



Applying the Model Aquatic Health Code to Grade Swimming Pool Safety in a Large Metropolitan Area

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Abstract The Model Aquatic Health Code (MAHC) provides voluntary guidelines that reduce the risk of disease, injury, and drowning at aquatic facilities. Its use varies across state and local jurisdictions. We sought to develop a swimming pool safety grading system in a metropolitan area by applying the MAHC to city swimming pool inspection data. We conducted a cross-sectional study that involved routine inspections of commercial aquatic venues in Houston, Texas, during 2016. We calculated the overall percentage of items in compliance with the MAHC. Next, we graded swimming pools by assigning points based on the MAHC to corresponding swimming pool violations and assigning a letter grade: A = 95–100%; B = 85–94%; C = 75–84%; and fail (F) = <75%. Graded pools were projected onto a map of Houston to geographically sort and visualize their location.

There were 3,100 commercial aquatic venues in Houston that were inspected. Venues were graded for safety as: A = 40.2%; B = 0.5%; C = 0%; and F = 59.3%. Swimming pool enclosure violations were most frequent (18.0%). Most swimming pools, irrespective of the degree of pool safety violations, were located in the Southwest section of Houston. Overall, the MAHC can be applied to grade swimming pool safety in jurisdictions where it has not been adopted. The degree of safety violations can be spatially demonstrated to inform injury-prevention measures.

Introduction

Drowning is the leading cause of unintentional injury death in U.S. children 1–4 years (National Center for Injury Prevention and Control, 2018). In children, swimming pools account for 33% of fatal drownings (Clemens et al., 2021) and 65.7% of nonfatal submersions in the U.S. (Felton et al., 2015). During 2017–2019, an average of 6,700 pool- or spa-related nonfatal drowning injuries treated in

hospital emergency departments occurred each year in children <15 years; each year, an estimated 76% occurred in children <5 years (Yang, 2020).

The risk of submersion is 2.7 times higher for a child at a multifamily residence compared with a single-family residence and 28 times more likely in a multifamily swimming pool than a single-family pool (Shenoi et al., 2015). The American Academy of Pediatrics

recommends multiple layers of protection to prevent drowning (Denny et al., 2021). Waterborne diseases, drowning, falling, diving, chemical use, and suction injuries are major recreational water illnesses and injuries (RWIs) associated with public aquatic facilities, particularly for young children. Between 2000–2014, there were 493 outbreaks of waterborne diseases associated with treated recreational water that resulted in at least 27,219 cases and 8 deaths (Hlavsa et al., 2018). Additionally, between 2003–2012 there were an estimated 4,247 emergency department visits for swimming pool chemical-related injuries (Hlavsa et al., 2014).

State and local agencies regulate safety at public aquatic facilities, as there is no federal regulatory authority responsible for the design, construction, operation, maintenance, and management of public pools and hot tubs/spas. Public pool codes for preventing and responding to RWIs are developed, reviewed, and approved by state and local public health officials or legislatures and thus can vary among local and state jurisdictions.

In 2007, the Centers for Disease Control and Prevention (CDC, 2023a) developed the Model Aquatic Health Code (MAHC) to provide guidance to local and state agencies regarding the design, operation, and maintenance of public aquatic facilities to reduce RWIs. As a result, 25 jurisdictions located in the 5 states with the highest estimated counts of public aquatic venues—Arizona, California, Florida, New York, and Texas—and a

TABLE 1

Comparison of the Model Aquatic Health Code (MAHC) and City of Houston Safety Codes and Violation Points

Safety Code	MAHC Violation Points	City of Houston Violation Points
Pool and spa		
Enclosure in good repair	10	10
Self-closing/self-latching gates	10	10
Protected overhead electrical wires	10	10
Grab rails, ladders secured; shell, deck in good repair	5	5
Float/safety line clearly present	5	5
Depth and no diving markers; stair stripes; in good repair and visible	5	5
Skimmers: weirs and baskets installed; clean and operating; covers in good repair	5	5
Recirculation inlets functional	5	5
Main drain grate secured in place and in good repair	10	10
Water is clear, main drain visible	10	10
Starting blocks removed, covered, or access blocked	5	5
Pool deck free from obstructions; emergency exit marked	5	5
Emergency phone or other communication device available and well-marked	5	5
First aid kit available	5	5
Appropriate safety equipment present and in good repair	10	10
Adequate supervision of the facility	10	*
Signs: bathing load, rules, chemicals, and spa legible and in good repair	5	5
Spa temperature ≤104 °F (40 °C)	10	10
Water chemicals		
Approved NSF/ANSI Standard 50 DPD test kit	5	5
Proper disinfectant level	10	10
pH between 7.2 and 7.8	10	10
Combined chlorine <0.4 ppm	5	*
Cyanuric acid ≤100 ppm	5	*

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few other counties and states have adopted the MAHC (Hlavsa et al., 2016). The City of Houston, Texas, has not adopted the MAHC and instead uses a Code of Ordinances to regulate the safety of city swimming pools (City of Houston, 2023).

The primary aim of our study was to develop a grading system for swimming pool safety for Houston by applying the MAHC to city swimming pool inspection data. We hypothesized that by using a safety grading

system for public aquatic facilities, it would be possible to disseminate swimming pool safety information to guide injury-prevention measures and inform pool operators and the public about problematic pools.

Methods

Study Design and Setting

We conducted a cross-sectional study of swimming pool safety inspection data for

3,107 public swimming pools, including spas and wading pools, in Houston during 2016. We defined a public swimming pool as one that is intended to be used collectively by people for swimming or bathing. This classification included a swimming pool owned or operated as part of a multifamily dwelling project, nonprofit recreational facility, hotel, educational facility, or fitness center (Houston Health Department, 2023a).

In 2021, Houston had a population of 2.29 million (U.S. Census Bureau, 2021). The Houston Health Department regulates public pools and spas through enforcement of Chapter 43 of the City of Houston Code of Ordinances (City of Houston, 2023). The code was adopted from the Texas Administrative Code (Public Swimming Pools and Spas, 2023), Texas Health and Safety Code (Pool Yard Enclosures, 1994), and International Code Council, Inc. (2018).

The ordinance ensures that aquatic facilities provide a clean, healthy, and safe environment for the public by protecting against waterborne illness and preventing drowning. The pool safety inspection consists of safety and administrative elements (Houston Health Department, 2019). All public pools, including multifamily and community swimming pools, require an annual inspection. More frequent inspections occur when safety violations are discovered at the time of inspection or in response to a complaint.

The city also lists critical violations that can result in immediate closure of the swimming pool (Houston Health Department, 2019). If uncorrected, these violations can be life-threatening. Private single-family residential swimming pools are not subject to annual safety inspections by the city but can be inspected when requested by the owner. These pools were excluded from our study. Our study did not involve human subjects. Patients or the public were not involved in the design, conduct, reporting, or dissemination plans of our research.

Inspection Data

Inspection data of all registered commercial swimming pools within the city limits of Houston were obtained from the Houston Health Department (HHD). Data included name and address of the property where the pool was sited, housing type (e.g., apartment, spa, city pool, club, condominium, commu-

nity association, fitness club, hotel, hospital, nursing home, mobile home, park, school, day care), and publicly available information on swimming pool violations per the Code of Ordinances for Houston.

Data obtained from HHD also included pool addresses. In some cases, the addresses that were provided were the establishment's parent company that was located outside Houston or were post office boxes rather than the physical location of the swimming pool. The addresses of these swimming pools were traced from their respective HHD swimming pool accounts. In total, seven swimming pools did not have associated addresses or a corresponding active account with HHD; these pools were excluded from our analysis. Swimming pool addresses were converted to longitude and latitude coordinates, geographically coded using Texas State Plane Southcentral NAD 83 (a projection system used by most government agencies in the region), and projected onto a map of Houston using ArcGIS Pro version 2.5.0.

Application of the MAHC to Swimming Pool Safety Violation Codes

The MAHC codifies aquatic safety inspection items and includes an inspection form to grade the safety of swimming pools against RWIs (CDC, 2018a, 2018b). The inspection form consists of 49 inspection items based on safety, chemical, and health hazards. The safety categories on the inspection form pertain to the pool and spa area, water chemicals, equipment and chemical room, hygiene facilities, records room, and general items.

Within each category are subitems that are assigned points. Points are deducted from subitems that are not in compliance with code after a pool inspection is performed. Overall, 13 of the MAHC compliance items are deemed critical for passing swimming pool inspections because noncompliance can be potentially life-threatening. Swimming pools are assigned safety grades based on the proportion of subitems that have passed inspection (expressed as a percentage). A swimming pool receives a failing grade if the percentage of subitems that pass inspection is <75% or if there is a critical violation that can be life-threatening (CDC, 2018a).

HHD inspects 29 items for safety violations during routine swimming pool inspections. These items are referenced by their correspond-

TABLE 1 continued from page 9

Comparison of the Model Aquatic Health Code (MAHC) and City of Houston Safety Codes and Violation Points

Safety Code	MAHC Violation Points	City of Houston Violation Points
Equipment and chemical room		
Automated feeder operable	10	10
Automated controller operable	5	*
Piping and valves identified and marked	5	5
Flow meter present and operating	5	5
Recirculation pump: approved, in good repair, operating	10	10
Filter: approved, in good repair, operating	10	10
Pump strainer: baskets in good condition, not clogged	5	5
Filter gauges operable: filter inlet and outlet, strainer; sight glass	5	5
Proper functioning UV system; ozone system	5	*
Chemicals: labeled, stored safely, secured	10	10
Appropriate personal protective equipment available	5	*
Hygiene facilities		
Diaper changing station present; sink, adjacent trash can, sanitizer	5	*
Used equipment separated from clean equipment	5	*
Toilets: clean, in good repair, bathroom appropriately stocked	5	*
Rinse showers: in good repair, accessible	5	*
Cleansing showers: warm, nonscalding water available; in good repair; soap	5	*
Records room		
Operator training certification available on-site	5	
Lifeguard training certification available on-site	5	5
Inspection report conspicuously posted at each entrance	5	*
Operator inspection daily items: checklist used daily	5	*
Operator inspection items: evidence of appropriate steps promptly taken	5	*
Chemical records: filled out daily	5	*
Chemical records: evidence of appropriate steps promptly taken	5	*
Emergency action plan available on-site	5	*
General		
Substantial unauthorized alterations/equipment replacement	10	*
Other: imminent health hazards are a 10-point critical violation	5 or 10	*
* Indicates items that the City of Houston does not inspect. Note. Bolded items represent critical code items in the MAHC.		

ing code in the Code of Ordinances for Houston. We reviewed the MAHC with HHD staff to determine which of the 49 safety items on the MAHC were in use by Houston during their

swimming pool inspections. HHD confirmed using 29 of 49 MAHC items and 11 of the 13 critical items in the MAHC. Moreover, there are additional subcodes in use by HHD that match

TABLE 2

City of Houston Swimming Pool Violation Codes With Matching Model Aquatic Health Code (MAHC) Items

MAHC Item	City of Houston Swimming Pool Violation Code
Pool and spa	
Enclosure in good repair	25 TAC §265.200, HSC 757.00, HSC 757.005
Self-closing/self-latching gates	25 TAC §265.200, HSC 757.004
Protected overhead electrical wires	25 TAC §265.192
Grab rails, ladders secured; shell and deck in good repair	25 TAC §265.186
Float/safety line clearly present	25 TAC §265.199
Depth and no diving markers; stair stripes; in good repair and visible	25 TAC §265.199
Skimmers: weirs and baskets installed; clean and operating; covers in good repair	25 TAC §265.191
Recirculation inlets functional	25 TAC §265.191
Main drain grate secured in place and in good repair	25 TAC §265.190, Sec 1404
Water is clear, main drain visible	25 TAC §265.203
Starting blocks removed, covered, or access blocked	25 TAC §265.186
Pool deck free from obstructions; emergency exit marked	25 TAC §265.186
Emergency phone or other communication device available and well-marked	25 TAC §265.199
First aid kit available	25 TAC §265.199
Appropriate safety equipment present and in good repair	25 TAC §265.199
Adequate supervision of the facility	N/A
Signs: bathing load, rules, chemicals, and spa legible and in good repair	25 TAC §265.205
Spa temperature ≤104 °F (40 °C)	25 TAC §265.205
Water chemicals	
Approved NSF/ANSI Standard 50 DPD test kit	Sec 43-4(b)
Proper disinfectant level	25 TAC §265.204
pH between 7.2 and 7.8	25 TAC §265.204
Combined chlorine ≤0.4 ppm	N/A
Cyanuric acid ≤100 ppm	N/A

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some of the 29 items that are common with the MAHC and HHD inspection forms.

The 20 items in the MAHC that do not have a corresponding HHD code were not included for analysis and were listed as “not applicable.” Items in the MAHC are scored 5 or 10 points; critical items carry a higher value of 10 points. We used the same scoring in the MAHC for the corresponding HHD safety items. All 49 inspection items in the MAHC inspection form are not required

to generate a complete score; an option for “not applicable” is available (CDC, 2018a). Based on this scoring, the maximum number of compliance points possible after an HHD swimming pool inspection is 210.

Letter grades were calculated as total compliance points scored after an inspection divided by the maximum possible compliance points. Letter grades were classified as: A = 95–100%; B = 85–94%; C = 75–84%; and fail (F) = <75% or noncompliance of a criti-

cal element regardless of the total score. Table 1 describes the 49 items in the MAHC, with the matching 29 items used by HHD during swimming pool inspections. Table 2 describes the subsection of the statutes used in the HHD code and its matching MAHC item.

We used descriptive statistics to describe pool violation data. SAS version 9.4 was used to group, analyze, combine items, and apply inspection data to the MAHC. All 2016 inspections and violation data from Houston were merged by unique identifiers in both data sets. Data were queried on active establishment status, nonabatement license status, and annual routine inspections. If a pool had more than one routine inspection, then the first date of inspection was selected. Violation codes were grouped into 29 categories with a score assigned to each violation group.

Results

There were 3,107 swimming pools inspected in Houston in 2016. Of these, 3,100 had addresses and accounts located within the city limits of Houston; a total of 7 pools had addresses that were not in the city limits or had a post office box listed and no current account associated. Table 3 describes the safety grades for swimming pool establishments based on the MAHC with 79.2% of the pools located in multifamily establishments. The second-most common type of establishment were pools located in hotels or motels (10.5%). Two swimming pools did not have a listed establishment.

As shown in Table 3, the safety grading process resulted in 1,246 (40.2%) swimming pools with an A grade, 15 (0.5%) pools with a B grade, 0 pools with a C grade, and 1,839 (59.3%) pools with an F grade. Of the 1,839 pools that received an F grade, 14 (<1%) obtained their failing grade based on a failing overall percentage. The remainder of pools with failing grades were noncompliant with ≥1 critical safety item in the MAHC.

Table 4 demonstrates the frequency of the pool violations for each of the 29 items in the MAHC that were observed during inspections in Houston. Violations related to swimming pool enclosures were the most frequent, with 729 violations (18.0%), followed by 558 violations (13.8%) related to self-closing or self-latching gates. The third-most common violation was related to disinfectant levels (516, 12.7%). Application of the city code inspection criteria resulted in 1,285 swim-

ming pools that failed safety inspection (30% less) compared with 1,839 pools that would have failed based on applying the MAHC.

Figures 1 and 2 demonstrate the spatial distribution of swimming pools in Houston based on their safety grades. Most swimming pools, irrespective of the degree of pool safety violations, were located in the Southwest section of Houston.

Discussion

In this study, we applied the MAHC inspection checklist to Houston pool violation data to grade swimming pools for safety in a jurisdiction that has not adopted the MAHC. The safety grading of commercial swimming pools revealed that pool safety violations were widespread, with more than one half of the pools receiving a failing grade.

In almost all cases, the cause of the failing grade was a critical violation that could have been life-threatening if not corrected. The majority of swimming pools that failed inspection occurred in multifamily establishments. A prior study in Harris County, Texas, for which Houston is the county seat, found that out of 196 unintentional drownings, one half occurred in multifamily residential pools (Warneke & Cooper, 1994). Another study in the same region revealed that pediatric drownings are 28 times more likely in a multifamily swimming pool than a single-family pool (Shenoi et al., 2015).

We observed that the most common safety violations were due to faulty swimming pool enclosures, gates and safety equipment, and improper disinfectant levels. Swimming pool chemical violations also occurred frequently. Our results are consistent with the high incidence of faulty pool enclosures and improper levels of pool chemicals documented on pool inspections conducted elsewhere in the U.S. Documenting the magnitude of pool violations and the number of RWIs is a first step toward advocating for improved legislation and enforcement of swimming pool safety regulations.

Additionally, data from 15 jurisdictions found that pool chemical violations were present in 10.7% of pool inspections (CDC, 2010). Hlavsa et al. (2016) described similar results with disinfectant concentration violations and pool chemical safety violations, which were identified in 11.9% and 4.6% of routine inspections, respectively. These findings are impor-

TABLE 2 continued from page 11

City of Houston Swimming Pool Violation Codes With Matching Model Aquatic Health Code (MAHC) Items

MAHC Item	City of Houston Swimming Pool Violation Code
Equipment and chemical room	
Automated feeder operable	25 TAC §265.197, 25 TAC §265.204
Automated controller operable	N/A
Piping and valves identified and marked	25 TAC §265.187
Flow meter present and operating	25 TAC §265.187
Recirculation pump: approved, in good repair, operating	25 TAC §265.189
Filter: approved, in good repair, operating	25 TAC §265.188
Pump strainer: baskets in good condition, not clogged	25 TAC §265.189
Filter gauges operable: filter inlet and outlet, strainer; sight glass	25 TAC §265.187, 25 TAC §265.188
Proper functioning UV system; ozone system	N/A
Chemicals: labeled, stored safely, secured	25 TAC §265.197
Appropriate personal protective equipment available	N/A
Hygiene facilities	
Diaper-changing station present; sink, adjacent trash can, sanitizer	N/A
Used equipment separated from clean equipment	N/A
Toilets: clean, in good repair, bathroom appropriately stocked	N/A
Rinse showers: in good repair, accessible	N/A
Cleansing showers: warm, nonscalding water available; in good repair; soap	N/A
Records room	
Operator training certification available on-site	N/A
Lifeguard training certification available on-site	25 TAC §265.199
Inspection report conspicuously posted at each entrance	N/A
Operator inspection daily items: checklist used daily	N/A
Operator inspection items: evidence of appropriate steps promptly taken	N/A
Chemical records: filled out daily	N/A
Chemical records: evidence of appropriate steps promptly taken	N/A
Emergency action plan available on-site	N/A
Substantial unauthorized alterations/equipment replacement	N/A
Other: imminent health hazards are a 10-point critical violation	N/A
<i>Note.</i> Bolded items represent critical code items in the MAHC. HSC = Texas Health and Safety Code; N/A = not applicable; TAC = Texas Administrative Code.	

tant because the median estimated number of persons visiting emergency departments for chemical-related injuries from pools was 4,247 per year between 2003 and 2012 (Hlavsa et al., 2014). Identifying these violations and enforcing corrective action can mitigate the risk of swimming pool chemical-related injuries.

We also observed that faulty swimming pool enclosures and gates and inappropriate safety equipment were the most common violations found during routine pool inspections. Many of these violations resulted in immediate pool closure. This finding is similar to another study where pool enclosure violations and

TABLE 3

Swimming Pool Safety Grades by Establishment After Applying the Model Aquatic Health Code

Establishment	Swimming Pool Safety Grades # (%)				
	A	B	C	F	Total
Multifamily	951	14	0	1,491	2,456 (79.2)
Hotel or motel	117	1	0	206	324 (10.5)
Health or fitness facility	52	0	0	47	99 (3.2)
Club	34	0	0	42	76 (2.5)
City or public facility	55	0	0	20	75 (2.4)
School or day care	25	0	0	26	51 (1.6)
Healthcare facility	8	0	0	5	13 (0.4)
Other	4	0	0	2	6 (0.2)
Total	1,246 (40.2)	15 (0.5)	0 (0)	1,839 (59.3)	3,100 (100)

Note. A = 95–100%; B = 85–94%; C = 75–84%; and F = <75% or noncompliance of a critical element regardless of the total score.

TABLE 4

Frequency of Observed Swimming Pool Violations

Item From the Model Aquatic Health Code (MAHC) Inspection Form Observed by the City of Houston	Observed Violations # (%)
Pool and spa	
Enclosure in good repair	729 (18.0)
Self-closing/self-latching gates	561 (13.8)
Protected overhead electrical wires	56 (1.4)
Grab rails, ladders secured; shell and deck in good repair	34 (0.8)
Float/safety line clearly present	0 (0)
Depth and no diving markers; stair stripes; in good repair and visible	136 (3.4)
Skimmers: weirs and baskets installed; clean and operating; covers in good repair	24 (0.6)
Recirculation inlets functional	0 (0)
Main drain grate secured in place and in good repair	244 (6.0)
Water is clear, main drain visible	88 (2.2)
Starting blocks removed, covered, or access blocked	5 (0.1)
Pool deck free from obstructions; emergency exit marked	1 (0.02)
Emergency phone or other communication device available and well-marked	151 (3.7)
First aid kit available	0 (0)
Appropriate safety equipment present and in good repair	374 (9.2)
Signs: bathing load, rules, chemicals, and spa legible and in good repair	88 (2.2)
Spa temperature ≤104 °F (40 °C)	7 (0.2)

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inappropriate safety equipment were identified in 5.1% and 12.7% of pool inspections, respectively (Hlavsa et al., 2016).

It is known that isolation swimming pool fences reduce the risk of drowning (Thompson & Rivara, 1998). As such, the American Academy of Pediatrics recommends a multilayered approach to reduce drowning that includes functioning isolation swimming pool fencing and self-latching and self-closing gates (Denny et al., 2021).

We found that pool safety inspections in Houston, as currently conducted, captured 30% fewer swimming pool violations than if the MAHC criteria were used. Almost all of the safety violations observed were individual violations and <1% of the swimming pools that failed did so because of a low overall score.

Many of the items that are not listed in the code used by Houston but that appear in the MAHC pertain to facility hygiene, record-keeping, and unauthorized alterations or replacement of equipment. Except for the latter, which could be potentially dangerous, the first two items pertain to maintaining a clean facility to reduce the transmission of illness and disease and implementing proper aquatic management practices. Other reasons for not including these MAHC items could be that inspections are conducted based on the basic and common certification requirements and therefore these less common requirements might be neglected (National Association of County and City Health Officials, 2015).

Implications

Our results have the following implications. Recreational water safety is regulated at the state or local level, and thus there is wide variation in implementing policy and safety practices across jurisdictions. Houston might need to update its inspection criteria to current MAHC standards and institute best practices for pool safety.

There has been a marked increase in recreational use of residential and public disinfected water as leisure time around the pool has increased. Changes in the design of aquatic facilities have occurred and regulatory agencies need to keep abreast of these changes. A legislative approach that includes instituting updated versions of the MAHC would be one solution. There are fiscal implications, however, that will also need to be evaluated.

These changes would involve training current safety inspectors and using an incremental approach to allow regulatory and industry partners to adapt to changing MAHC guidelines. CDC (2023b) provides resources for public health officials and aquatic staff to implement MAHC recommendations or strengthen their aquatic health and safety programs. The advantages of incorporating MAHC guidelines would be use of the most effective water safety inspection criteria, which could translate into reduced RWIs. Furthermore, inspection results could be compared with other jurisdictions that use similar inspection criteria.

A promising aspect of our study is the ability to illustrate the distribution of swimming pools in Houston based on their safety grade. This mapping has potential use in injury prevention. This approach has been used in playground safety, where the safety scores of playgrounds in need of maintenance were spatially mapped in Chicago to effect improvements in fall surfacing and equipment maintenance (Allen et al., 2013).

The same approach could be applied to swimming pool safety in Houston. Currently, Houston maintains an up-to-date listing of all pool violations by property that is accessible to the public (Houston Health Department, 2023b). The City of Plano, Texas, employs a similar scoring system that allows the public to look up swimming pools with color-coded scores that show the results of the swimming pool inspection (Plano Health Department, n.d.).

Data from our study demonstrate that the swimming pools that failed safety inspections were predominantly concentrated in Southwest Houston, which has a larger percentage of residents belonging to a lower socioeconomic status (City of Houston Planning & Development Department, 2016a) and racial and ethnic minority groups (City of Houston Planning & Development Department, 2016b). The rate of unintentional drownings is higher in children belonging to racial and ethnic minorities (Felton et al., 2015; Gilchrist & Parker, 2014), which could serve as a focus for injury prevention efforts to reduce drowning.

Limitations

There are several limitations to our study. First, our findings are not generalizable to other jurisdictions that have other types of

TABLE 4 continued from page 13

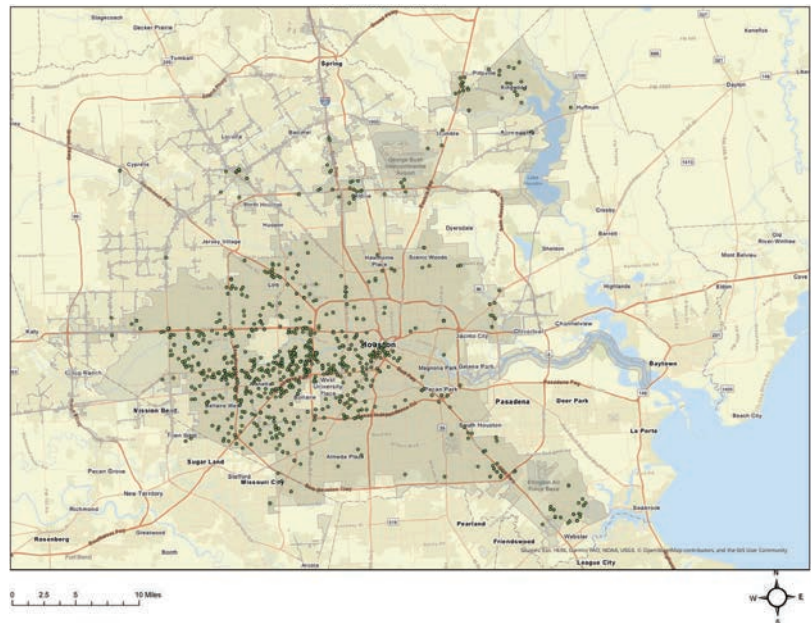
Frequency of Observed Swimming Pool Violations

Item From the Model Aquatic Health Code (MAHC) Inspection Form Observed by the City of Houston	Observed Violations # (%)
Water chemicals	
Approved NSF/ANSI Standard 50 DPD test kit	2 (0.05)
Proper disinfectant level	516 (12.7)
pH between 7.2 and 7.8	449 (11.1)
Equipment and chemical room	
Automated feeder operable	99 (2.4)
Piping and valves identified and marked	238 (5.9)
Flow meter present and operating	126 (3.1)
Recirculation pump: approved, in good repair, operating	38 (0.9)
Filter: approved, in good repair, operating	8 (0.2)
Pump strainer: baskets in good condition, not clogged	1 (0.02)
Filter gauges operable: filter inlet and outlet, strainer; sight glass	74 (1.8)
Chemicals: labeled, stored safely, secured	1 (0.02)
Records room	
Lifeguard training certification available on-site	2 (0.05)

Note. Bolded items represent critical code items in the MAHC.

FIGURE 1

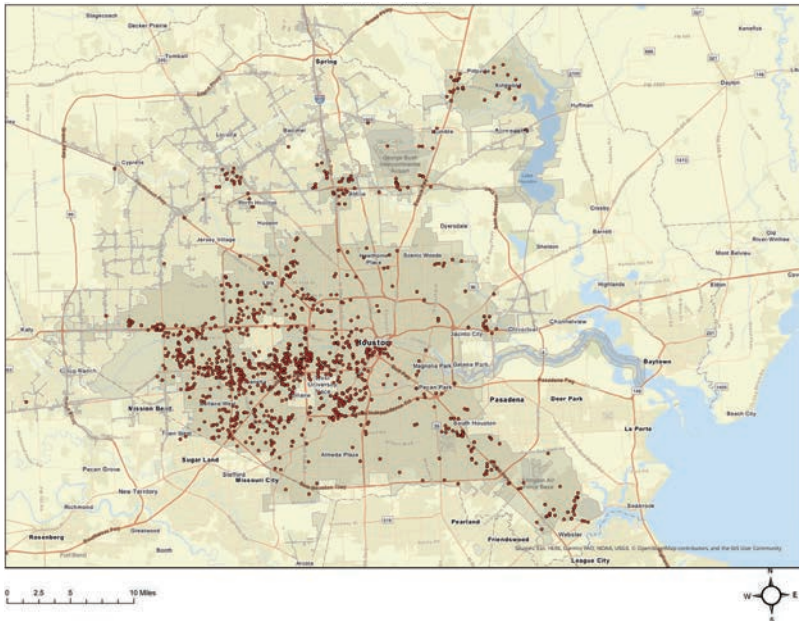
Location of Swimming Pools in the City of Houston That Received A Grades



Note. Shaded area indicates the City of Houston.

FIGURE 2

Location of Swimming Pools in the City of Houston That Received F Grades



Note. Shaded area indicates the City of Houston.

aquatic bodies and permitting agencies. For example, we did not study pool violations in single-family homes, as they are not subject to annual safety inspections. Second, we included only 1 year of data. It would, however, be preferable to include additional years of data to assess safety trends. Third, some swimming pools that failed safety inspection might have corrected their deficiencies after the routine inspection. Thus,

we were unable to determine if the safety deficiency was long-standing. It is highly likely, however, that the safety concerns were addressed in a timely manner because the property managers would want to open the aquatic facility to their clients at the earliest possible point. Finally, we cannot comment on aboveground or portable swimming pools, as they are not subject to safety inspections.

Conclusion

The strength of our study is that our methodology could be used by other jurisdictions that have not adopted MAHC criteria yet. If used across jurisdictions, our approach can ensure consistency in swimming pool safety grading. Future directions include evaluating if safety issues with swimming pools persist in subsequent years, investigating prevailing socioeconomic and health disparities in areas with a high concentration of pools that fail safety inspections, and developing an online platform that is available to the public that could host a map of swimming pools by safety grade. Overall, the MAHC can be applied to grade swimming pool safety in jurisdictions where it has not yet been adopted. The degree of safety violations can be spatially demonstrated (e.g., mapped) to inform injury-prevention measures. 🌸

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Did You Know?

The 2024 Integrated Foodborne Outbreak Response and Management (InFORM) Conference will be held on January 22–24, 2024, in Washington, DC. Stay tuned to www.neha.org/inform for details on abstract submission, preconference sessions, registration, and room reservations.