire/flame (51%)	Scald (52%)*	Scald (73%)*	Scald (43%)* Fire/flame (46%)*	Fire/flame (72%)*	Scald (56%)*
10-14	Fire/flame (73%)	Scald (45%)* Fire/flame (45%)*	Scald (46%)* Fire/flame (51%)*	Fire/flame (60%)*	Fire/flame (70%)	Fire/flame (51%)*
15-17	Fire/flame (71%)	Scald (43%)* Fire/flame (47%)*	Fire/flame (54%)*	Fire/flame (56%)*	Fire/flame (56%)*	Fire/flame (55%)*

* $P < .01$, comparison between individual race vs Caucasian for each age and etiology category.

Table 3
Logistic regression models for injury etiology controlling for race and payor status variables

	Intentional Etiology OR (95% CI)	
	Univariate	Multivariate
Caucasian	Reference	Reference
African American	3.0 (2.7–3.3)	2.4 (2.1–2.8)
Asian	1.4 (1.1–1.9)	1.6 (1.1–2.2)
Hispanic	1.4 (1.2–1.6)	1.5 (1.3–1.7)
Native American	1.9 (1.2–3.0)	1.5 (0.9–2.5)
Medicaid/uninsured	2.7 (2.4–3.0)	2.2 (1.9–2.5)

OR, odds ratio; CI, confidence interval.

Table 4
Comparing racial categorization of NBR study population with U.S. census population for each age category

Racial Category	Population	0–1 yr	2–4 yr	5–9 yr	10–14 yr	15–17 yr
Caucasian	NBR	44.3	49.2	52.9	65.9	68.5
	U.S.	57.9	58.7	59.9	62.8	63.5
African American	NBR	24.4	22.2	23.1	17.7	16.4
	U.S.	14.0	14.3	15.2	14.9	14.3
Asian	NBR	4.3	3.2	2.8	1.2	1.4
	U.S.	3.5	3.6	3.4	3.4	3.7
Hispanic	NBR	21.8	20.8	17.2	11.7	10.8
	U.S.	19.9	19.1	17.6	15.4	15.3
Native American	NBR	0.8	0.9	1.0	0.8	0.5
	U.S.	0.9	0.9	0.9	1.0	1.0
Other	NBR	4.5	3.7	3.1	2.8	2.5
	U.S.	3.8	3.5	3.0	2.5	2.3

NBR population is the average of all subjects from 1996 to 2006. U.S. population is based on the 2000 U.S. Census data. Census data races were categorized as single race, non-Hispanics (white, black or African American, Asian or Pacific Islander, and Native American or Alaska Native); Hispanics of all races; and some other race or two or more races.

NBR, National Burn Registry.