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Spatial analysis of paediatric swimming pool submersions by housing type

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ABSTRACT

Objective Drowning is a major cause of unintentional childhood death. The relationship between childhood swimming pool submersions, neighbourhood sociodemographics, housing type and swimming pool location was examined in Harris County, Texas.

Study design and setting Childhood pool submersion incidents were examined for spatial clustering using the Nearest Neighbor Hierarchical Cluster (Nnh) algorithm. To relate submersions to predictive factors, an Markov Chain Monte Carlo (MCMC) Poisson-Lognormal-Conditional Autoregressive (CAR) spatial regression model was tested at the census tract level.

Results There were 260 submersions; 49 were fatal. Forty-two per cent occurred at single-family residences and 36% at multifamily residential buildings. The risk of a submersion was 2.7 times higher for a child at a multifamily than a single-family residence and 28 times more likely in a multifamily swimming pool than a single family pool. However, multifamily submersions were clustered because of the concentration of such buildings with pools. Spatial clustering did not occur in single-family residences. At the tract level, submersions in single-family and multifamily residences were best predicted by the number of pools by housing type and the number of children aged 0–17 by housing type.

Conclusions Paediatric swimming pool submersions in multifamily buildings are spatially clustered. The likelihood of submersions is higher for children who live in multifamily buildings with pools than those who live in single-family homes with pools.

INTRODUCTION

This study investigates the relationship between swimming pool submersions involving children, the location of pools and sociodemographic factors by housing type in Harris County, Texas.

Drowning is the second leading cause of unintentional death in children.¹ Children younger than 5, especially males, are at greatest risk for drowning.^{2–4} Among US children 0–4, 50% of fatal and 65% of non-fatal submersions occurred in pools.¹ Over the time period of our study (2003–2007), 179 Texas children drowned in swimming pools.⁵ Factors that affect drowning include inadequate supervision, poor swimming ability and insufficient pool fencing.²

It is not clear whether there are sociodemographic differences in paediatric submersions. One study found higher pool drowning rates for children under 10 in affluent communities in California.⁶ Another study found drowning in US children and youth to be more common among black and Hispanic males adjusting for income.⁷ During the

1980s, in the same area as our study, drowning at multifamily (apartment) pools was more frequent than in single-family homes and was concentrated among minorities.⁸ However, a recent study found no differences in the outcome of paediatric swimming pool submersion victims when compared by age, ethnicity and location of pool.⁹

Drowning mortality and morbidity rates may be distorted when age-specific population is used to calculate rates instead of actual swimming risk.¹⁰ To our knowledge, the number of pools as a predictive factor for submersions has not been investigated.

METHODS

This was a retrospective study of children and youth 0–17 who were swimming pool submersion victims in Harris County, Texas, between 2003 and 2007. Harris County, which includes Houston, had a population of 4 million in 2010.¹¹ Twenty-eight per cent were under age 18.

Data on submersion incidents were obtained from four paediatric hospitals, the Houston Fire Department and county fatality records. The hospitals account for 80% of all paediatric admissions in the metropolitan area and almost all transfers from surrounding areas.¹² Our study was approved by the Institutional Review Boards of all collaborating hospitals.

Records with a primary or secondary International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) diagnosis code for drowning injury (994.1) were included. Only the primary submersion encounter was selected. Data included age, gender, ethnicity, date and time of injury, submersion address and type of building. These were entered into a standardised data collection instrument¹³ and verified. Duplicate records were removed. Cases were matched by age, date of occurrence, name, age, gender and address of injury. To verify fatalities, we compared victims of all unintentional fatal submersions for children 0–14 with the county fatality records with Centers for Disease Control (CDC) Wonder⁵ during 2003–2007. There was complete agreement for these ages. However, since CDC Wonder only has a grouping for 15–19, we were unable to verify fatalities for children 15–17.

Submersion addresses were geographically coded using Texas State Plane South Central, NAD 83¹⁴ and double-checked for accuracy. Exact coordinates were obtained for 202 of the 260 submersions.

Swimming pool locations were obtained from the county appraisal district for 2005 and verified by the regional planning agency, Houston-Galveston Area Council. There were 62 872 swimming pool locations in Harris County in 2005



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(single-family homes: 59 914; multi-family residences: 1858; and other parcels—commercial, government, mobile homes: 1100). Larger multifamily complexes may have multiple pools. However, our information only lists whether there is a pool on the parcel.

Data analysis

Three levels of analysis were conducted: (1) characteristics of submersions by housing type; (2) spatial clustering and (3) multivariate spatial modelling by census tract to examine environmental correlates. The focus was on submersions occurring in single-family and multifamily residences.

Spatial clustering

The Nearest Neighbor Hierarchical Cluster (Nnh) algorithm in the *CrimeStat IV* software program was used to determine clusters of submersions that are concentrated more closely than would be expected with spatial randomness.¹⁵ A number of studies have shown this algorithm to be among the most accurate at detecting concentrations with reasonable precision.^{16–18} The method selects multiple events that are closer together than the random nearest neighbour distance.^{15 19} The algorithm identifies a hierarchy of clusters (first-order for the events; second-order for a clustering of the first-order clusters; etc). To avoid obtaining very small clusters, a minimum of events per cluster is defined. For submersions, we used a minimum of 5 and for pools a minimum of 10. Significance was tested with Monte Carlo simulation of randomly assigned data to detect the number of clusters expected by chance. Ten thousand simulations were run and 95% credible intervals were calculated.

The method is also able to determine clusters relative to an ‘at risk’ variable. In this study, we related the clusters of submersions to the concentrations of swimming pools, particularly in multifamily units.

Census tract variables

Spatial modelling was conducted to relate submersions to environmental conditions. Geocoded incidents and pool locations were assigned to 2010 census tracts (N=786) and the centroid of the tract used as the geographical location. The number of submersions per tract was calculated, annualised by dividing the total by 5, and scaled (units are in hundredths of a submersion). With one exception, the data were standardised to 2005, the mid-point of the 2003–2007 time frame. Based on data from the 2000 and 2010 censuses and the American Community Survey (ACS) for 2005–2009, interpolations were made for 2005. The one exception was the number of children 0–17 by housing type for 2005–2009, where the information was not available for earlier years to allow an interpolation.

Model variables

Box 1 lists the independent variables used. There were two exposure variables (number of children 0–17 and number of residential swimming pools, both subdivided into single-family and multifamily), and two additional statistical control variables that have been shown to effect the distribution of incidents—area of the tract and distance of the tract from the Houston city centre.¹ In addition, there are four sociodemographic variables, three measuring ethnicity, which has been shown to be important in

Box 1 Variables used in environmental models (N=761 census tracts in Harris County, Texas)

- ▶ Dependent variables
 - Number of submersions, 2003–2007
 - Number in single-family residences;
 - Number in multifamily residential buildings.
- ▶ Sociodemographic variables
 - Number of persons of African-American ethnicity, 2005;
 - Number of persons of Asian ethnicity, 2005;
 - Number of persons of Hispanic ethnicity, 2005;
 - Median household income, 2005.
- ▶ Exposure variables
 - Number of residential swimming pool locations, 2005
 - Number in single-family residences;
 - Number in multifamily buildings.
 - Number of children ages 0–17, 2005–2009
 - Number in single-family residences;
 - Number in multifamily buildings.
- ▶ Control variables
 - Distance from downtown Houston (miles);
 - Area of the census tract (square miles).

some studies, and one measuring income which could be important in capturing differences in the quality of the pool protection (eg, better fences; better supervision of children).

Spatial modelling

A random-effects Poisson-Lognormal-Conditional Autoregressive (CAR) spatial regression model was utilised to estimate the effect of the environmental variables on the number of submersions per tract.^{22–24} This model has been shown to be more accurate than a traditional Poisson-Gamma model when there is a low sample mean, as with our data set.²⁵

The number of submersions per tract is assumed to be Poisson distributed and independent over all tracts, and has the form:

$$y_i | \lambda_i \sim \text{Poisson}(\lambda_i) \quad (1)$$

with the mean organised as:

$$\lambda_i = \exp(\mathbf{x}_i^T \boldsymbol{\beta} + \varepsilon_i + \phi_i) = \exp(\mathbf{x}_i^T \boldsymbol{\beta} + \phi_i) \cdot \xi_i \quad (2)$$

where $\exp()$ is an exponential function, $\boldsymbol{\beta}$ is a vector of unknown coefficients for the k covariates plus an intercept, ϕ_i is a spatial random effect and is estimated using a CAR function,²⁶ and ε_i is the model error independent of all covariates. The error, $\xi_i = \exp(\varepsilon_i)$, is assumed to follow a lognormal distribution with a mean equal to 0 and a variance equal to $\sigma_\varepsilon^2 = \tau_\varepsilon \sim \text{Gamma}(a_\varepsilon, b_\varepsilon)$. The CAR measure is an observation-specific adjustment.

The interpretation of equation (2) is that the number of submersions per tract changes exponentially with a unit change in each predictor, controlling for other variables and for remaining spatial autocorrelation due to unknown factors. Because of the complexity of the model, it was tested with a Markov Chain Monte Carlo (MCMC) simulation method using the *CrimeStat IV* software.²² The MCMC method is used with complex functions where maximum likelihood estimation does not work.

¹The area of the block group controls for the Modifiable Area Unit Problem.²⁰ The distance from the city centre controls for concentration effects in the central city.²¹

Table 1 Rates of submersions by housing type

Indicator	Single-family residences	Multifamily residences	Ratio of multifamily to single-family
Submersions (2003–2007)	108	94	–
Annual average	21.60	18.80	0.87
Children 0–17 (2005–2009)	849 133	279 285	0.33
Approximate annual submersions per 100 000 children 0–17 by housing type	2.54	6.73	2.65
Buildings (2005–2006)	875 461	50 679	0.06
Pool locations (2005)	59 914	1858	0.03
Percentage of buildings with pools	6.84	3.67	0.54
Annual submersions per 10 000 pool locations	3.61	101.18	28.03

To produce reliable estimates of parameters, the model was run with 200 000 samples with 100 000 ‘burn in’ samples being discarded. The coefficients were tested with 95% credible intervals.

Models run

Separate models were tested for submersions in single-family and multifamily residences. For each housing type model, the housing-specific independent and dependent variables were selected. Two runs were made, one with all the appropriate independent variables (full model) and the second with only the significant independent variables along with the statistical control variables (reduced model).

RESULTS

There were 260 submersion incidents with 49 fatalities. A majority (65%) occurred to children under 5. Median age was 3.9. Males (66%) and minorities (African-Americans 35%; Hispanics 24%) were more commonly affected. Most submersions occurred during May–August (75%), on weekends (45%) and in the daytime hours (50%). The locations of submersions were: single-family residences (42%), multifamily complexes (36%), hotels/motels (3%), community pools (13%) and missing in 6%.

Table 1 presents data on the risk of submersions for single-family and multifamily residences. For Harris County as a whole, the overall submersion rate relative to children under age 18 was 4.6/100 000 children 0–17.

However, when submersions were broken down by type of housing, it is apparent that the risk for children in multifamily buildings was substantially higher than for those in single-family residences. The risk of a submersion for a child living in a multifamily building is approximately 2.7 times higher than for a child living in a single-family residence, though there is some uncertainty about the exact number of children in 2005 since the estimates by housing type came from the ACS for 2005–2009.

Further, since only a small proportion of single-family and multifamily residences have swimming pools (about 7% for single-family and 4% for multifamily), it is clear that those children living in buildings with pools have a much higher risk, particularly those in multifamily buildings.ⁱⁱ The submersion rate relative to swimming pool locations was 101.2/1000 pool locations per year in multifamily buildings compared with 3.6/1000 per pool location in single-family residences, a relative ratio that was 28 times higher.

ⁱⁱExact rates cannot be calculated since the number of children who lived in single-family homes or multifamily buildings with pools is not known.

Spatial clustering of submersions and pools

Using the Nnh algorithm, we examined the clustering of submersions for the two housing types. Figure 1 shows the distribution of submersions in single-family homes. Using a requirement of at least five submersions per cluster, the Nnh did not find any clusters for submersions in single-family residences. Monte Carlo simulation indicated that one cluster would be expected by chance. Single-family submersions are very dispersed throughout the county, even more so than would be expected if the distribution were spatially random.

For submersions in multifamily residences, five first-order clusters of five or more submersions were identified. Monte Carlo simulation indicated that one cluster would be obtained by chance. Figure 2 shows the distribution of the five clusters which included 50% of all submersions in multifamily residential buildings where the location was known.

Using the Nnh algorithm, the 1858 multifamily pools in 2005 were examined for clustering using a minimum requirement of 10 pools per cluster. Thirty-nine first-order clusters were identified and three second-order clusters. Figure 3 shows the clustering.

Comparing figures 2 and 3, it can be seen that the clusters tend to overlap with the location of multifamily submersions. A risk-adjusted Nnh was run that related multifamily submersions to multifamily pool locations but found only one small cluster where the number of submersions was greater than that expected by the number of pools (not shown). Otherwise, the distribution of multifamily submersions reflects the distribution of multifamily pools.

Multivariate analysis of submersions by tract

The third analysis examined predictive variables associated with the distribution of submersions by tract, including the spatial clustering. The submersions were allocated to census tracts and a Moran’s ‘I’ test for spatial autocorrelation was run on the raw data prior to the model.²⁷ This statistic tests for similarity in the number of submersions for nearby tracts. A positive ‘I’ indicates similarity (nearby tracts have similar numbers of submersions) while a negative ‘I’ indicates dissimilarity. For single-family submersions, the ‘I’ was 0.0045 (significant at the $p \leq 0.05$ level) while for multifamily submersions the ‘I’ was 0.0255 (significant at the $p \leq 0.0001$ level). This indicates that there is overall spatial similarity in the number of submersions by tract, but the effect is much stronger for those occurring in multifamily than for single-family residences.ⁱⁱⁱ

ⁱⁱⁱNote that there was no clustering for single-family submersions using the actual addresses but there is some when the data were allocated to tracts using the centroid for the location.

Single-family Child Submersions: 2003-07

Location of Submersions

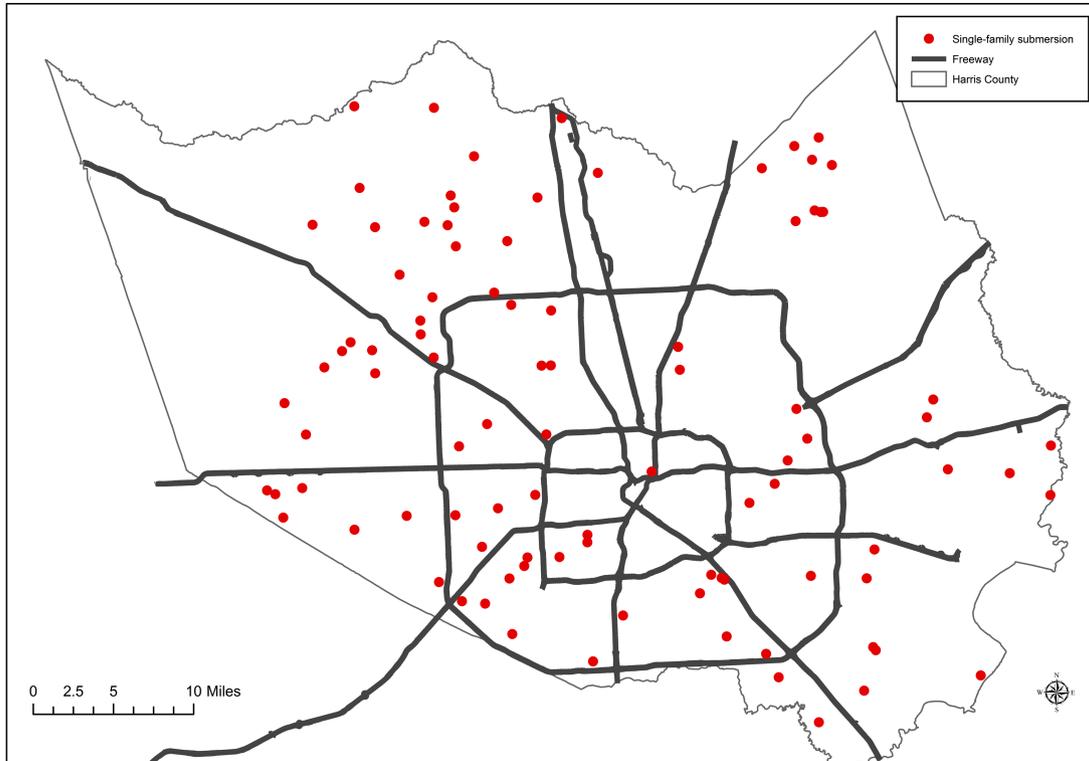


Figure 1 Map showing single-family child submersions.

Multi-family Child Submersions: 2003-07
Location of Hot Spots with 5 or More Submersions

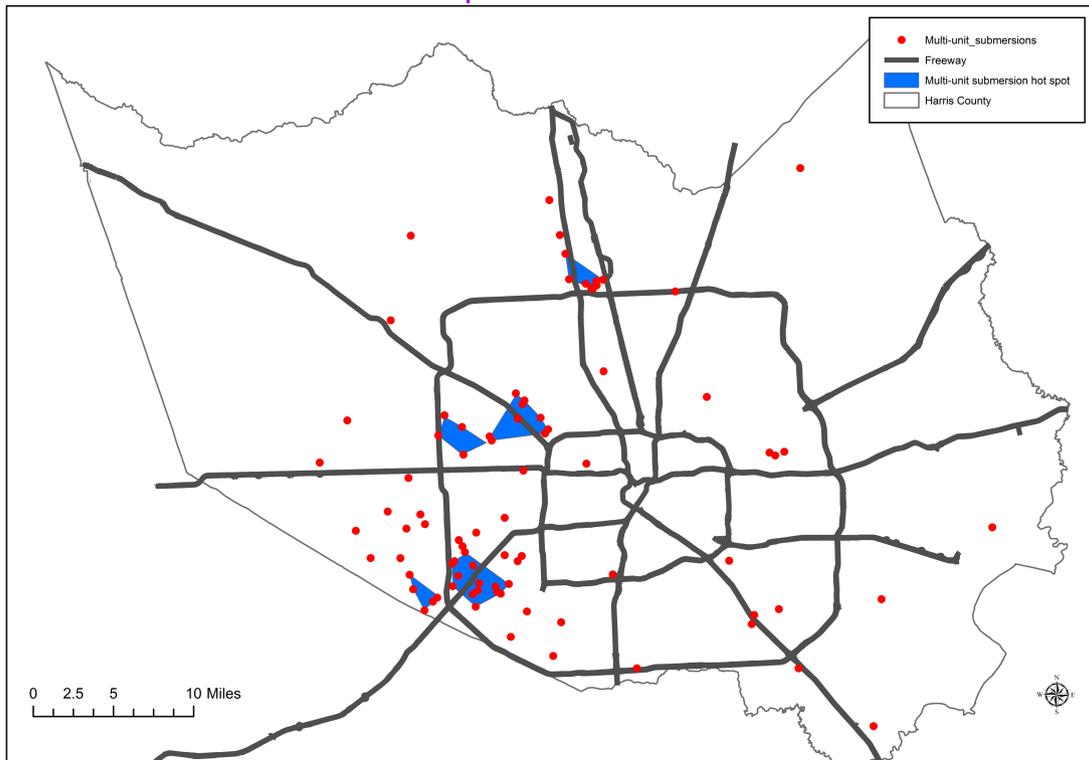


Figure 2 Map showing multifamily child submersions and hotspots.

Multi-family Pool Concentrations in Harris County: 2005

Location of Swimming Pools and Pool Concentrations in Multi-family Buildings

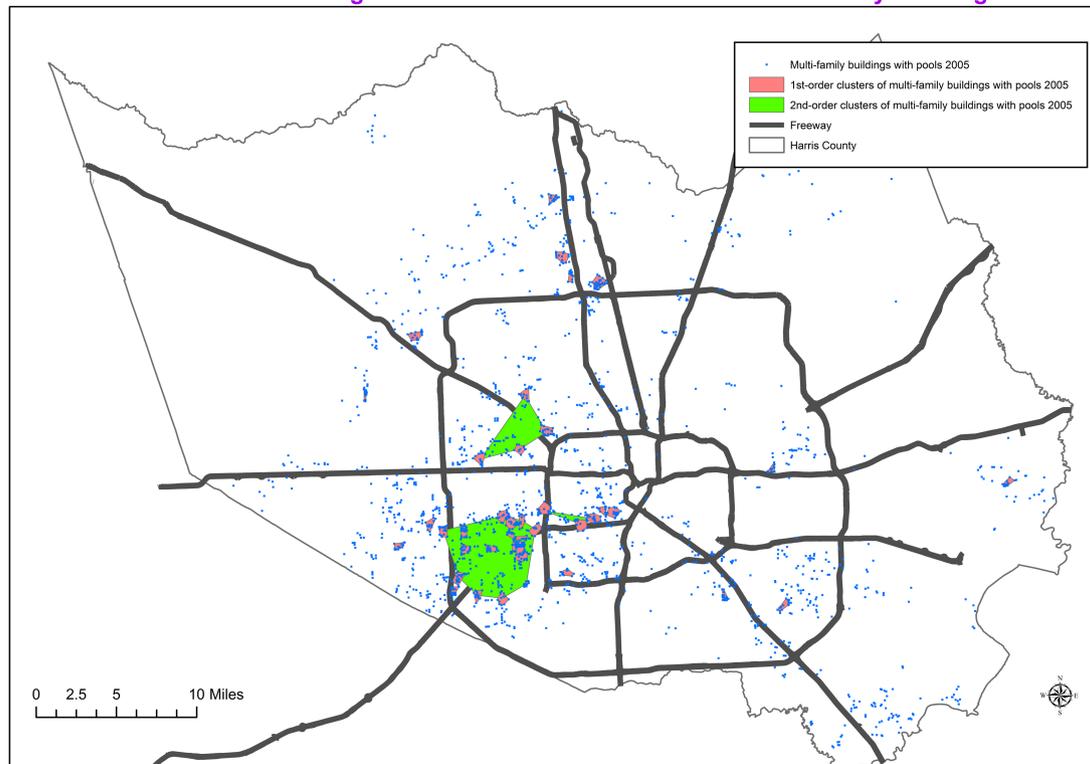


Figure 3 Map showing multifamily pool concentrations in Harris County.

Modelling submersions in building types by tract

Using the tract data, spatial regression models were run to examine multivariate submersions per tract (per 100) by housing type. The dependent variable was the annual number of submersions and the independent variables are listed in [box 1](#).

Submersions in single-family residences

[Table 2](#) shows the results of the full and reduced models predicting the number of submersions occurring in single-family residences by tract. The number of single-family pool locations was used to model pool risk and the number of children 0–17 living in single-family residences was the age-related exposure variable.

In the full model, the number of single-family swimming pool locations and the distance to the city centre (downtown Houston) were significant, whereas the number of single-family pools and the number of children 0–17 were significant in the reduced model while distance to the city centre was not. In other words, there are no sociodemographic correlates other than the number of available pools and the number of children, ages 0–17.

The spatial autocorrelation coefficient was not significant.^{iv} Further, a Moran's 'I' test of the residual error was 0.0013 and was not significant. Thus, the model eliminated the spatial clustering that was shown with the raw data ('I' of 0.0045).

Submersions in multifamily residences

The pattern for submersions in multifamily residences was similar to that for single-family residences. The number of

multifamily pool locations was used to model pool risk and the number of children 0–17 living in multifamily residences was the age-related exposure variable.

[Table 3](#) shows the results of the full and reduced models predicting the number of submersions in multifamily residential buildings by tract. In the full model, only the number of multifamily pool locations was significant, while in the reduced model, the number of children 0–17 was also significant. Spatial autocorrelation was reduced, but not eliminated, by the predictor variables (Moran's 'I' of the residuals was 0.0149 compared with 0.0255 for the raw data). The additional spatial autocorrelation reflects variables that were not measured (eg, use of pools by residents; adequacy of protective fencing).

DISCUSSION

Children who lived in multifamily units with pools had a higher risk of a submersion than children who lived in single-family units with pools whether measured relative to the number of children 0–17 (2.7 times higher) or to the number of swimming pools (28 times higher). Unfortunately, we could not calculate the exact rate because of lack of information on the number of children living in units with pools for each type of housing.

The risk of paediatric submersions in swimming pools depends on the number of children and pools. There were more submersions in neighbourhoods where there were both many children and pools. Warneke and Cooper⁸ observed that half of paediatric drowning occurred in apartment pools and a third in private residential pools in metropolitan Houston and suggested the relatively higher number of apartment pools as the cause. However, we found that submersions in single-family pools slightly exceeded those in multifamily pools. Since their data

^{iv}In the CAR model, the spatial adjustment is for each individual tract. The overall average for the adjustment was not significant but the adjustment for individual observations could be so.

Table 2 Multivariate predictors of annual Harris County single-family submersions Poisson-Lognormal-CAR model coefficients and 95% credible intervals (N=786 census tracts)

DepVar: log of annual number of single-family submersions per 100 per tract				
	Model 1		Model 2	
N	786		786	
Df	775		779	
Number of samples	200 000		200 000	
Number of 'burn in' samples	100 000		100 000	
Log likelihood	-8366.1		-8130.6	
AIC	16 754.3		16 275.2	
BIC	16 805.6		16 307.9	
Deviance	15 589.5****		15 123.8****	
Mean absolute deviation	4.34		3.08	
Mean-squared error	3558.9		612.7	
Dispersion multiplier	45.2****		43.6****	
	Coefficient	(95% credible interval)	Coefficient	(95% credible interval)
Modelled parameters				
Constant	-16.5050	(-23.9792 to -11.5879)	-13.1852	(-16.1096 to -10.4492)
<i>Socioeconomic variables</i>				
African-American population	0.0004	(-0.0007 to 0.0013)	-	-
Asian population	-0.0003	(-0.0030 to 0.0021)	-	-
Hispanic population	0.0008	(-0.0001 to 0.0017)	-	-
Median household income (\$'000)	-0.00003	(-0.00005 to 0.0001)	-	-
<i>Exposure variables</i>				
Number of single-family pools	0.0131	(0.0060 to 0.0208)	0.0120	(0.0069 to 0.0175)
Number of children, ages 0-17, in single-family residences	-0.0007	(-0.0005 to 0.0020)	0.0014	(0.0004 to 0.0024)
<i>Statistical controls</i>				
Area of tract (m ²)	-0.1674	(-0.4486 to 0.0885)	-0.1633	(-0.4545 to 0.0785)
Distance to city centre (m)	0.1792	(0.0161 to 0.3515)	0.1170	(-0.0413 to 0.2669)
<i>Unmeasured spatial effect</i>				
Spatial autocorrelation (Φ)	-0.0014	(-0.0753 to 0.0630)	-0.0007	(-0.0547 to 0.0476)

****p<0.0001.

[Bold] represents significant beyond the 0.0001 credible interval.

AIC, Aikake information criterion; BIC, Bayesian information criterion; CAR, Conditional Autoregressive; Df, degrees of freedom.

were from the 1980s, we suspect the difference is due to the growth in residential pool construction.

We also did not find that minority children were more vulnerable as Saluja⁷ and Warneke and Cooper⁸ noted. The proportion of submersions by minority children (65%) was approximately the same as the proportion of all children who were minority in Harris County in 2005 (67%).¹¹ There were subtle differences in that submersions of African-American children were slightly higher than their share in the population, whereas submersions in Hispanic children were lower than their share in the population. However, this difference was not statistically significant.

Another important finding was that around half of multifamily submersions were clustered in five separate 'hot spots' whereas single-family submersions were not clustered. The primary reason for the concentration of multifamily submersions is the clustering of multifamily units with pools. Many of these were built after 1970 when the region's population suburbanised, mostly to the western part of the county.

Nevertheless, clustering has a practical dimension in that any effort to mitigate submersions in multifamily buildings can be more efficiently targeted compared with those in single-family homes. Increased inspections and educational outreach can be more efficiently done when there are a limited number of locations to target.

The main contributing factors for drowning are inadequate supervision, poor swimming skills and improper safety

equipment. Prevention involves education and policy changes. The education of parents and caregivers should focus on supervising children when they use the pool, enrolling children in swim classes, and offering cardiopulmonary resuscitation (CPR) classes to those who supervise. Close supervision entails never leaving a child unattended around water even for a brief period. Younger children may require having an adult present in the pool within grasping distance of a swimming child. Safety pledges by supervising adults to refrain from being distracted is also recommended.²⁸ Since very young children are most commonly affected, prevention should be specially geared towards parents of these ages. Safe pool practices include discouraging children from running around recklessly or pushing others into the pool, keeping away from drains to avoid entrapment and avoiding collisions with other swimmers.

Parents should also ensure that their children learn to swim. In our study, though minority status and median household income at the census tract level did not predict submersions, we recommend swimming classes for residents of multifamily buildings since many of them are predominantly minority. The US Swimming Foundation observed that 70% of African-American, 60% of Hispanic and 40% of white children were unable to swim.²⁹ Saluja *et al*⁷ reported that foreign-born children also had a higher incidence of drowning. Formal swimming lessons have been shown to decrease the likelihood of drowning by 88% for children under 5.³⁰ Offering low-cost or free classes,

Table 3 Multivariate predictors of annual Harris County multifamily submersions Poisson-Lognormal-CAR model coefficients and 95% credible intervals (N=786 census tracts)

DepVar: log of annual number of multifamily submersions per 100 per tract				
	Model 1		Model 2	
N	786		786	
Df	775		779	
Number of samples	200 000		200 000	
Number of 'burn in' samples	100 000		100 000	
Log likelihood	-6022.7		-6008.5	
AIC	12 067.4		12 031.1	
BIC	12 118.8		12 063.7	
Deviance	11 023.0****		11 007.8****	
Mean absolute deviation	2.62		2.33	
Mean-squared error	201.1		74.6	
Dispersion multiplier	44.8****		40.6****	
	Coefficient	(95% credible interval)	Coefficient	(95% credible interval)
Modeled parameters				
Constant	-15.5845	(-22.2055 to -9.9184)	-13.9681	(-17.8787 to -10.7023)
<i>Socioeconomic variables</i>				
African-American population	0.0008	(-0.0002 to 0.0018)	-	-
Asian population	0.0031	(0.0009 to 0.0055)	-	-
Hispanic population	0.0005	(-0.0003 to 0.0013)	-	-
Median household income (\$'000)	-0.00005	(-0.0001 to 0.00 004)	-	-
<i>Exposure variables</i>				
Number of multifamily pools	0.7669	(0.4301 to 1.1507)	0.6825	(0.3748 to 1.0107)
Number of children, ages 0-17, in multifamily residences	0.0023	(-0.00001 to 0.0048)	0.0038	(0.0019 to 0.0059)
<i>Statistical controls</i>				
Area of tract (m ²)	-0.0047	(-0.3178 to 0.2876)	-0.0355	(-0.4086 to 0.2171)
Distance to city centre (m)	0.0504	(-0.1704 to 0.2444)	0.0428	(-0.1138 to 0.2046)
<i>Unmeasured spatial effect</i>				
Spatial autocorrelation (Φ)	-0.0015	(-0.0711 to 0.0551)	-0.0031	(-0.0760 to 0.0467)

****p<0.0001.

[Bold] represents significant beyond the 0.0001 credible interval.

AIC, Aikake information criterion; BIC, Bayesian information criterion; CAR, Conditional Autoregressive; Df, degrees of freedom.

possibly underwritten through corporate sponsorship, would help reduce costs.²⁹ Finally, parents and caregivers should be offered opportunities to learn cardiopulmonary resuscitation.

Suggested policy changes include increased code enforcement, minimum supervision standards and dissemination of safety education. The City of Houston has an ordinance on swimming pool equipment.³¹ But local ordinances may be unable to reduce childhood drowning in residential pools due to insufficient separation of pools from homes, poor enforcement and inadequate fencing.⁶ Recently, pool inspectors were granted greater authority to issue citations for code violations and to close pools if remediation did not occur. Cities, like Houston, need to reinforce existing regulations.^v Other policy suggestions are for private pool owners to provide safety information, as in California where private pool owners are encouraged to produce a booklet explaining drowning hazards,³² or ensuring that there are adequate adults to supervise children who are swimming, such as in New York State where there must be at least two adults 18 years or older who can swim when children are in semipublic pools.^{33 34} Requiring managers of multifamily

buildings to take periodic courses on pool safety would reinforce this emphasis. The City of Dallas requires managers of public pools (though not apartments) to take a training course in pool safety and recertify every 2 years.³⁵ Such training could be extended to multifamily residences.

Prevention of childhood submersions in single-family homes is more challenging. Since these are more numerous and spatially dispersed, it is difficult for a public agency to inspect or monitor all such pools or to educate homeowners. Pool inspections occur at the time of construction prior to issuing a building permit, after a complaint is received about a pool violation, or after a drowning. Methods to prevent drowning in single-family homes include education through public service announcements, sharing water safety information with neighbours and engaging local health officials to ensure continuing inspections of pool, fencing and barrier issues.²⁸

LIMITATIONS

There are several limitations. First, we may have missed victims who were treated and released from other medical facilities in Harris County. We believe this number to be small, since most clinically important submersions are treated at the children's hospitals. Second, owing to incomplete data, we could not ascertain the proportion of submersions that occurred in above-ground (temporary) swimming pools. However, we believe this

^vPool inspection and code violation data for Houston are not available. As a sequel to this study, we are surveying managers of multiresidential dwellings in Harris County to obtain information on access, safety measures and submersion history at their swimming pools.

number is small. Between 2001 and 2009, there were 209 fatal and 35 non-fatal submersions in children under 12 in portable pools for the entire USA.³⁶ Third, submersion locations were unavailable in 22% of the cases which may have decreased the accuracy of our findings. Fourth, there was no information on actual pool exposure in multifamily buildings or information on the extent to which multifamily residential management actively supervised swimming. Fifth, data on the number of children 0–17 in single-family and multifamily housing, respectively, came from the ACS for 2005–2009. Thus, there might be imprecision due to using an important variable from a different time frame. Sixth, relationships found are ecological in nature and may not hold for individual apartments.³⁷

CONCLUSION

Paediatric swimming pool submersions in multifamily buildings are spatially clustered. The likelihood of submersions is higher for children who live in multifamily buildings with pools than those who live in single-family homes with pools.

What is already known on this subject

- ▶ The role of sociodemographic factors, housing type and swimming pool exposure in childhood submersions is poorly understood.

What this study adds

- ▶ Swimming pool submersions of children who reside in multifamily residential buildings are spatially clustered while those in single-family homes are not.
- ▶ Children who live in multifamily buildings with swimming pools have a greater risk of submersion than those who live in single-family homes with swimming pools.

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Cost of preventable injuries grows

'Parachute' is Canada's leading injury prevention organisation. In June it released a Cost of Injury in Canada Report that showed the financial costs of preventable injuries was rising and it predicted that without intervention, the numbers will continue to climb. The launch included a statement from the Minister of Health thanking Parachute for its work, adding, "Nothing is more important than the health and safety of Canadians". The Minister failed to reveal what actions her government has taken to remedy matters. No previous 'Cost' report has moved successive governments to act on injuries. Parachute now proposes we 'stop the clock' on preventable injuries but also fails to say how. *Comment:* The report gives no indication whose ultimate responsibility injury prevention is. I still think it belongs to Health Canada - noted by IBP.

Children still falling from windows

In spite of the landmark discovery about 40 years ago that 'children can't fly', and that protection was needed on the windows of high rise apartments, these deaths continue. In Seattle, USA, last year alone 13 children had injuries related to window falls. Safe Kids Seattle organised a demonstration about window guards. *Comment:* Beth Ebel was one of the speakers - noted by IBP.

Nearly \$3 million to hospital for sports injury prevention

The Hospital for Special Surgery in New York, famous for treating injured professional athletes, has received \$2.76 million to establish a programme to prevent such injuries from the Dinan Foundation. The Sports Medicine Injury Prevention Program is intended to last 5 years e.g., with a review of best practices. It will then launch an awareness campaign and skills enhancement for coaches and trainers. *Comment:* Welcome news but the focus is narrow (Anterior Cruciate Ligament (ACL) injuries) and awareness alone rarely works - noted by IBP.

Walmart settles truck crash lawsuit

Walmart Stores has settled a lawsuit with a comedian and two others seriously injured in a truck crash. The victims were in a limousine bus that was rear-ended by a Walmart truck - noted by IBP.

GM penalty tax deductible?

A mother whose daughter died in a General Motors (GM) crash is asking why such deaths can be treated as a tax deduction. If such settlements were not tax deductible companies would have more incentive to provide safer vehicles. Source: <http://money.cnn.com/2015/04/09/news/companies/gm-airbag-tax-break/> - noted by IBP.