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Socio-Economic and Racial Disparities in Severity of Pediatric Pool Drownings

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Abstract

Objectives: Pediatric drownings are a leading cause of death in the United States. There are racial/ethnic and socioeconomic disparities in the incidence of swimming pool-related drownings in pediatric patients. This study measures racial/ethnic and socioeconomic disparities in severity of pediatric pool drownings.

Study Design: We performed a cohort study using the Pediatric Health Information System database from 2007 to 2017. Patients 0-19 years old with diagnosis codes of pool drownings were included. We used summary statistics to calculate the severity, measured by mortality, mechanical ventilation, intensive care unit admission, and hospital admission, of drownings. Multivariable logistic regression was used to measure the relative effect size of these factors on severity of drownings after adjusting for age, gender, urban location and geographic locations.

Results: There were 5923 pool drownings from 31 hospitals. Overall, 7.8% of children died, 18.5% required mechanical ventilation 29.4% required intensive care unit admission and 70% of children required hospitalization. Publicly insured children had higher odds of mortality (aOR 1.35; 1.01, 1.80), mechanical ventilation (aOR 1.36; 1.07, 1.73), intensive care unit admission (aOR 1.18; 1.00, 1.39), and hospitalization (aOR1.19; 1.00, 1.41) compared to those with private insurance. Children in the lowest income quintile (<$32,516) had higher odds of mortality (aOR 1.69; 1.23, 2.34) and mechanical ventilation (aOR 1.59; 1.11, 2.28) when compared to the highest income quintile (>$61,078).

Conclusion: Children who are publicly insured and from lower income quintiles experience more severe pool drownings. Race/ethnicity was not associated with increased severity of pool drownings in children.

Keywords: Pediatric health; Emergency medicine; Pediatric pool drowning

Abbreviations: PHIS: Pediatric Health Information System database; ICU: Intensive Care Unit; MV: Mechanical Ventilation

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Introduction

Drownings are the leading cause of death from unintentional injury in children ages 1 to 4 years of age and the third leading cause of death from unintentional injury in children 5 to 19 years of age. Nearly 1000 deaths and 2000 hospitalizations are due to pediatric (age 0-19 years) drowning-related injuries in the United States annually [1]. Swimming pool-related drowning comprises 20% of all drowning-related injuries in children and are associated with poor outcomes [1]. The mortality and hospitalization rate of children submersed in pools is 23% and 60% respectively [2,3].

There have been marked racial and socioeconomic disparities in rates and severity of pool drownings. From 1995-2001 black children were 5.5 times more likely to drown when compared to white children, and Hispanic school-aged males were 10 times more likely to drown in pools than white males. Furthermore, publicly insured children were more likely to drown in pools than privately insured children, and patients with lower income levels were more likely to require inpatient management after a near drowning event [4,5].

Since 2007, the USA Swimming Foundation has made significant

efforts to improve water safety for at-risk children by providing low cost swim lessons [6]. In addition, Water Safety USA was organized in 2014 to develop interventions, such as providing provisions for swim lessons in public schools [7]. Furthermore, in its latest policy statement on drowning, the American Academy of Pediatrics acknowledges the value of culturally sensitive and community-based programs providing low cost or free swim lessons for high risk populations [8,9]. This study goes beyond incidence and explores the severity of pediatric pool drownings. The objective of this study was to determine if there are racial/ethnic or socioeconomic status differences in severity of pool-related drownings.

Research Methodology

Study design and data source

We conducted a retrospective cohort study using the Pediatric Health Information System (PHIS) database. PHIS is an administrative database that includes validated, deidentified data (demographics, diagnosis codes, procedure codes) from all inpatient, ambulatory surgery, emergency department and observation unit patient encounters from 45 children's hospitals.[11]The Institutional Review Board determined that this study did not meet the definition of human subjects research, and thus was deemed exempt from IRB review.

Study population

All patient visits by children between the ages of 0 and 19 with swimming pool-related submersions, both intentional and unintentional, between 2007-2017 were included in this study. We used the following ICD codes to develop our study cohort: ICD 9 code of E910.8 (Accidental drowning and submersion while in swimming pool) and ICD 10 code of W67 (a non-billable or specific code for accidental drowning and submersion while in swimming-pool), W67.XXXA, W67.XXXD, and W67.XXXS. All types of visits reported to PHIS using the above stated codes were included in the study including inpatient, emergency department and observation unit encounters. Visits to hospitals that did not contribute comprehensive data during the entire study period were excluded from analysis. This process eliminated 22 hospitals' data from being included in the study.

Outcome measures

Our primary outcome was the severity of pool-related drownings. We used mortality, mechanical ventilation, ICU admission, and hospital admission to characterize severity.

Exposure variables

The primary exposure variables were race/ethnicity and socioeconomic status. Race/ethnicity was categorized as non-Hispanic white, non-Hispanic black, Hispanic, and non-Hispanic "other". The "other" category included Asian, Native American and Pacific Islander. Socioeconomic status was analyzed by income quintiles and insurance type (public, private or other). Similar to income categories of other studies, the study population was equally divided so each quintile represented 20% of the study population resulting in income-based quintile categories of <$32,516.00, $32,516.00-39,484.50, $39,484.51-48,197.00, $48,197.01-61,078.00, and >$61.078.00. Potential confounding variables included age, gender, region in the US (Northeast, Midwest, South, and West) and whether or not the patient presented to a hospital in an urban versus rural location.

Analysis

We used summary statistics to calculate the distribution and severity (mortality, mechanical ventilation, ICU admission, and hospital admission) of swimming pool-related drownings by race/ethnicity and socioeconomic markers. We performed separate bi-variable and multivariable logistic regression to measure the strength of association of race/ethnicity and socioeconomic status on severity of pool drownings. We made an a priori decision to include all potential co-variables in the multivariable models. Generalized estimating equations were used to account for clustering by hospital in all models. An α of 0.05 was used to signify statistical significance, and adjusted odds ratios (aORs) with 95% confidence intervals (CIs) were reported. We used SAS Software version 9.3 (SAS Institute, Inc., Cary, NC) to perform all analyses.

Results

During the 11-year study period there were 5923 cases of pediatric pool-related drownings among the 31 hospitals included in analysis. Of these children involved in pool-related drownings, 53% were non-Hispanic (NH) white. Forty-five percent of patients were publicly insured. The majority of pool drowning (68%) occurred in children between 1-4 years old with a median age of 4.6 (SD+/-3.6) years. Males accounted for 62% of drowning victims. The majority of drownings occurred in the South (57%). The characteristics of the study population are further described in **Table 1**.

Mortality

Among our entire study population, 7.8% of children involved in a pool-related drowning died. Drowning victims included in the "Other" race categories including Asian patients had increased odds of dying after pool drowning compared to white patients. There was significantly increased odds of mortality from drowning in the lower income quintiles (<$32,516.00) when compared to the highest income quintiles in both the unadjusted (OR 1.81, 95% CI 1.35, 2.43) and adjusted analysis (aOR1.69, 95% CI 1.23, 2.34) (Refer to **Table 2** for all adjusted odds ratios and **Figure 1** for severity comparison based on race, insurance type and income levels). Similarly, individuals with public insurance were more likely to die from pool drownings than patients with private insurance after adjustment for the previously stated parameters (aOR 1.35, 95% CI 1.01, 1.80).

Mechanical ventilation

Of the 5923 cases of pool-related drowning in children, 18% required mechanical. There were no racial/ethnic differences in mechanical ventilation requirement. Patients from households with incomes less than $48,197.00 had increased rates of requiring

Table 1 Characteristics of study population.

Patient Demographics	Number (Percent) N=5923 (this table does not include patients who had demographics listed as "Unknown")
Patient Race/Ethnicity	
Non-Hispanic White	3108 (52.5)
Other	605 (10.2)
Non-Hispanic Black	1047 (17.7)
Hispanic	928 (15.7)
Gender	
Male	3674 (62.0)
Female	2224 (37.6)
Age (in years)	
0-1 year	139 (2.4)
1 year- 4 years	4039 (68.2)
5-9 years	1153 (19.5)
10-14 years	448 (7.6)
15-19 years	144 (2.4)
Region	
Midwest	1089 (18.4)
Northeast	119 (2.01)
South	3384 (57.1)
West	1331 (22.5)
Insurance	
Private	2256 (38.1)
Public	2657 (44.9)
Other	462 (7.8)
Income	
<$32.516.00	1148 (19.4)
$32, 516-39484.50	1143 (19.3)
$39, 484.50-48, 197	1146 (19.4)
$48, 210-61, 078	1145 (19.3)
>$61, 078	1145 (19.3)
Rural vs. Urban	
Urban	4466 (75.4)
Rural	1457 (24.6)

Table 2 Adjusted odds ratios.

Patient Demographics	Mortalities	Mechanical Ventilation Required	ICU Admission	Hospital Admission
Patient Race/Ethnicity				
White	**Reference Group**			
Black (Non-Hispanic)	0.90 (0.64, 1.25)	0.81 (0.62, 1.06)	1.11 (0.89, 1.37)	1.14 (0.95, 1.38)
Hispanic	0.72 (0.57, 0.91)	0.67 (0.49, 0.92)	0.73 (0.57, 0.94)	0.90 (0.68, 1.20)
Other Non-hispanic (Asian, Native American, Pacific Islander)	1.46 (1.05, 2.03)	0.99 (0.79, 1.25)	1.27 (1.03, 1.56)	1.22 (0.95, 1.57)
Insurance				
Private	Reference Group			
Public	1.35 (1.01, 1.80)	1.36 (1.07, 1.73)	1.18 (1.00, 1.39)	1.19 (1.00, 1.41)
Other	1.44 (0.91, 2.28)	0.86 (0.55, 1.36)	0.66 (0.52, 0.83)	0.84 (0.69, 1.03)
Income				
>61, 078	Reference Group			
$48, 210-61, 078	1.22 (0.95, 1.58)	1.10 (0.80, 1.51)	0.99 (0.75, 1.31)	1.11 (0.88, 1.41)
$39, 484.50-48, 197	1.31 (1.01, 1.70)	1.24 (0.93, 1.66)	1.22 (0.98, 1.53)	1.14 (0.93, 1.39)
$32, 516-39, 484.50	1.44 (1.05, 1.98)	1.45 (1.02, 2.06)	1.13 (0.86, 1.48)	1.09 (0.81, 1.46)
<$32, 516.00	1.69 (1.23, 2.34)	1.59 (1.11, 2.28)	1.22 (0.87, 1.70)	1.18 (0.89, 1.57)[13]

This table represents adjusted odds ratios. Race/ethnicity values were adjusted for income level, insurance status, gender, region, and living in urban setting. Income level data was adjusted for race/ethnicity, insurance status, gender, region and living in urban setting.

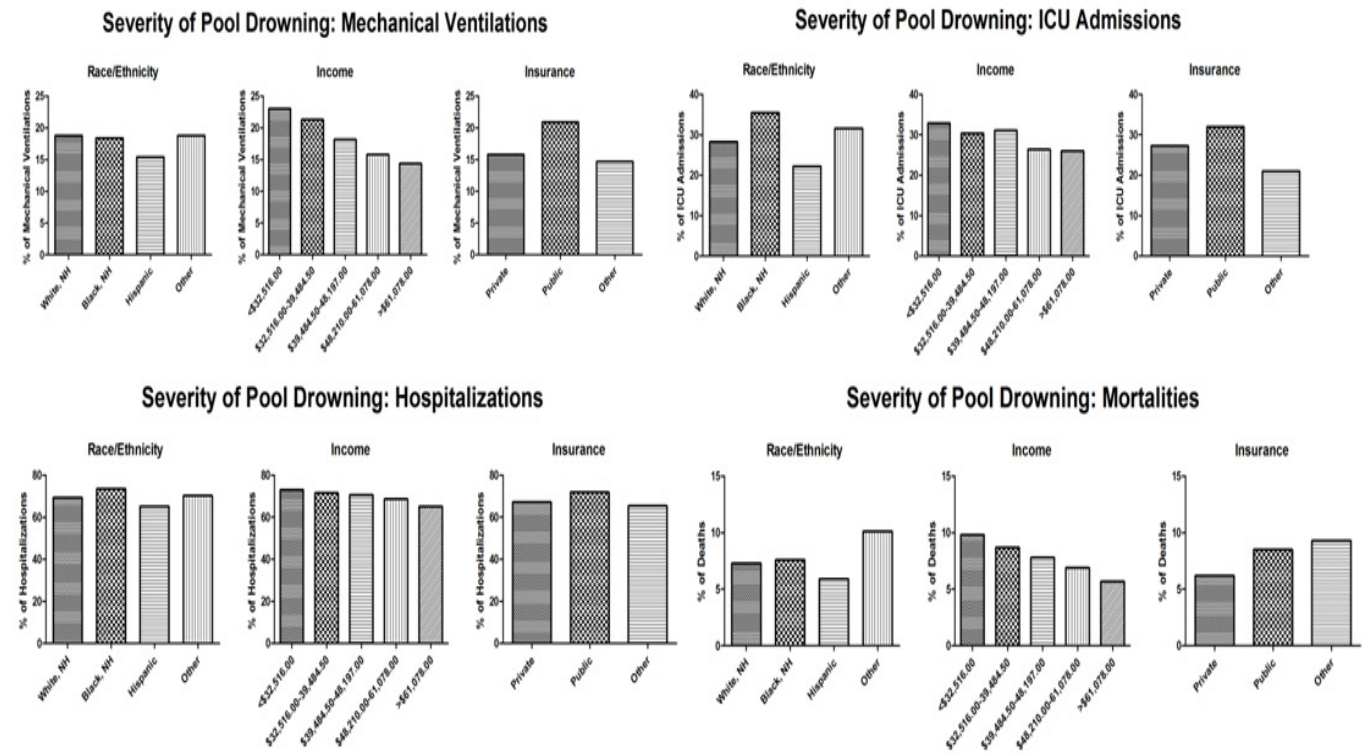

Figure 1 Severity of pool drowning based on race and income.

mechanical ventilation compared to patients from households in the highest income quintile (OR 1.32, 95% CI 1.05, 1.65). In addition, after adjusting for the gender, race, region, insurance type, and urban environments, patients with household incomes less than $39,484.00 had increased odds of requiring mechanical ventilation compared to patients from households with incomes greater than $61,078.00 (aOR 1.45, 95% CI 1.02, 2.06).

Intensive care unit admission

Of all pediatric pool-drowning victims, 29% required ICU admission. Black children had increased odds of requiring ICU admission compared to white children prior to any adjustments for other demographics (OR 1.40, 95% CI 1.14, 1.72). After adjustment for gender, race, region, and living in urban setting, there were no significant differences in ICU admission based on income quintile; however, publicly insured patients had increased odds of ICU admission compared to privately insured patients (aOR 1.18, 95% CI 1.00, 1.39).

Hospital admission

Approximately 70% of patients in the cohort were admitted. There were no differences in admission rates among racial/ethnic groups. While the bivariate analysis suggested that the lower three income levels (<$48,210.00) were more likely to be hospitalized in comparison to the highest income level (OR 1.28, 95% CI 1.07, 1.54), when adjusted for gender, race, region, insurance type, and living in urban setting there were no longer differences in hospital admission rates between income quintiles. After adjustment, publicly insured pool drowning victims had increased rates of hospital admission as compared to privately insured patients (aOR 1.19, 95% CI 1.00, 1.41).

Discussion

In this study we differentiated racial/ethnic disparities in severity of pool drowning from socioeconomic disparities. Historically, Hispanic and black males greater than 10 years of age had a higher rate of drowning compared to white males [10], and white children had higher rates of non-fatal pool drowning when compared to other races [5]. This is the first study we are aware of to address racial/ethnic and socioeconomic disparities specifically in pool drowning severity.

From 2007 to 2017 patients with public insurance and those from the lowest income households had increased odds of experiencing more severe pool drownings. Specifically, patients from lower income groups had higher rates of mechanical ventilation and mortality. In contrast, there was no difference in rates of mortality and mechanical ventilation amongst different racial/ethnic groups. Interestingly, we found no difference in hospital admission and intensive care unit admission amongst income groups; however, patients with public insurance were more likely to be admitted to the hospital and the ICU as compared to privately insured patients. Household income and insurance status are both markers for socioeconomic status and therefore, we concluded that worse outcomes in pool related drownings were associated with socioeconomic status.

Previous findings indicate that patients in the US with self-payer insurance have worse drowning outcomes in general pediatric

drowning [11]. In a Canadian sample, unintentional drownings in all ages are associated with higher mortality in individuals who do not have a high school education, who are from the lowest income quintile, and who are not in a professional/managerial occupation, regardless of race/ethnicity. Other countries that have studied SES and drowning mortality in pediatrics have demonstrated conflicting results [12-15]. There are no previous studies focused on socioeconomic status and pediatric pool specific related drowning severity in the United States.

This study did not demonstrate any significant difference in severity of pool drowning based on race/ethnicity. This is in contrast to a previous studies that demonstrated that non-white patients were more likely to experience fatal pool drownings, even when controlling for income [10,16]. In these prior studies, income levels were estimated using zip codes matched with US census data. In contrast, when adjusting for actual income quintiles, we found that there were no increased odds of mortality, mechanical ventilation use, and hospital or ICU admission in black and Hispanic races compared to white children. It is likely that our study more accurately controlled for income when compared to prior studies that used extrapolated income information. Another potential reason for the different outcome in our study could be related to the strategy of forming income categories. Previous studies divided income into tertiles using census data with almost 50% of the population who drowned being included in the lowest income tertile. In contrast, we divided income by quintiles of study population, creating more nuanced study groups.

Previous studies have identified risk factors for mortality in pediatric drowning to be poor swimming skills [2]. Patients from lower socioeconomic levels may have less access to swim lessons resulting in more severe drownings. Continuing to provide swimming education to children from communities with lower socioeconomic status is an important intervention to help close the gap in drowning severity. Previous studies have demonstrated that the risk of drowning is 2.7 times more likely in a child in multifamily residences (apartment buildings) as compared to single family home, and specifically a child is 28 times more likely to drown in a multifamily swimming pool compared to single-family pool [17]. Lower income children are more likely to swim in apartment building pools and public community pools, have inadequate supervision and be swimming in pools with faulty or open pool gates, factors which have been associated with higher mortality in pediatric drowning.

Limitations

There are several important limitations in this study. A major limitation is that many pediatric hospitals did not contribute data to PHIS consistently during 2007-2017, the time period covered by this study. Hospitals that did not contribute data consistently were eliminated and many of these hospitals included West coast hospitals in warm climates where children are more likely to swim in pools more frequently. This may have resulted in underrepresentation of pool drownings in our sample.

In using a large database such as PHIS for data, we are limited by the way data is entered into the electronic medical record. Capturing all pool drownings was dependent on providers/institutions coding patient visits specifically with an ICD code representing pool drowning as opposed to a generic drowning code. It is possible that many pool drowning cases were missed due to lack of specification of drowning type. In addition, PHIS contains de-identified data and therefore, reviewing charts to capture pool drownings that were not coded specifically by location of drowning, was not possible. PHIS also only includes data from large children's hospitals and majority of children presenting to Emergency Departments tend to present to smaller community hospitals. As a result, this data may not be representative of the US population as a whole. We were also limited to the severity parameters included in the PHIS database. Parameters such as the duration of submersion or the Glasgow-Pittsburgh coma scale to classify neurologic outcomes are not readily available in the PHIS database. There were a large amount of patients with "unknown" race that experienced more severe drowning. It is possible that given the clinical condition of these patients no race/ethnicity data was collected and entered.

In addition, it is difficult to determine length of hospital or ICU stay using PHIS and therefore, there may be significant difference in severity among patients grouped together by ICU or hospital admission. Many hospitals have drowning protocols that require pediatric patients to be admitted to either the general floor or ICU for a brief observation period.

Conclusion

This study did not observe any significant differences in drowning severity based on race/ethnicity. This study did however demonstrate that children who drown in pools who are from lower socioeconomic backgrounds are more likely to experience more severe drownings, including increased odds of death, mechanical ventilation use, ICU admission and hospital admission. The results of this study suggest the need to implement policies that improve pool supervision, lifeguard presence and secure gates for pools in low-income communities.

Conflict of Interest

None of the authors have potential conflicts of interest to disclose.

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