Population-based study of factors associated with severe paediatric drowning events in Maryland

Katherine Macmillan ,[1,2] Katherine Hoops,[3,4] Sapna Kudchadkar,[3] Andrea C Gielen,[5] Eileen M McDonald ,[4,6] Laura Prichett,[7] Isam Nasr,[8] Leticia Manning Ryan [8]

For numbered affiliations see end of article.

Correspondence to
Dr Katherine Macmillan, Critical Care Medicine, Children's Mercy Kansas City Adele Hall Campus, Kansas City, Missouri, USA; kgmacmillan@cmh.edu

Parts of this work have been presented nationally at Pediatric Critical Care Colloquium 2022 and Society of Critical Care Medicine Congress 2023. Macmillan, Katherine1; Hoops, Katherine2; Kudchadkar, Sapna2; Gielen, Andrea3; McDonald, Eileen3; Pritchett, Laura4; Nasr, Isam2; Ryan, Leticia2. 260: Population-based study of factors associated with hospitalization of pediatric drowning in Maryland. *Critical Care Medicine* 51(1):p 115, January 2023. | DOI: 10.1097/01.ccm.0000906776.61732.e1.

To cite: Macmillan K, Hoops K, Kudchadkar S, *et al*. *Inj Prev* Epub ahead of print: [*please include* Day Month Year]. doi:10.1136/ip-2023-045160

ABSTRACT

Introduction Paediatric drowning is an injury associated with significant morbidity and mortality.
Objective The objective is to describe drowning trends, including associations with inpatient hospitalisation or fatality, in a state-wide paediatric cohort to inform prevention strategies.
Methods In this retrospective cohort study using the Health Services Cost Review Commission database, we used International Classification of Diseases, Tenth Revision (ICD-10) codes to identify patients aged 0–19 years with an outpatient (including emergency department) or inpatient medical encounter following a non-fatal or fatal drowning event between 2016 and 2019. Descriptive statistics and logistic regression were used to summarise the data and evaluate associations with inpatient hospitalisation or fatality.
Results There were 541 medical encounters for drowning events, including 483 non-fatal outpatient encounters, 42 non-fatal inpatient encounters and 16 fatal cases. Overall, most patients were boys, 0–4 years, white and lived in urban settings. White children accounted for 66% of encounters among those aged 0–4 years, whereas non-white children accounted for 62% of visits among those aged 10–19 years. Non-white children were more likely than white children to experience a fatal drowning (OR 3.6, 95% CI: 1.2 to 11.5). Adolescents were more likely than younger children to be hospitalised (OR 3.1, 95% CI: 1.6 to 6.5) and had higher charges in outpatient (p=0.002) and inpatient settings (p=0.003).
Discussion Our study revealed high fatality rates among non-white children and high admission rates among adolescents.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Drowning is a significant source of paediatric morbidity and mortality with known racial disparities.
⇒ Despite awareness of drowning risk among those in the medical field and injury prevention sectors, drowning remains a leading cause of death during childhood.

WHAT THIS STUDY ADDS

⇒ In this population-based analysis, although most drowning-related medical encounters occurred in young children, adolescents were more likely to be hospitalised.
⇒ Race-related risk varied by age group.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Future research can further investigate why fatality varies by race.
⇒ This analysis reveals some trends related to hospitalisation risk based on age and could alter anticipatory guidance for adolescents.
⇒ Providing current epidemiology informs policymakers of areas that need to be addressed.

INTRODUCTION

Fatal drowning was the leading cause of injury-related death in children ages 1–4 years and was within the top seven causes of death by unintentional injury in 2018 for all age groups.[1–3] While 6% of injury-related emergency department (ED) visits led to admission in the USA, drowning resulted in a disproportionately high number of injury-related hospitalisations, with 50% of ED visits for non-fatal drowning leading to transfer of care or admission.[4] Drowning has remained a significant danger to children despite ongoing prevention efforts, such as the American Academy of Pediatrics (AAP), providing guidelines on how to prevent drowning events and optimise rescue efforts when they do occur.[5] Thus, additional implementation strategies or interventions may be needed to supplement AAP guidelines.

Disparities have been demonstrated in drowning rates. For instance, black children have experienced particularly high risk and were 5–10 times more likely to drown in swimming pools compared with their age-matched white counterparts.[3 6 7] While previous studies showed a stable incidence in drowning rates among racial and ethnic minority children,[8] more recent data suggested that rates of drowning events among children from minority communities were increasing.[9] In addition to racial disparities, other studies have shown higher rates of injury in areas with lower median income and lower educational attainment,[10–12] whereas little is known about injury patterns relating to rurality.

The AAP Policy Statement on drowning prevention stated paediatricians should be aware of local leading causes of drowning to target discussions based on age, sex, risk and location.[4] Relatedly, our primary objective was to provide an updated epidemiological overview of paediatric drownings in Maryland, with a focus on risk for hospitalisation or fatality to identify those more severely injured and explore health disparities in this context. Specifically, we examined factors that may contribute to health inequities, including age, sex, race, ethnicity, geography and health insurance status.

Table 1 Patient demographics and drowning event timing, stratified by care setting and fatality: Maryland (2016–2019)

		All*	Non-fatal (outpatient)	Non-fatal (inpatient)	Fatal (outpatient and inpatient)	
		n=541	n=483	n=42	n=16	P value
Age group	0–4 years	281 (52%)	257 (53%)	15 (36%)	9 (56%)	0.081
	5–9 years	127 (24%)	115 (24%)	10 (24%)	2 (13%)	
	10–19 years	133 (25%)	111 (23%)	17 (41%)	5 (31%)	
Sex	Male	319 (59%)	280 (58%)	26 (62%)	13 (81%)	0.16
	Female	222 (41%)	203 (42%)	16 (38%)	3 (19%)	
Race	White	292 (54%)	266 (55%)	22 (52%)	4 (25%)	0.33
	African American or black	165 (31%)	145 (30%)	12 (29%)	8 (50%)	
	Asian	10 (2%)	9 (2%)	1 (2%)	0 (0%)	
	AI or Alaska Native	5 (1%)	5 (1.0%)	0 (0%)	0 (0%)	
	Other/unknown	50 (9%)	41 (9%)	5 (12%)	4 (25%)	
	Two or more races	19 (4%)	17 (4%)	2 (5%)	0 (0%)	
Compressed race	White	292 (54%)	266 (55%)	22 (52%)	4 (25%)	0.058
	Non-white	249 (46%)	217 (45%)	20 (48%)	12 (75%)	
Ethnicity	Spanish/Hispanic origin	49 (9%)	42 (9%)	3 (7%)	4 (25%)	0.21
	Not Spanish/Hispanic origin	471 (87%)	422 (87%)	38 (91%)	11 (69%)	
	Declined or unknown	21 (4%)	19 (4%)	1 (2%)	1 (6%)	
County	Urban	449 (83%)	400 (83%)	36 (86%)	13 (81%)	0.93
	Rural	16 (3%)	14 (3%)	1 (2%)	1 (6%)	
	Other/unknown	76 (14%)	69 (14%)	5 (12%)	2 (13%)	
Payer 1 category	Public	220 (41%)	194 (40%)	19 (45%)	7 (44%)	0.26
	Commercial	239 (44%)	216 (45%)	19 (45%)	4 (25%)	
	Other/self/charity	82 (15%)	73 (15%)	4 (10%)	5 (31%)	
Year	2016	140 (26%)	122 (25%)	15 (36%)	3 (19%)	0.47
	2017	152 (28%)	136 (28%)	12 (29%)	4 (25%)	
	2018	135 (25%)	120 (25%)	11 (26%)	4 (25%)	
	2019	114 (21%)	105 (22%)	4 (10%)	5 (31%)	
Quarter	January–March	32 (6%)	28 (6%)	3 (7%)	1 (6%)	0.28
	April–June	221 (41%)	198 (41%)	13 (31%)	10 (63%)	
	July–September	270 (50%)	239 (50%)	26 (62%)	5 (31%)	
	October–December	18 (3%)	18 (4%)	0 (0%)	0 (0%)	

*Data represented as n (%).
AI, American Indian

METHODS

We conducted a retrospective study of patients aged 0–19 years with an outpatient or inpatient medical encounter following a non-fatal or fatal drowning event in Maryland from January 2016 to December 2019 using the publicly accessible Health Services Cost Review Commission (HSCRC) dataset for outpatient and inpatient encounters. This study was limited to retrospective chart review, so no efforts pertaining to patient relations were addressed.

Health Services Cost Review Commission (HSCRC)

HSCRC reported abstracted data from approximately 700 000 inpatient discharge records and 5.7 million outpatient visit records from all Maryland hospitals and their affiliated clinics. Outpatient encounters included clinic visits, outpatient surgeries and ED visits at locations affiliated with a hospital. Inpatient encounters included patients admitted to a hospital. Patients were recorded as inpatient or outpatient based on the final location where care was provided. We identified patients using the following International Classification of Diseases, Tenth Revision (ICD-10) diagnosis codes for unintentional and intentional drowning events in the dataset: T751,Y213XXA, W65, W65XXXA, W67, W69, W73, W74, W16011, W16021, W16031, W16111, W16121, W16131, W16211, W16221, W16311, W16321, W16331, W1641, W16511, W16521, W16531, W16611, W16621, W16711, W16721, W16811, W16821, W16831, W1691, V90, V92, X71, X92, W67XXXA, W69XXXA, W74XXXA, W74XXXD, W74XXXS, T751XXA, T751XXD, T751XXS, W16011A, W16111A, W16112A, W1642XA, W1642XS, W16511A, W16622A, W65XXXA, W67XXXA, W69XXXA, W74XXXA, X719XXA. Available demographic data included patient age, sex, race, ethnicity, county of residence and health insurance. Available clinical data included principal diagnosis, secondary diagnoses, source of admission, length of stay, median charges, discharge status, year of presentation, and quarter of presentation.

Statistical analysis

We examined the distribution of characteristics of patients by age, using age groups of 0–4, 5–9 and 10–19 years to aid in comparison to previous databases and reflect preschool, school-age and adolescent age groups. When completing analyses, we compressed race into categories of non-white (defined as any racial/ethnic minority) and white due to smaller sample sizes of relative groups. However, data on race were also presented in a non-compressed form so that the data could be used in

Table 2 Admitted drowning patient disposition, stratified by age group: Maryland (2016–2019)

			Patient age				
			All ages*	0–4 years	5–9 years	10–19 years	
			(n=47)	(n=15)	(n=11)	(n=21)	P value
LOS†			2 (1, 3)	1 (1, 2)	2 (1, 2)	3 (1, 4)	0.011
Patient dispo	Patient died		5 (11%)	0 (0%)	1 (9%)	4 (19%)	0.18
	PICU		29 (61%)	10 (67%)	9 (82%)	10 (48%)	
		1–4 days	26 (90%)	10 (100%)	8 (89%)	8 (80%)	0.33
		5–10 days	2 (7%)	0 (0%)	1 (9%)	1 (20%)	
		11–29 days	1 (3%)	0 (0%)	0 (0%)	1 (20%)	
	Other unit		13 (28%)	5 (33%)	1 (9%)	7 (33%)	
Year	2016		17 (36%)	6 (40%)	4 (36%)	7 (33%)	0.56
	2017		12 (26%)	5 (33%)	3 (27%)	4 (19%)	
	2018		12 (26%)	4 (27%)	3 (27%)	5 (24%)	
	2019		6 (13%)	0 (0%)	1 (9%)	5 (245)	
Quarter	January–March		3 (6%)	1 (7%)	1 (9%)	1 (5%)	0.97
	April–June		18 (38%)	5 (33%)	4 (36%)	9 (43%)	
	July–September		26 (55%)	9 (60%)	6 (55%)	11 (53%)	
	October–December		0 (0%)	0 (0%)	0 (0%)	0 (0%)	

*Data represented as n (%).
†Data reported as median with IQR in days.
dispo, disposition; LOS, length of stay; PICU, paediatric intensive care unit; RH, referring hospital.

future studies pooling data. We classified counties as urban or rural based on Centers for Disease Control and Prevention, Census Bureau and Office of Management and Budget Classifications.[13 14] Insurance was categorised as public, commercial or other/self/charity.

Patient characteristics were stratified by outpatient versus inpatient encounters and compared using χ^2 tests. To understand the relative association between characteristics of patients and severity of medical needs, we generated a series of univariate and multivariable logistic regression

Table 3 Drowning patient demographics, stratified by setting and age groups: Maryland (2016–2019)

		Outpatient				Inpatient			
		0–4 years*	5–9 years	10–19 years		0–4 years	5–9 years	10–19 years	
		(n=266)	(n=116)	(n=112)	P value	(n=15)	(n=11)	(n=21)	P value
Sex	Male	150 (56%)	70 (60%)	69 (62%)	0.58	9 (60%)	7 (64%)	14 (67%)	0.92
	Female	116 (44%)	46 (40%)	43 (38%)		6 (40%)	4 (36%)	7 (33%)	
Race	White	173 (65%)	54 (47%)	42 (38%)	<0.001	12 (80%)	2 (18%)	9 (43%)	0.099
	Black	57 (21%)	44 (38%)	49 (44%)		2 (13%)	7 (64%)	6 (29%)	
	Asian	4 (2%)	2 (2%)	3 (3%)		0 (0%)	0 (0%)	1 (5%)	
	AI or Alaska Native	2 (1%)	2 (2%)	1 (1%)		0 (0%)	0 (0%)	0 (0%)	
	Other/unknown	17 (6%)	11 (9%)	16 (14%)		0 (0%)	2 (18%)	4 (19%)	
	Two or more	13 (5%)	3 (3%)	1 (1%)		1 (7%)	0 (0%)	1 (5%)	
Compressed race	White	173 (65%)	54 (47%)	42 (38%)	<0.001	12 (80%)	2 (18%)	9 (43%)	0.006
	Non-white	93 (35%)	62 (53%)	70 (63%)		3 (20%)	9 (82%)	12 (57%)	
Ethnicity	Spanish/Hispanic	19 (7%)	10 (9%)	16 (14%)	0.13	0 (0%)	0 (0%)	4 (19%)	0.14
	Not Spanish/Hispanic	238 (90%)	102 (88%)	89 (80%)		15 (100%)	11 (100%)	16 (76%)	
	Unknown	9 (3%)	4 (3%)	7 (6%)		0 (0%)	0 (0%)	1 (5%)	
County	Urban	228 (86%)	100 (86%)	82 (73%)	0.039	13 (87%)	9 (82%)	17 (81%)	0.57
	Rural	7 (3%)	2 (2%)	5 (5%)		0 (0%)	0 (0%)	2 (10%)	
	Other/unknown	31 (12%)	14 (12%)	25 (22%)		2 (13%)	2 (18%)	2 (10%)	
Median charge†		428	456	730	0.002	4586	6790	11 224	0.003
Health insurance	Public	105 (40%)	46 (40%)	46 (41%)	0.32	8 (53%)	6 (55%)	9 (43%)	0.71
	Commercial	122 (46%)	55 (47%)	42 (38%)		6 (40%)	5 (46%)	9 (43%)	
	Other/self/charity	39 (15%)	15 (13%)	24 (21%)		1 (7%)	0 (0%)	3 (14%)	

*Data represented as n (%).
†Median charge reported in dollars.
AI, American Indian

Table 4 Logistic regression demonstrating associations with inpatient status following a drowning event (excluding fatal outpatient): Maryland (2016–2019)

		Unadjusted OR	95% CI	Adjusted* OR	95% CI
Age group	0–4 years	Reference		Reference	
	5–9 years	1.639	0.73 to 3.678	1.627	0.713 to 3.709
	10–19 years	3.241	1.611 to 6.521	3.477	1.666 to 7.257
Sex	Male	Reference		Reference	
	Female	0.782	0.42 to 1.456	0.822	0.434 to 1.556
Non-white			0.686 to 2.27	1.010	0.525 to 1.944
Ethnicity	Spanish/Hispanic	Reference		Reference	
	Not Spanish/Hispanic	1.045	0.357 to 3.057	1.387	0.448 to 4.291
	Declined or unknown	0.553	0.058 to 5.282	0.496	0.046 to 5.377
County	Urban	Reference	0.321 to 6.683	Reference	
	Rural	1.465	0.364 to 2.186	1.446	0.277 to 7.542
	Other/unknown	0.892		0.936	0.355 to 2.468
Health insurance	Public	Reference		Reference	
	Commercial	0.781	0.416 to 1.466	0.822	0.413 to 1.638
	Other/self/charity	0.462	0.155 to 1.382	0.430	0.134 to 1.374

*Adjusted for all covariates (age, sex, minority status, ethnicity, urban vs rural county and health insurance).

models; (1) using non-fatal inpatient status as the outcome (excluding patients who died in the ED), (2) using fatality as the outcome and (3) using combined fatality and/or inpatient status as the outcome of interest. Multivariable model components were selected using clinically significant characteristics in combination with significant characteristics per the univariate models. A significance cut-off of $p<0.05$ was used. All analyses were performed using Stata V.17.0 (College Park, Texas, USA).

RESULTS

From 2016 to 2019, there were 483 non-fatal outpatient encounters, 42 non-fatal inpatient encounters and 16 deaths captured, including both outpatient and inpatient settings (table 1). Of the 47 children admitted, 5 (11%) died, 29 (61%) were admitted to the paediatric intensive care unit and the remaining 13 (28%) were admitted to another unit (table 2).

Overall, more than half of patients with any drowning event were 0–4 years (52%), boys (59%), white (54%), not Spanish/Hispanic (87%) and resided in urban counties (83%) (table 1). The months April–September accounted for the timing of more than 90% of encounters. Those patients who died were mostly 0–4 years (56%), boys (81%), non-white (75%) and from urban areas (81%). Among non-fatal inpatient encounters, 41% were 10–19 years old, whereas this age group represented 23% of non-fatal outpatient encounters. We did not find significant differences between non-fatal outpatient encounters, non-fatal inpatient encounters and deaths based on age, sex, race, ethnicity, urban versus rural status or health insurance.

When stratifying all outpatient and inpatient encounters by age group, some significant differences were seen between racial groups (table 3). For instance, in the outpatient setting, white children represented the majority of patients ages 0–4 years (65%), and non-white children represented the majority of patients ages 10–19 years (63%). Of those patients admitted, admission was highest in white children 0–4 years of age (80%) and non-white children 5–9 years of age (82%). Children 10–19

Table 5 Logistic regression showing association with death following a drowning event: Maryland (2016–2019)

		Unadjusted OR	95% CI	Adjusted* OR	95% CI
Age group	0–4 years	Reference		Reference	
	5–9 years	0.484	0.103 to 2.271	0.351	0.072 to 1.72
	10–19 years	1.181	0.388 to 3.594	0.650	0.194 to 2.178
Sex	Male	Reference		Reference	
	Female	0.322	0.091 to 1.145	0.310	0.084 to 1.145
Non-white		3.646	1.161 to 11.451	3.461	1.038 to 11.543
Ethnicity	Spanish/Hispanic	Reference		Reference	
	Not Spanish/Hispanic	0.269	0.082 to 0.88	0.318	0.09 to 1.125
	Declined or unknown	0.563	0.059 to 5.357	0.508	0.049 to 5.386
County	Urban	Reference		Reference	
	Rural	2.236	0.274 to 18.223	1.453	0.155 to 13.576
	Other/unknown	0.906	0.2 to 4.099	0.750	0.136 to 4.139
Health insurance	Public	Reference		Reference	
	Commercial	0.518	0.15 to 1.794	0.869	0.235 to 3.215
	Other/self/charity	1.976	0.609 to 6.41	2.407	0.652 to 8.892

*Adjusted for all covariates (age, sex, minority status, ethnicity, urban vs rural county and health insurance).

years had statistically significant higher median charges during both outpatient (p=0.002) and inpatient encounters (p=0.003).

Children ages 10–19 years were more likely to require admission. Logistic regression showed that patients aged 10–19 years had an unadjusted odds of admission that was 3.2 times (95% CI: 1.6 to 6.5) greater than those of children 0–4 years of age (table 4) and an adjusted odds of admission that was 3.5 times (95% CI: 1.7 to 7.3) higher. Logistic regression showed that non-white children had an unadjusted odds of death that was 3.6 times (95% CI: 1.2 to 11.5) greater than white children and an adjusted odds of death that was 3.5 times (95% CI: 1.0 to 11.5) greater (table 5). Admitted patients ages 10–19 years had a median length of stay of 3 days (IQR, 1–4) which was significantly (p=0.011) longer when compared with the median for those 0–4 years (1 day (1–2)) and 5–9 years (2 days (1–2)) (table 1).

DISCUSSION

This study identified epidemiological patterns that can inform prevention initiatives at the state level. Similar to other studies, most drowning events occurred in the spring and summer, representing a high-yield time for intervention efforts.[5] We demonstrated that most visits following a drowning event occurred in young children and represented about half of the fatal cases, which aligns with prior studies.[1–3 8] After non-fatal drowning events, adolescents were more likely to be hospitalised, had a longer length of stay when admitted and had higher median charges, suggesting that injury severity was high for this population. The higher charges seen in the inpatient cohort were likely attributed to longer length of stay, while higher charges seen in the outpatient cohort might point towards injury severity requiring more interventions and diagnostic studies. The trend of higher injury severity among adolescents from all cause injury has been seen in other international studies, adding merit to the need for further investment in specific interventions targeting this age group.[15] We also found that fatality was higher for non-white children. These racial patterns merit further study to guide specific interventions and prevent drowning in Maryland children.

This study had a number of strengths, for instance, the HSCRC database included both inpatient and outpatient encounters. While we could not include children with fatal drowning who were not transported from the scene or children who did not have an inpatient or outpatient medical encounter after a non-fatal drowning event, it is likely that this represented few, if any, patients. There are state protocols for Emergency Medical Services (EMS) staff that prohibit the termination of resuscitation efforts in the field for drowning-associated cardiac arrests; thus, nearly all patients evaluated by EMS would be represented in this database.[16]

Some limitations present for any retrospective database review include the limited availability of clinical details to explain the circumstances of the event. We did not compare our fatal drownings to death certificates, so may have missed some cases of fatal drowning. Similarly, lack of event details, including the type of body of water involved, can limit efforts to target drowning prevention interventions and the ability to compare this study population to those from prior studies. State law requires all pools be surrounded by a fence, with county and city jurisdiction having more specific regulations about fencing for public versus residential pools,[17–19] but the adherence to these safety requirements in the individual events was also not available. When considering race and ethnicity data recorded in medical records, it is important to know who documented and reported race and/or ethnicity.[20] However, it was not specified in the HSCRC database whether categories of race and ethnicity were patient reported or documented by a third party, and this likely varied among the different hospitals represented in this database. Similarly, preferred language was inconsistently documented and could not be included in analysis. Given database classification of clinic and ED encounters as outpatient, we are limited in our ability to exam the rates of admission from ED to compare to prior studies.[4] In evaluating county, the county listed likely represents the patients' residence, but the location of the drowning event may have been different, which has implications for the application of this information toward prevention efforts. Additionally, use of private vs public insurance as a proxy for socioeconomic status was limited due to the high percentage of unknown or other insurance types. Lastly, the time period of this study did not include the COVID-19 pandemic, excluding influence from the pandemic on our results, and it is uncertain how drowning epidemiology may have been impacted by the pandemic.

In future studies, it will be important to look more in depth at drowning events to determine presence or integrity of fencing, swim competence, presence of supervision, substance use and/or floatation devices. It is also important to improve our demographic documentation to be able to accurately capture information that will influence prevention efforts. We need to further study injury within the adolescent population to understand their unique risks. It would be important to engage adolescents directly in prevention strategies, as their injuries may be more related to risk taking compared with lack of supervision, which can be a risk factor for younger children. Similarly, we need to further study risks among non-white children to understand their higher rates of fatality. A clearer understanding of factors increasing fatality rates among non-white children is needed to inform development and implementation of effective prevention measures.

Author affiliations
[1]Critical Care Medicine, Children's Mercy Kansas City Adele Hall Campus, Kansas City, Missouri, USA
[2]School of Medicine, University of Missouri—Kansas City, Kansas City, Missouri, USA
[3]Anesthesia and Critical Care Medicine, Johns Hopkins School of Medicine, Baltimore, Maryland, USA
[4]Center for Injury Research and Policy, Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland, USA
[5]Johns Hopkins Center for Injury Research & Prevention, Johns Hopkins School of Public Health, Baltimore, Maryland, USA
[6]Health, Behavior and Society, Johns Hopkins University Bloomberg School of Public Health, Baltimore, Maryland, USA
[7]Johns Hopkins School of Medicine, Baltimore, Maryland, USA
[8]Johns Hopkins University School of Medicine, Baltimore, Maryland, USA

Competing interests None declared.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants and was approved by the institutional review board at Johns Hopkins University School of Medicine, IRB00277827.

Provenance and peer review Not commissioned; externally peer reviewed.

ORCID iDs
Katherine Macmillan http://orcid.org/0000-0002-9824-8025
Eileen M McDonald http://orcid.org/0000-0002-1007-2986
Leticia Manning Ryan http://orcid.org/0000-0003-3603-8652

REFERENCES

1 10 leading causes of death by age group, United States – 2018. 2018. Available: https://www.cdc.gov/injury/wisqars/pdf/leading_causes_of_death_by_age_group_2018-508.pdf

2 National Center for Injury Prevention and Control. 10 leading causes of injury death by age group highlighting unintentional injuries deaths, United States – 2018. 2018. Available: https://www.cdc.gov/injury/wisqars/pdf/leading_causes_of_injury_deaths_highlighting_unintentional_2018-508.pdf

3 Borse NN, Dellinger AM, Rudd RA, *et al*. CDC childhood injury report: patterns of unintentional injuries among 0 –19 year olds in the United States 2000. 2008.

4 Ryan KM, Dugas J, Pina T, *et al*. Drowning injuries in the United States: patient characteristics, mortality risk, and associated primary diagnoses. *Injury* 2020;51:2560–4.

5 Denny SA, Quan L, Gilchrist J, *et al*. Prevention of Drowning. *Pediatrics* 2021;148:e2021052227.

6 Saluja G, Brenner RA, Trumble AC, *et al*. Swimming pool drownings among US residents aged 5-24 years: understanding racial/ethnic disparities. *Am J Public Health* 2006;96:728–33.

7 Gilchrist J, Parker EM, Centers for Disease Control and Prevention (CDC). Racial/ethnic disparities in fatal unintentional drowning among persons aged ≤ 29 years - United States, 1999-2010. *MMWR Morb Mortal Wkly Rep* 2014;63:421–6.

8 Felton H, Myers J, Liu G, *et al*. Unintentional, non-fatal drowning of children: US trends and racial/ethnic disparities. *BMJ Open* 2015;5:e008444.

9 Clemens T, Moreland B, Lee R. Persistent Racial/Ethnic Disparities in Fatal Unintentional Drowning Rates Among Persons Aged ≤29 Years - United States, 1999-2019. *MMWR Morb Mortal Wkly Rep* 2021;70:869–74.

10 Pomerantz WJ, Dowd MD, Buncher CR. Relationship between socioeconomic factors and severe childhood injuries. *J Urban Health* 2001;78:141–51.

11 Rivara FP, Barber M. Demographic analysis of childhood pedestrian injuries. *Pediatrics* 1985;76:375–81.

12 Faelker T, Pickett W, Brison RJ. Socioeconomic differences in childhood injury: a population based epidemiologic study in Ontario, Canada. *Inj Prev* 2000;6:203–8.

13 U.S. Census Bureau. Maryland urban and rural population by jurisdiction: 2010, 2000, 1990. 2012. Available: https://planning.maryland.gov/MSDC/Documents/Census/Cen2010/urban_rural/PctUrbanRural_County_region_r2.pdf

14 Rural classifications. n.d. Available: https://www.ers.usda.gov/webdocs/DataFiles/53180/25575_MD.pdf?v=0

15 Peden AE, Cullen P, Bhandari B, *et al*. A systematic review of the evidence for effectiveness of interventions to address transport and other unintentional injuries among adolescents. *J Safety Res* 2023;85:321–38.

16 Division of State Documents, Office of the Secretary of State, State of Maryland. *The maryland medical protocols for emergency medical services: maryland institute for emergency medical services systems*. 2020.

17 Baltimore County Government. *Building inspections*.2020. Available: https://www.baltimorecountymd.gov/departments/permits/buildinspec/#:~:text=Required%20pool%20fences%20and%20houses,closing%2C%20self%2Dlatching%20gate

18 Cochran Firm. Maryland laws for swimming pools and fences. 2021. Available: http://drowninglaw.com/maryland-laws-for-swimming-pool-fences-and-gates/

19 Department of Health and Mental Hygiene. Code of maryland regulations: public swimming pools and spas. 2001. Available: https://health.maryland.gov/washhealth/Documents/download-forms/MD%20COMAR%20Regulations%20for%20Swimming%20Pools%20and%20Spas.pdf

20 Flanagin A, Frey T, Christiansen SL, *et al*. The Reporting of Race and Ethnicity in Medical and Science Journals: Comments Invited. *JAMA* 2021;325:1049–52.