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Epidemiology of paediatric drowning hospitalisations in the USA: a population-based study

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Abstract

Background—Drowning is a leading cause of death in children ≤5 years old. Detailed data on the epidemiology of drowning in this high-risk population can inform preventative efforts. We aimed to study trends in incidence and case fatality rates (CFR) in the USA among young children hospitalised after drowning.

Methods—Children ≤5 years old hospitalised in the USA after drowning were identified from the Kids Inpatient Database 2000–2016. Incidence and CFRs by calendar year, age, sex, race/ethnicity and hospital region were calculated. Trends over time were evaluated. Factors associated with fatal drowning were assessed.

Results—Among 30 560 804 hospitalised children ≤5 years old, 9261 drowning cases were included. Patients were more commonly male (62.3%) and white (47.4%). Two years old had the

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highest incidence of hospitalisation after drowning, regardless of race/ethnicity, sex and region. Overall drowning hospitalisations decreased by 49% from 2000 to 2016 (8.38–4.25 cases per 100 000 children). The mortality rate was 11.4% (n=1060), and most occurred in children ≤3 years old (83.0%). Overall case fatality decreased between 2000 and 2016 (risk ratio (RR) 0.44, 95% CI 0.25 to 0.56). The lowest reduction in incidence and case fatality was observed among Black children (Incidence RR 0.92, 95% CI 0.75 to 1.13; case fatality RR 0.80, 95% CI 0.41 to 1.58).

Conclusions—Hospitalisations and CFRs for drowning among children ≤5 years old have decreased from 2000 to 2016. Two years old are at the highest risk of both fatal and non-fatal drowning. Disparities exist for Black children in both the relative reduction in drowning hospitalisation incidence and case fatality. Interventions should focus on providing equitable preventative care measures to this population.

INTRODUCTION

Drowning is responsible for 7% of all fatal injuries worldwide.[1] In the USA, unintentional drowning has resulted in over 60 000 deaths in all age groups from 2001 to 2018.[2] Drowning is the leading cause of death in children aged 1–4 and the second-leading cause of death of children aged 5–9 years old.[3] This has spurred efforts at the state and national level to reduce fatal and non-fatal drowning among children in the USA, including the Virginia Graeme Baker Pool and Spa Safety Act of 2008, a federal law that instituted standards for minimum pool safety features, including barriers to unintended access by children, drain covers and alarms, and dedicated millions of dollars to state governments to support water safety education.[4] Despite evidence that foursided pool fencing prevents paediatric drowning deaths, there is currently no federal requirement for pool fencing in the USA.[5 6]

Although rates of paediatric drowning have decreased among children<18 years old within the USA, little is known about how these trends apply specifically to children aged ≤5.[7–9] Drowning incidence among US children ages 0–4 has varied between 9.3 and 5.6 cases per 100 000 from 1998 to 2008, which is significantly higher than the incidence for all other age groups under 20 years of age.[7] Similarly, between 2003 and 2016, children aged 0–5 comprised the majority of both non-fatal and fatal drowning cases among all age groups under 20.[10]

Previously published studies lack comprehensive analyses of trends among very young children, the highest risk age group. We aimed to perform an epidemiological analysis of hospitalisations for fatal and non-fatal drowning in children aged 0–5 in the USA to identify disparities that can inform the development of state and federal policies targeted at preventing these tragic deaths.

METHODS

Study design and data source

Patients or the public were not involved in the design, conduct, reporting or dissemination plans of our research. Cases were extracted from the Kid's Inpatient Database (KID), a Healthcare Cost and Utilisation Project (HCUP) database. Hospital discharges are sampled primarily from paediatric populations, capturing more patients under age 21 compared with

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other HCUP databases. Hospital discharge data from KID is available every 3 years, except for the 2016 database, which was released after 4 years to account for the change from International Classifications of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) to ICD-10-CM coding. These data are reported through a network of participating community- based, non-rehabilitation hospitals from numerous states. Hospital participation has increased from 2784 hospitals in 27 states in 2000, to 4200 hospitals with paediatric hospitalisations in 47 states in 2016. For this study, data from 2000, 2003, 2006, 2009, 2012 and 2016 were used. All participating hospitals are in the USA.

Patient selection and exposure

Children ≤5 years old at the time of drowning were included. Drowning was defined by the ICD-9-CM diagnostic code 994.1 from 2000 to 2012 and the ICD-10-CM diagnostic code T75.1XXA in 2016. The ICD-10-CM diagnostic codes used to define drowning are specific to initial encounters.

Patient and hospital factors

The age of children in this study is the age at admission in years. Race/ethnicity is self-reported and captured into the following categories: white, Black, Hispanic, Asian or Pacific Islander, Native American or Alaskan Native and other. The KID database does not separately report race and ethnicity. Given small patient numbers, Native American or Alaskan Native, Asian or Pacific Islander and other race/ethnicity groups were aggregated into a single group noted as ‘other’. Estimates for incidence and case fatality are not explicitly reported for patients in the ‘other’ race/ethnicity group in this study given the challenges of defining appropriate denominators for groups not specifically defined (eg, other). Distribution of cases by census-defined geographical region, defined as the Northeast, Midwest, South and West, was analysed (online supplemental table 1). The season during which a drowning case was admitted to the hospital, was categorised into spring (March–May), summer (June–August), fall (September–November) and winter (December–February) based on the date of hospital admission.

Statistical analysis

Discharge weights provided by HCUP were used to generate national estimates. Incidence and case fatality rates (CFRs) were reported in cases per 100 000 children ≤5 years old. Incidence was defined as the number of survey-weighted drowning cases within each stratum divided by the total bridged-race estimates of children aged 0–5 from the National Center of Health Statistics.[11] CFRs were calculated similarly within each stratum, with deceased cases defined as cases who were recorded as dead at the time of discharge. The 95% CIs for incidence and case fatality were calculated by dividing the survey-weighted confidence intervals for the weighted drowning cases by the recorded population of children ages 0–5 years or per demographic group during that year. Risk ratios (RRs) for drowning incidence and case fatality in 2016 compared with 2000 were calculated overall and by demographic groups. Incidence and CFR in 2000 and 2016 were also illustrated by heat maps. Demographic differences between fatal and non-fatal drownings were evaluated by χ^2 tests. All statistical analyses were performed using SAS V.9.4 (SAS Institute).

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RESULTS

Overall characteristics of cohort

From 2000 to 2016, there were 9261 drowning cases out of 30 560 804 hospitalised children ≤5 years old (table 1). The mortality rate was 11.4% (n=1060). 62.3% were male (n=5766) and 47.4% (n=4388) were white. The most common region represented was the South (n=4196, 45.3%). Most patients were admitted on a weekday (n=5546, 59.9%) and in the summer (n=3983, 43.0%, table 1).

Incidence

From 2000 to 2016, overall incidence of hospitalisation after drowning decreased from 8.38 (95% CI 6.93 to 9.84) to 4.25 (95% CI 3.58 to 4.92) cases per 100 000 children ≤5 years old (table 2). The incidence among males was consistently higher than among females for all years, although the overall reduction in hospitalisations for drowning from 2000 to 2016 was similar by sex (RR 0.50, 95%CI 0.46 to 0.55 for males; RR 0.51, 95%CI 0.45 to 0.58 for females). Although all three race/ethnicity groups analysed experienced a reduction in hospitalisations for drowning from 2000 to 2016, the decline was not uniform. Hispanic children experienced the greatest decline in hospitalisations for drowning (67% reduction from 8.03 to 2.69 cases per 100 000), while Black children experienced the smallest decline in hospitalisations for drowning (8% reduction from 5.16 to 4.73 cases per 100 000). White children, in comparison, had a 45% reduction in hospitalisations for drowning (6.96 to 3.83 cases per 100 000). When looking at US regions, the South and West had consistently higher incidence per 100 000 children for each year compared with the Northeast and Midwest (range of 5.47–9.84 for the South, range of 4.95–12.51 for the West, range of 2.60–5.16 for the Northeast, range of 2.43–4.27 for the Midwest, table 2). The West had the greatest reduction in the risk of hospitalisation following drowning (RR 0.40, 95% CI 0.35 to 0.45).

Regardless of calendar year of injury, 2-year-old children had the highest incidence of drowning hospitalisations compared with children of all other age groups (15.3 cases per 100 000 in 2000 and 8.4 cases per 100 000 in 2016, table 2). Regardless of age, the incidence of drowning hospitalisation was consistently higher among males of all ages (online supplemental table 2, figure 1). Aside from 5-year-old females, all other age, sex and race/ethnicity groups experienced a reduction in risk of drowning hospitalisation from 2000 to 2016 (figure 1). The West experienced large decreases in drowning hospitalisations across all age groups from 2000 to 2016 (figure 2). Incidence per 100 000 among children ages 1 and 2 was highest in both 2000 and 2016 in the South (2000: 22.2 cases for 1 year, 15.8 cases for 2 years 2016: 5.9 cases for 1 year, 13.4 cases for 2 years) and the West (2000: 13.3 cases for 1 year, 24.8 cases for 2 years, 2016: 7.5 cases for 1 year, 7.5 cases for 2 years) (figure 2). By region, hospitalisations decreased from 2000 to 2016 among all age groups except for 3-year-old children in the South, who experienced a marginal increase of 1%.

Factors associated with fatal and non-fatal drownings

Overall mortality was 11.4% among hospitalised children following drownings. The proportion of fatal cases compared with non-fatal cases was higher in younger children (ages 0, 1 and 2), while the proportion of non-fatal cases was higher in older children (ages 3, 4

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and 5, p<0.0001, table 1). There was no association between race/ethnicity and drowning mortality (p=0.30). Most drowning cases took place on a weekday, regardless of fatality status (weekday cases 63.4% fatal and 59.4% non-fatal). Season was not associated with fatal or non-fatal drowning, even though most hospital admissions took place in the summer (46.9% fatal and 51.2% non-fatal).

Overall case fatality and case fatality by sex, race/ethnicity, region and age

Among all hospitalised children ≤5, the overall case fatality decreased by nearly half from 2000 to 2016 (RR 0.44, decrease from 1.05 to 0.45 deaths per 100 000, table 3). Females experienced a greater decrease in case fatality between 2000 and 2016 than males (male RR 0.48, decrease from 1.21 to 0.58 deaths per 100,000; female RR 0.35, decrease from 0.89 to 0.31 deaths per 100 000). Black children experienced the smallest decrease in case fatality between 2000 and 2016 (RR 0.80, decrease from 0.52 to 0.42 deaths per 100 000) while Hispanic children experienced the greatest decrease (RR 0.21, decrease from 0.97 to 0.20 deaths per 100 000). Children in the South and West had consistently higher CFRs in all years compared with the Northeast and Midwest. Case fatality was highest among children ages 1 and 2 for all years. The largest reduction in the risk of fatal drowning between 2000 and 2016 occurred among children aged 5 (RR 0.25, 95%CI 0.08 to 0.73, table 4). Among other age groups, this reduction of risk ranged from 33% to 70%.

DISCUSSION

In this large nationwide database study of 9261 hospitalisations for fatal and non-fatal drownings of children ≤5 years old from spanning 2000–2016, several trends were identified. Male children were consistently at an increased risk of drowning hospitalisation than female children, and the highest risk of drowning hospitalisation was observed among children of age 2. There was an overall 49% decrease in the incidence of drowning hospitalisations, with the greatest decrease occurring in Western states. However, this reduction in drowning hospitalisations was not observed equally among children of different races/ethnicities, with the lowest incidence reduction in Black children. The overall mortality was 11.4%, and CFRs decreased by half over the study period. CFRs were highest for children aged 1–2 years among most racial/ethnic and regional categories. To our knowledge, there is currently no study in the literature that documents the spike in drowning hospitalisations among 2-year-old children in the USA, as most studies aggregate children into larger age categories. Internationally, this age group has also been found to be the highest risk for drowning.[12–15]

Drowning hospitalisations decreased by half for male and female children from 2000 to 2016, although male children consistently had a higher incidence of drowning hospitalisation than female children of the same age. Other studies have shown a higher incidence of drowning among male children as compared with female children of similar age groups.[8 10 16 17] Similar reductions in drowning hospitalisations are also reflected in the literature. In a study utilising data from KID and the National Inpatient Sample (NIS), from 2003 to 2016, drowning hospitalisations decreased among children and adolescents ≤20 years old by 31%.[10] Similarly, in a study using NIS data, drowning hospitalisations

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decreased by 49% among all age groups <19 years from 1993 to 2008, from 4.2 cases per 100 000 to 2.6 cases per 100,000.[7] Among children aged 0–4 in the same study, drowning risk was reduced by 56%.[7] Not all studies, however, have reported long-term decreasing trends in drowning incidence. A study of the NIS and Nationwide Emergency Department Sample (NEDS) databases from 2006 to 2011 found that non-fatal drownings were stable, fluctuating minimally around 2 cases per 100 000 within the same age group.[8] These studies differ from ours because they primarily used the NIS database. We used the KID database specifically because it oversamples both newborn and non-newborn paediatric hospitalisations, thereby serving as an optimal database for studying hospitalisation trends among younger age groups, especially under the age of 1. The reasons for decreased drowning hospitalisations in this age group may reflect several contributing factors. As the NEDS reports on US emergency department (ED) visits but not hospitalisations, stable rates of non-fatal drownings in this dataset may reflect improved ED treatment and discharge capabilities for less severe cases. This may be due to advances in on-scene rescue and resuscitation, and prehospital transport. Three-quarters of paediatric drowning patients who present to the hospital are discharged from the ED and predictors of ED discharge include not requiring supplemental oxygen, normal chest radiography and no interventions performed at the scene.[18] A duration of monitoring can identify patients who can safely be discharged from the ED without admission.[19] In particular, many patients with normal oxygen saturations may be safely discharged home.[20] Clinical assessments such as the Paediatric Submersion Score may aid in the identification of patients who can safely discharge home from the ED, in the setting of normal mental status, normal respiratory rate, lack of dyspnoea or need for supplemental oxygen and lack of hypotension.[21] Advances such as these may have contributed to an overall decrease in hospitalisations following paediatric drownings.

By region, incidence of drowning hospitalisations in the South and West were both collectively higher than incidence in the Northeast and Midwest. The greatest decline in drowning hospitalisations occurred in Western states, which experienced a 60% decrease in drowning hospitalisations from 12.51 cases per 100 000 in 2000 to 4.95 cases per 100 000 in 2016. This finding is consistent with past literature using ECUP data, with drowning hospitalisations within the South and West being higher than drowning hospitalisations in the Northeast and Midwest from 1993 to 2008 among patients ≤19 years old, and among patients ≤20 years old from 2003 to 2016.[7 10] However, the greatest decline in drowning hospitalisation within this time and age group was within the South, with a decline of approximately 50%.[7] In comparison, we found a 46% decrease in drowning hospitalisations within the South from 2000 to 2016 among children ≤5 years old, which is a similar magnitude to that previously published, but not the highest regional decrease seen in our study.

The dramatic declines of hospitalisations following drowning in the South and West may be related to federal and state swimming pool drowning prevention policies. At the federal level, the Virginia Graeme Baker Pool and Spa Safety Act of 2008 required pool manufacturers to modify drainage systems to prevent small children from being sucked underwater and funnelled millions of dollars to state governments and pool owners for public education on pool safety.[4] Additionally, many states in different

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regions of the country have laws regulating residential pool fences, generally including requirements for self-latching gates, pool covers, and minimum fence height requirements to prevent unintentional access by children. Laws, city ordinances and building codes have been passed in the South, in Florida and Texas, and in the West, in California and Arizona.[22 23] In Florida, pool safety guidelines were implemented in 2000, while for the other states mentioned implementation began in either the early or late 1990s.[24–27] Despite implementation of similar state guidelines, the differing declines in drowning hospitalisations by region are notable. The efficacy of such legislation has not been well studied in the USA. One study from Los Angeles, California, found no association between pool fence ordinances and reduction in childhood drownings from 1990 to 1995.[28] However, in Australia, there was a significant decrease in childhood drownings after implementation of pool fencing legislation.[29] Updated analyses of the effects of state and federal legislation on drowning prevention in the USA are needed.

We noted disparate reductions of drowning hospitalisations from 2000 to 2016 when the data were analysed by race/ethnicity. Although children of all three races/ethnicity categories experienced reductions in drowning hospitalisations, Hispanic children experienced the most dramatic reduction (67%) while Black children experienced the least dramatic reduction (8%). This is supported by literature on the presence of disparities in drowning. Black children, in particular, have been found to have a greater risk of drowning compared with white children.[8 10 30 31] From 2006 to 2011, among children ages 0–4, Hispanic and Black children both had over 25 cases per 100 000 whereas white children had an incidence of 6.8 hospitalisations per 100 000.[8] Both Hispanic and Black males aged 5–24 experienced a greater risk of drowning in swimming pools than white children.[30] Several contributing factors may explain these racial/ethnic disparities. A survey-based study of children aged 4–11 years old conducted in both 2010 and 2017 found unchanged rates of no or low self-reported swimming ability among Black children (69% in 2010 vs 66% in 2017), while the proportion of Hispanic children reporting no or low swimming ability decreased (58% in 2010 vs 45% in 2017).[32] Mortality data from the US CDC has found an increasing disparity in the rates of drowning deaths among people <30 years old when comparing Black persons to white persons from 2005 to 2019. When comparing Hispanic persons to white persons, the relative risk of drowning decreased from 1999 to 2015, with no changes from 2015 to 2019. Interestingly, these data did not find disparities in drowning rates among Black children aged 1–4 compared with white children of the same age.[33] These racial/ethnic differences could be explained by gaps in current drowning prevention laws, inequality in community outreach and resources such as access to swim lessons, or potentially differing medical care if children of different race/ethnicity may be less likely to be discharged home after a drowning event, and further research should address these disparities. Also, given the reduction in drowning hospitalisations among Hispanic children, future efforts should investigate the factors contributing to this reduction and analyse their applicability to children of other high-risk groups.

Many of the trends we noted in drowning hospitalisations applied to drowning CFRs as well. Case fatality decreased from 1.05 to 0.45 cases per 100 000 between 2000 and 2016 in our cohort, a 56% reduction in fatal drowning risk among hospitalised patients. Although children of all races/ethnicities experienced a decrease in case fatality between

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2000 and 2016, Black children also had the lowest reduction in CFR, suggesting continued disparities in the care of these children. Likewise, males consistently displayed a higher CFR than females for all years studied. This trend is also reflected among both children and adolescents in the NIS from 2003 to 2016, with a 46% reduction in case fatality among patients ≤20 years old.[10] Similarly, a 42% reduction in case fatality was recorded among patients ≤19 years old from 1993 to 2008.[7] The reasons for these reductions are likely multifactorial, but have not been directly studied. There is evidence that educational interventions aimed at adolescents increases beach safety knowledge,[34] but this is less practical to study in children ≤5 years old. Swimming lessons aimed at young children have been found to be effective in increasing swimming ability.[35] In this young age group, in particular, caregiver knowledge of cardiopulmonary resuscitation (CPR), is critical, and education and training in CPR has been effective in improving the confidence and ability of caregivers to perform CPR.[36] There is evidence that bystander CPR is associated with improved rates of survival after drowning.[37] Education on how to best respond to a drowning event can be provided by incorporating the Drowning Chain of Survival, aimed at increasing knowledge of prevention, recognition, rescue efforts and delivery of appropriate medical care.[38] In the hospital setting, improvements in paediatric ED readiness for the care of children have been noted which may have contributed to improved drowning CFRs.[39] Advanced in-hospital resuscitation measures, including extracorporeal life support (ECLS), may also contribute to decreased mortality, with a survival rate of 80% among victims of drowning/suffocation treated with ECLS from the National Trauma Data Bank.[40] Additionally, data from the Extracorporeal Life Support Organization reveal a 51% survival in drowning patients undergoing ECLS.[41] While these clinical advances in care may contribute to reduced mortality among paediatric drowning patients, the effect of state and federal policy on drowning hospitalisations and mortality in the USA is less well known.

Limitations

This study has several limitations. The data are limited to participating hospitals in the USA only. The first is that the drowning diagnoses were based on administrative billing codes. Because HCUP changed its methodology of recording diagnoses and procedures from ICD-9 to ICD-10 in late 2015, misclassification bias may affect the 2016 measurement of drowning hospitalisations. Unlike ICD-10 coding, ICD-9 coding does not account for encounter-level information, and it is possible that the drowning hospitalisations for 2016 are lower than other years because drowning hospitalisations in sequelae were not excluded from 2000 to 2012. The potential inconsistencies with external cause codes regarding unintentional drowning between the ICD-9 and ICD-10 have been noted previously,[41] and it is possible that they extend to diagnostic codes as well. Even so, we believe that reporting the most updated numbers, while acknowledging the code change, is the best way to acquire a holistic view of these trends at large. Furthermore, the only study we found which analysed HCUP data through the ICD-9 to ICD-10 code change also noted a decrease in drowning hospitalisations between 2012 and 2016. This supports the validity of our finding of a decrease in drowning hospitalisations, even if the exact magnitude may not be entirely accurate.[10] Coding limitations also extend to our ability to report on the setting of the drowning incident, as many are coded as ‘unspecified’ location, limiting the utility of that data. A second limitation is that the KID database only includes inpatient hospitalisations,

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thus less severe cases not requiring hospitalisations, such as ED or outpatient visits, and more severe cases where the patient died at the scene of drowning, were not included. The KID database also does not provide longitudinal data, so long-term outcomes cannot be assessed. Third, due to low case numbers of children who were Asian or Pacific Islanders, Native Americans and Alaskan Natives or of other races/ethnicities, as well as a lack of bridged-race NCHS data on other races/ethnicities, we could not assess drowning trends in these demographic groups. The KID database does not separately report race and ethnicity. Future studies on drowning could study these populations by using cohorts with significant representation these understudied racial/ethnic groups. Lastly, the decision to hospitalise a child who drowns is dependent on the physician's assessment of the patient and may vary across different practice settings and hospital systems.

CONCLUSION

Although the incidence and CFRs of children hospitalised following drowning have declined from 2000 to 2016, disparities in age and race/ethnicity remain. Children aged 1 and 2 years consistently had much higher hospitalisation rates and CFRs compared with ages 3–5 from 2000 to 2016. Moreover, although Black children did not have a higher rate of drowning hospitalisations compared with white or Hispanic children in the same age group, they experienced the smallest improvement in the risk of drowning hospitalisation. The consistency of these disparities over a 16-year period despite an overall reduction in drowning hospitalisations reflect the need for more research to discern factors that contribute to the increased risk among younger children as well as the need for more robust and targeted interventions towards Black children, 1-year-old and 2-year-old children, and children in the Southern and Western USA.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Data availability statement

No data are available.

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What is already known on the subject

- Drowning is a leading cause of death in children ≤5 years old.
- Overall rates of paediatric drowning have decreased among children of all ages.
- Limited data are available on age-based trends in drowning hospitalisations and case fatality rates in the USA.

What this study adds

- The overall rates of drowning hospitalisations and case fatality have decreased for children ≤5 years old from 2000 to 2016 in the USA.
- Two-year-old children are at highest risk for hospitalisation after fatal and non-fatal drowning.
- Disparities are evident, with the lowest reduction in hospitalisations and case fatality rates seen in Black children.

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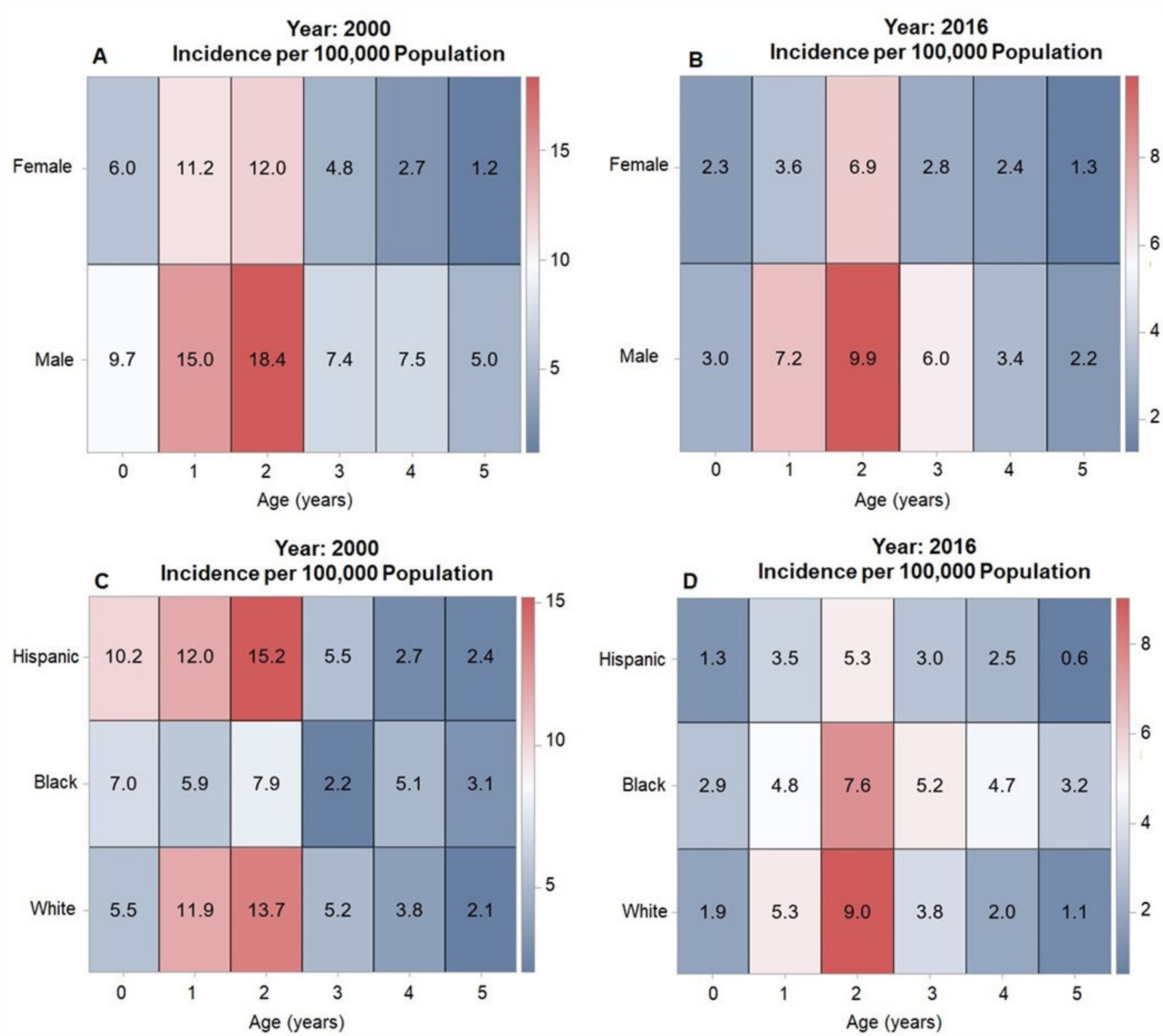

Figure 1.

Annual incidence of drowning hospitalisations stratified by age, gender and race/ethnicity for the years 2000 and 2016.

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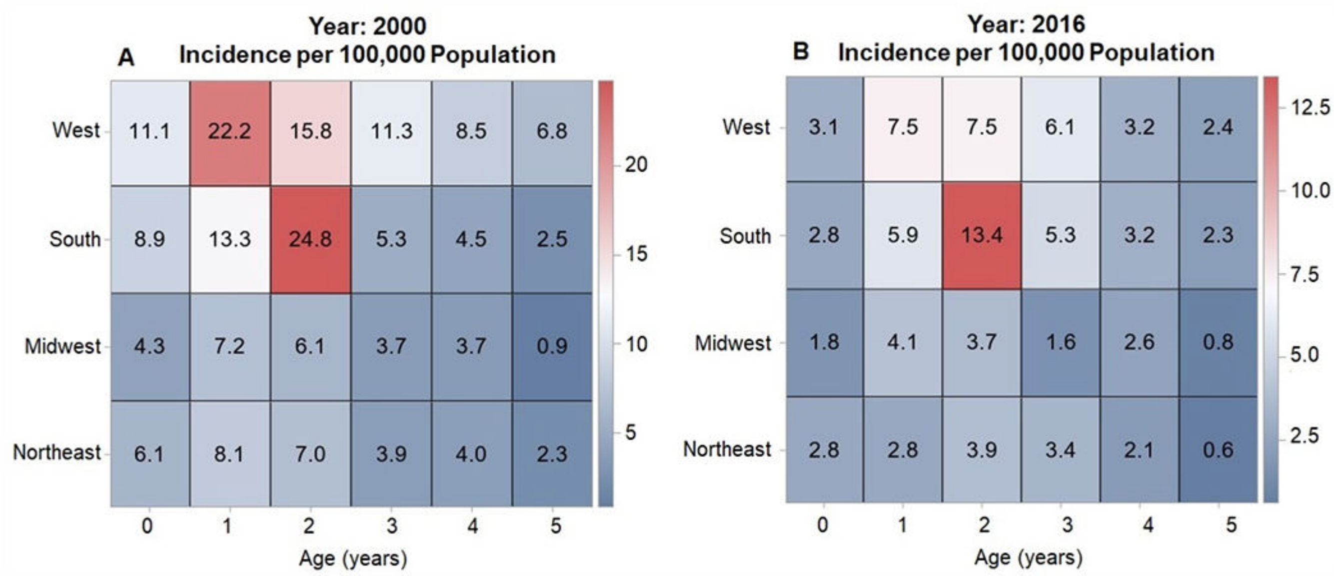

Figure 2.

Annual incidence of drowning hospitalisations stratified by age and region for 2000 and 2016.

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Table 1

Characteristics of drowning-related hospital admissions among children ages 0–5 years

Variable	All cases n=9261	Fatal cases n=1060 (11.4%)	Non-fatal cases n=8197 (89.6%)	P value
Male, n (%)	5766 (62.3)	676 (63.8)	5090 (62.1)	0.53
Age in years, n (%)				<0.0001
0	1163 (12.6)	147 (13.8)	1015 (12.4)	
1	2158 (23.3)	295 (27.9)	1862 (22.7)	
2	3067 (33.1)	386 (36.4)	2680 (32.7)	
3	1298 (14.0)	128 (12.1)	1168 (14.3)	
4	935 (10.1)	53 (5.0)	882 (10.8)	
5	641 (6.9)	52 (4.9)	589 (7.2)	
Race/ethnicity, n (%)†				0.30
White	4388 (47.4)	518 (48.9)	3869 (55.0)	
Black	1061 (11.5)	99 (9.3)	963 (13.7)	
Hispanic	1671 (18.0)	184 (17.4)	1487 (21.1)	
Other*	821 (8.86)	103 (9.7)	716 (10.2)	
Region, n (%)				1.0
Northeast	888 (9.6)	98 (9.2)	789 (9.6)	
Midwest	1187 (12.8)	135 (12.7)	1050 (12.8)	
South	4196 (45.3)	485 (45.8)	3711 (45.3)	
West	2990 (32.3)	342 (32.3)	2647 (32.3)	
Day of drowning, n (%)				0.03
Weekday	5546 (59.9)	672 (63.4)	4871 (59.4)	
Weekend	3715 (40.1)	388 (36.6)	3326 (40.6)	
Season of drowning, n (%)*				0.23
Spring	1990 (21.5)	268 (25.3)	1720 (21.0)	
Summer	3983 (43.0)	438 (41.3)	3544 (43.2)	
Fall	1176 (12.7)	140 (13.2)	1036 (12.6)	
Winter	703 (7.6)	87 (8.3)	616 (7.5)	

*Fall: September–November, Winter: December–February, Spring: March–May, Summer: June–August.

†'Other' race/ethnicity includes Native American or Alaskan Native, Asian or Pacific Islander, and unlisted. Number of survey-weighted cases with missing data pervariable: race/ethnicity (1319); mortality (4); month of admission (1408).

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Table 2

Incidence of drowning hospitalisations per 100 000 children ages 0–5 years and 95% CIs

Variable	Year of hospital discharge						Risk ratio (2016/2000)
	2000	2003	2006	2009	2012	2016	
All cases	8.38 (6.93 to 9.84)	6.78 (5.87 to 7.69)	6.09 (5.01 to 7.17)	6.74 (5.72 to 7.76)	6.69 (5.67 to 7.71)	4.25 (3.58 to 4.92)	0.51 (0.47 to 0.55)
Sex							
Male	10.43 (8.37 to 12.49)	8.22 (6.98 to 9.45)	7.51 (6.14 to 8.89)	7.74 (6.51 to 8.96)	8.30 (7.01 to 9.58)	5.26 (4.38 to 6.15)	0.50 (0.46 to 0.55)
Female	6.25 (5.09 to 7.40)	5.06 (4.31 to 5.82)	4.39 (3.50 to 5.28)	5.53 (4.60 to 6.46)	4.98 (4.11 to 5.84)	3.19 (2.62 to 3.76)	0.51 (0.45 to 0.58)
Race/ethnicity							
White	6.96 (5.59 to 8.32)	5.23 (4.32 to 6.14)	4.95 (3.93 to 5.98)	5.84 (4.85 to 6.82)	6.35 (5.33 to 7.37)	3.83 (3.10 to 4.57)	0.55 (0.49 to 0.62)
Black	5.16 (3.65 to 6.67)	5.12 (3.62 to 6.62)	3.34 (2.20 to 4.48)	5.37 (4.06 to 6.67)	5.70 (4.29 to 7.10)	4.73 (3.66 to 5.80)	0.92 (0.75 to 1.13)
Hispanic	8.03 (5.91 to 10.14)	4.71 (3.43 to 6.00)	5.12 (3.57 to 6.67)	4.96 (3.62 to 6.29)	5.16 (3.76 to 6.56)	2.69 (2.03 to 3.35)	0.33 (0.28 to 0.40)
Region							
Northeast	5.16 (3.46 to 6.87)	3.60 (2.44 to 4.76)	2.89 (1.84 to 3.94)	4.30 (2.91 to 5.70)	3.92 (2.51 to 5.33)	2.60 (1.63 to 3.56)	0.50 (0.40 to 0.64)
Midwest	4.27 (1.96 to 6.58)	4.56 (3.31 to 5.81)	3.90 (2.74 to 5.06)	3.97 (2.76 to 5.17)	3.74 (2.82 to 4.65)	2.43 (1.61 to 3.25)	0.57 (0.46 to 0.71)
South	9.84 (6.98 to 12.69)	8.11 (5.99 to 10.19)	7.14 (5.03 to 9.25)	8.12 (6.18 to 10.05)	8.66 (6.68 to 10.65)	5.47 (4.13 to 6.80)	0.56 (0.50 to 0.62)
West	12.51 (8.69 to 16.34)	9.12 (6.52 to 11.72)	8.59 (5.68 to 11.5)	8.66 (5.56 to 11.25)	7.99 (5.28 to 10.71)	4.95 (3.30 to 6.61)	0.40 (0.35 to 0.45)
Age							
0	7.87 (5.99 to 9.75)	5.29 (4.00 to 6.58)	4.54 (3.36 to 5.73)	4.96 (3.97 to 5.94)	4.15 (3.27 to 5.02)	2.64 (1.92 to 3.36)	0.34 (0.27 to 0.42)
1	13.13 (10.43 to 15.82)	9.85 (7.98 to 11.72)	8.91 (6.76 to 11.07)	8.99 (7.29 to 10.70)	8.40 (6.69 to 10.10)	5.40 (4.20 to 6.61)	0.41 (0.35 to 0.48)
2	15.26 (11.44 to 19.09)	14.01 (11.19 to 16.83)	13.11 (9.98 to 16.23)	13.80 (10.87 to 16.74)	12.59 (9.90 to 15.27)	8.42 (6.68 to 10.17)	0.55 (0.48 to 0.63)
3	6.12 (4.59 to 7.64)	5.35 (4.22 to 6.49)	4.37 (3.30 to 5.43)	6.10 (4.81 to 7.38)	6.58 (5.20 to 7.96)	4.44 (3.39 to 5.48)	0.73 (0.60 to 0.88)
4	5.16 (3.49 to 6.82)	3.39 (2.43 to 4.36)	3.11 (2.13 to 4.10)	3.94 (3.02 to 4.86)	5.04 (3.87 to 6.20)	2.88 (2.16 to 3.60)	0.56 (0.44 to 0.70)
5	3.12 (2.25 to 3.98)	2.43 (1.76 to 3.09)	2.57 (1.81 to 3.32)	2.57 (1.83 to 3.31)	3.55 (2.78 to 4.33)	1.72 (1.19 to 2.25)	0.55 (0.41 to 0.74)

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Table 3

Drowning case fatality rates and 95% CIs among hospitalised patients

	Year of hospital discharge						
Variables	**2000**	**2003**	**2006**	**2009**	**2012**	**2016**	**Risk ratio (2016/2000)**
All cases	1.05 (0.73 to 1.37)	0.86 (0.67 to 1.05)	0.67 (0.48 to 0.86)	0.65 (0.49 to 0.82)	0.78 (0.61 to 0.94)	0.45 (0.34 to 0.56)	0.44 (0.35 to 0.56)
Sex							
Male	1.21 (0.78 to 1.64)	1.17 (0.87 to 1.46)	0.96 (0.66 to 1.26)	0.69 (0.48 to 0.90)	0.97 (0.72 to 1.21)	0.58 (0.41 to 0.75)	0.48 (0.36 to 0.64)
Female	0.89 (0.50 to 1.27)	0.53 (0.36 to 0.71)	0.37 (0.22 to 1.33)	0.61 (0.40 to 0.82)	0.56 (0.39 to 0.73)	0.31 (0.20 to 0.43)	0.35 (0.24 to 0.52)
Race/ethnicity							
White	0.73 (0.48 to 0.97)	0.80 (0.58 to 1.02)	0.60 (0.36 to 0.84)	0.57 (0.37 to 0.77)	0.81 (0.59 to 1.03)	0.39 (0.25 to 0.54)	0.54 (0.39 to 0.76)
Black	0.52 (0.14 to 0.90)	0.52 (0.14 to 0.91)	0.45 (0.15 to 0.75)	0.28 (0.08 to 0.48)	0.55 (0.27 to 0.82)	0.42 (0.18 to 0.66)	0.80 (0.41 to 1.58)
Hispanic	0.97 (0.45 to 1.49)	0.57 (0.27 to 0.87)	0.61 (0.30 to 0.92)	0.47 (0.23 to 0.71)	0.59 (0.34 to 0.84)	0.20 (0.08 to 0.32)	0.21 (0.11 to 0.39)
Region							
Northeast	0.72 (0.30 to 1.14)	0.48 (0.24 to 0.73)	0.22 (0.00 to 0.47)	0.30 (0.11 to 0.48)	0.43 (0.17 to 0.69)	0.32 (0.08 to 0.56)	0.45 (0.23 to 0.87)
Midwest	0.73 (0.00 to 1.58)	0.40 (0.15 to 0.65)	0.35 (0.18 to 0.53)	0.40 (0.21 to 0.59)	0.48 (0.27 to 0.69)	0.22 (0.02 to 0.43)	0.31 (0.16 to 0.60)
South	1.10 (0.64 to 1.56)	1.15 (0.67 to 1.62)	0.83 (0.50 to 1.17)	0.78 (0.42 to 1.14)	1.04 (0.70 to 1.38)	0.58 (0.40 to 0.77)	0.53 (0.38 to 0.74)
West	1.52 (0.71 to 2.34)	1.13 (0.66 to 1.60)	1.01 (0.45 to 1.58)	0.91 (0.54 to 1.28)	0.84 (0.47 to 1.21)	0.52 (0.24 to 0.80)	0.34 (0.23 to 0.52)

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Table 4

Case fatality rates associated with drowning hospitalisations and 95% CIs by age

	Year of hospital discharge						
	2000	**2003**	**2006**	**2009**	**2012**	**2016**	**Risk ratio (2016/2000)**
Overall	1.05 (0.73 to 1.37)	0.86 (0.67 to 1.05)	0.67 (0.48 to 0.86)	0.65 (0.49 to 0.82)	0.78 (0.61 to 0.94)	0.45 (0.34 to 0.56)	0.44 (0.35 to 0.56)
Age in years							
0	0.82 (0.31 to 1.33)	1.75 (0.99 to 2.50)	2.23 (1.33 to 3.13)	0.83 (0.31 to 1.35)	0.31 (0.06 to 0.56)	0.42 (0.14 to 0.69)	0.52 (0.29 to 0.94)
1	0.61 (0.30 to 0.93)	1.50 (0.98 to 2.02)	2.17 (1.41 to 2.92)	0.47 (0.20 to 0.74)	0.17 (0.02 to 0.31)	0.20 (0.00 to 0.43)	0.30 (0.18 to 0.49)
2	0.44 (0.18 to 0.69)	1.29 (0.73 to 1.85)	1.62 (0.92 to 2.32)	0.42 (0.16 to 0.68)	0.12 (0 to 0.26)	0.16 (0.00 to 0.36)	0.47 (0.33 to 0.68)
3	0.74 (0.38 to 1.11)	1.00 (0.57 to 1.43)	1.16 (0.69 to 1.64)	0.56 (0.27 to 0.86)	0.25 (0.07 to 0.44)	0.19 (0.02 to 0.35)	0.47 (0.26 to 0.87)
4	0.68 (0.37 to 0.98)	1.44 (0.96 to 1.92)	1.49 (0.99 to 1.99)	0.58 (0.32 to 0.84)	0.28 (0.09 to 0.47)	0.23 (0.07 to 0.39)	0.67 (0.28 to 1.63)
5	0.42 (0.18 to 0.67)	0.53 (0.23 to 0.82)	1.06 (0.67 to 1.44)	0.39 (0.18 to 0.61)	0.21 (0.06 to 0.36)	0.10 (0 to 0.22)	0.25 (0.08 to 0.73)