

Report from the Field

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Immediate Injury Deaths Related to the Remnants From Hurricane Ida in New York City, September 1-2, 2021

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Abstract

The remnants from Hurricane Ida in September 2021 caused unprecedented rainfall and inland flooding in New York City (NYC) and resulted in many immediate deaths. We reviewed death records (electronic death certificates and medical examiner reports) to systematically document the circumstances of death and demographics of decedents to inform injury prevention and climate adaptation actions for future extreme precipitation events. There were 14 Ida-related injury deaths in NYC, of which 13 (93%) were directly caused by Ida, and 1 (7%) was indirectly related. Most decedents were Asian (71%) and foreign-born (71%). The most common circumstance of death was drowning in unregulated basement apartments (71%). Themes that emerged from the death records review included the suddenness of flooding, inadequate exits, nighttime risks, and multiple household members were sometimes affected. These deaths reflect interacting housing and climate crises, and their disproportionate impact on disadvantaged populations needing safe and affordable housing. Climate adaptation actions, such as improving stormwater management infrastructure, informing residents about flood risk, implementing Federal Emergency Management Agency recommendations to make basements safer, and expanding emergency notification measures can mitigate risk. As climate change increases extreme precipitation events, multi-layered efforts are needed to keep residents safe.

Hurricane Ida made landfall as a Category 4 hurricane in Louisiana on August 29, 2021, downgrading to a post-tropical storm when it hit New York City (NYC) the night of September 1, 2021.^{1,2} The National Weather Service issued NYC's first-ever flash flood emergency declaration at 9:28 PM that evening.² City officials declared a state of emergency and issued a travel ban at 11:45 PM. The Ida Remnants Cloudburst (sometimes referred to as "Hurricane Ida" or "Ida") marked a historic event for NYC, an urban area that has faced coastal flooding, but had not yet experienced inland flooding to the extent caused by Ida.^{3,4} Nine inches of rainfall were recorded, with a record-breaking 3.5 inches/hour of maximum rainfall in some areas, exceeding NYC's sewer capacity of 1.75 inches/hour.^{1,2} The storm resulted in many immediate injury deaths. We reviewed death records identified by the NYC Department of Health and Mental Hygiene's (DOHMH) Office of Vital Statistics to systematically collect and document the circumstances of death and demographics of NYC decedents to inform injury prevention and climate adaptation actions for future extreme precipitation events.

Methods

We examined immediate injury deaths, defined as external-cause deaths of unintentional manner, from September 1-2, 2021, in NYC. This case definition was chosen because the NYC Office of the Chief Medical Examiner (OCME) investigates all external-cause deaths, thus providing detailed information (eg, circumstances of death) on these cases. Intentional injury deaths (suicide or homicide) were not assessed due to differing potential prevention pathways.

We used death data from 2 sources: (1) NYC DOHMH's Office of Vital Statistics electronic death certificate data; and (2) NYC OCME records data—death certificates; case worksheets; investigation, autopsy, and toxicology reports. The NYC DOHMH's Office of Vital Statistics provided death certificate data on immediate injury deaths from its mortality surveillance system, identified by ICD-10 and text searches. Death records were searched for unintentional external cause of death ICD-10 codes (V01-X59). Text fields for injury and cause of death were searched for injury mechanisms known to be storm-related, and used in a NYC DOHMH review of injury deaths from Hurricane Sandy⁴: drowning, asphyxiation, suffocation, electrocution, hypothermia, carbon monoxide or other gas poisonings, struck/crushed by blunt object, motor vehicle crash or collision related to road conditions, cut/puncture, and fire/burn.

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We developed an abstraction form based on Centers for Disease Control and Prevention (CDC) guidance to collect detailed information from OCME records.⁵ We reviewed OCME records for all deaths identified by ICD-10 code and text searches to determine connection to Ida, assign injury mechanism, and assess circumstances of death and other risk factors. Following criteria developed by Combs et al.,⁶ an approach consistent with CDC guidance,⁷ deaths were categorized as directly caused by Ida (ie, caused by environmental forces of the event and direct consequences of these forces), indirectly caused (ie, caused by unsafe or unhealthy conditions because of loss or disruption of usual services, personal loss, or lifestyle disruption), or unrelated.

To assess building characteristics for deaths occurring at home, we matched NYC Department of City Planning's land use and building data to these death records by geocoded addresses. Death data and building characteristics were summarized in frequency tables and circumstances of death were reviewed in detail to identify shared themes. This research protocol was determined to be exempt by NYC DOHMH's Institutional Review Board.

Results

Sixteen deaths were identified by the death record search from September 1-2, 2021. After reviewing the circumstances of these deaths, 14 were determined to be Ida-related, of which 13 (93%) were directly caused by Ida, 1 (7%) was indirectly related (Table 1), and 2 were unrelated. Most of the 14 decedents were Asian (71%), foreign-born (71%), and Queens County, NY residents (79%). All age groups were affected, with people 65 y and older (36%) most impacted.

Of the 13 direct deaths, 11 were caused by drowning due to basement apartment flooding; 1 by drowning outdoors after falling into a body of water during the storm; and 1 by asphyxiation caused by a fire started from flooding in their motor vehicle. The indirect death was caused by a fall that occurred while the decedent was moving a large item out of a flooded basement.

Time of injury, available in 2 records, was between 11 PM (September 1) and 12 AM (September 2). Time of death, which could be when decedent was found, ranged from 12 AM to 7 PM on September 2 for all 14 decedents; most ($n = 8$) of the drowning deaths in basement apartments occurred between 12 AM and 3 AM.

The most common place of injury was the home, in the basement, with 12 deaths across 7 homes. Six homes were basement apartments, of which 5 were unregulated (ie, cannot be lawfully occupied) according to the NYC Department of Buildings^{8,9}; 1 death occurred in the basement of a larger home (Table 2). Six basements were in 1-to-4-family, low-rise buildings; 1 was in a 50+ unit, high-rise building. Most basements were in older buildings built before 1938 ($n = 3$) or between 1938-1977 ($n = 3$) and in standalone (detached or semi-attached) buildings ($n = 5$). The 4 homes with basement grade information available had full, below-grade basements (basement is 75% or more of the first-floor area with walls that are fully submerged or less than 4 feet on at least 3 sides above grade).

Only 1 decedent lived alone—an older adult who drowned in a basement apartment. One decedent had an unstable housing situation.

Overlapping themes emerged from the OCME records review of the 11 decedents who drowned in basement apartments. All 11 decedents experienced 1 or more of the following themes (counts are not mutually exclusive): (1) The suddenness of flooding ($n = 7$); (2) Individuals noticed signs of flooding, but the decedent

Table 1. Demographic characteristics and circumstances of immediate injury deaths related to the remnants from Hurricane Ida, New York City (NYC), September 1-2, 2021

Characteristic	No. of deaths (%)
	<i>N</i> = 14
Age, years^a	
0-24	3 (21%)
25-44	4 (29%)
45-64	2 (14%)
65+	5 (36%)
Sex^a	
Female	6 (43%)
Male	8 (57%)
Race/ethnicity^a	
Asian	10 (71%)
Black, non-Hispanic	1 (7%)
Hispanic	2 (14%)
White, non-Hispanic	1 (7%)
Country of birth^a	
Foreign-born	10 (71%)
United States	4 (29%)
Education^a	
Less than high school	1 (7%)
High school graduate	2 (14%)
Some college	1 (7%)
Unknown	10 (71%)
Lived alone^b	
Yes	1 (7%)
No	10 (71%)
Unknown	3 (21%)
County of residence^a	
Brooklyn	2 (14%)
Queens	11 (79%)
Staten Island	1 (7%)
Circumstance of death^b	
Unintentional injury death ^c	14 (100%)
Directly storm-related ^d	13 (93%)
Asphyxiation related to flooding	1 (7%)
Drowning in basement apartment ^e	11 (79%)
Drowning outdoors	1 (7%)
Indirectly storm-related ^d	1 (7%)
Preparation/repair injury	1 (7%)
Mechanism of injury^b	
Drowning	11 (79%)
Fall	2 (14%)
Smoke inhalation/burn	1 (7%)
Place of injury^b	
Inside residence/in a basement	12 (86%)
Motor vehicle	1 (7%)
Outdoors	1 (7%)

^aData source: NYC Department of Health and Mental Hygiene's Office of Vital Statistics death certificate data.

^bData source: NYC Office of the Chief Medical Examiner records.

^cInjury that occurred without intent to cause harm, also known as "accident".

^dDirect deaths are caused by environmental forces of the hurricane and direct consequences of these forces. Indirect deaths are caused by unsafe or unhealthy conditions because of loss or disruption of usual services, personal loss, or lifestyle disruption.

^eOf the 14 Ida-related deaths, 10 (71%) drowning deaths occurred in unregulated (ie, cannot be lawfully occupied) basement apartments.

Table 2. Building characteristics of homes with residential injury deaths related to the remnants from Hurricane Ida, New York City (NYC), September 1-2, 2021

Building characteristic	No. of homes (%) N = 7
Basement type ^a	
Basement apartment ^b	6 (86%)
Basement of a larger home	1 (14%)
Building size ^c	
1-4 units	6 (86%)
50+ units	1 (14%)
Building height ^c	
Low-rise (1-3 floors)	6 (86%)
High-rise (10+ floors)	1 (14%)
Year built ^c	
<1938	3 (43%)
1938-1977	3 (43%)
1978+	1 (14%)
Proximity to other buildings ^c	
Attached	1 (14%)
Detached/semi-attached	5 (71%)
Unknown	1 (14%)
Basement grade ^c	
Full basement below grade ^d	4 (57%)
Unknown	3 (43%)

^aData source: NYC Office of the Chief Medical Examiner records.

^bFive of the 6 basement apartments were unregulated (ie, cannot be lawfully occupied), according to NYC Department of Buildings.^{8,9}

^cData source: NYC Department of City Planning land use and building characteristics data.

^dBasement is 75% or more of the first-floor area with walls that are fully submerged or less than 4 feet on at least 3 sides above grade.

could not be reached in time ($n = 6$); (3) Decedent unable to evacuate due to blocked exits (door or stairway) or flood-induced structural damage ($n = 6$); and (4) Emergency responders unable to easily access the basements ($n = 6$).

Each theme is illustrated by the following examples: (1) Family members living nearby noticed signs of flooding and went to check on 1 decedent, who was unrevivable when found. (2) Household members noticed basement flooding and woke up the sleeping decedent. The decedent could not open the door due to the water pressure, and household members could not assist because the stairway exit was impassable due to flooding. The decedent was pronounced dead less than an hour later. (3) Two decedents were unable to evacuate when flooding caused the house foundation to collapse, causing rapid flooding into their basement apartment. Less than an hour passed between times of injury and death. (4) A neighbor called 911 after seeing water coming from a basement and hearing people inside. Five feet of water prevented responders from entering through windows or doors. In another basement apartment, responders had to remove metal bars from the only window to access the decedents—the only door was blocked by household items. Draining was required to access decedents in both households.

Discussion

Fourteen people died due to inland flooding caused by Ida's extreme rainfall in NYC. Most decedents were individuals of color, primarily

foreign-born and Asian New Yorkers. The most common circumstance of death was drowning in unregulated basement apartments.

Flooding occurred rapidly in basement apartments during the night—when decedents were home—with little time to evacuate. Records indicate how quickly flooding overtook people and, in several cases, decedents were actively trying to evacuate and could not escape. In at least 1 case, the decedent was sleeping. In both cases with injury time available, deaths occurred before the state of emergency declaration, which also lacked basement-specific safety messaging. Many decedents spoke limited English.¹⁰ The circumstances of these Ida-related deaths illustrate the importance of issuing early weather and basement-specific warnings in multiple languages, as well as installing basement flood alarms to mitigate risk for residents who are sleeping or have not yet noticed signs of flooding (if any).

Apartments more than 50% subgrade are at higher flood risk and are, by definition, unregulated in NYC.^{11,12} They often lack adequate egress (exits).¹¹ Estimates suggest that at least 100,000 New Yorkers live in unregulated basements, although getting an accurate census of this population is difficult.¹³ NYC lacks enough affordable housing and has extremely expensive housing costs—half of the city's renter households face rent burden, spending more than 30% of income on rent.¹⁴ Many New Yorkers do not have access to safe and affordable housing options other than unregulated basement apartments, which are disproportionately located in rent-burdened communities of color where 1-to-4 family homes comprise most of the building stock.¹⁵ Severe flooding is a fatality risk in other cities experiencing affordable housing crises where residents live in basements—in Seoul, South Korea, 4 people drowned in basement apartments following extreme rainfall in 2022.¹⁶

Details on the deaths from Ida reinforce the importance of ensuring safe conditions in basements. Implementing recommendations from Federal Emergency Management Agency's NYC study on building damage from Ida, such as modifications to improve egress from basements or keep surface flooding out, can provide safer basement conditions.¹⁷ The recommendations also address reinforcing basement walls in older buildings—the 2 deaths associated with a collapsed foundation occurred in a building built before the 1938 NYC Building Code¹⁸ required reinforced walls.

As climate change increases extreme precipitation events, NYC will experience more frequent inland flooding.¹⁹ Climate adaptation actions such as increasing sewer capacity, installing green and blue infrastructure, and informing residents about flood risk can mitigate risk. Green (eg, rain gardens, permeable pavements) and blue (eg, bluebelts) infrastructure are stormwater management strategies that use or mimic natural systems to collect stormwater from impervious surfaces (eg, streets, sidewalks), reduce stormwater stress on NYC's sewer system, and, as a result, reduce inland flooding.^{20,21} Informing New Yorkers about flood risk can also help residents understand and prepare for this risk.

This review has several limitations. It may not include all deaths related to Ida because the review was limited to unintentional external-cause deaths from September 1-2, 2021. Event details leading up to the death were not always available in the records so themes and other circumstances may be undercounted (eg, number of decedents sleeping) or not recorded in the records (eg, health conditions that impact the ability to safely leave or avoid hazardous conditions). It was outside the scope of this review to assess non-external (natural) cause deaths from delays or disruptions of medical care or estimate statistical increases in morbidity or mortality at the population level (ie, excess morbidity or mortality).

NYC DOHMH will apply the results of this review to future surveillance by creating a standardized mortality surveillance

protocol for significant extreme rainfall events to improve data collection and review processes. To inform injury prevention, storm abstraction forms will have additional standardized fields for relevant housing conditions, such as residing in a basement; whether the decedent was sleeping; or conditions that may affect decedent's ability to safely leave or avoid hazardous conditions, including mobility impairing or other health conditions associated with storm-related mortality.²² Future mortality reviews could expand in scope with a longer time period post-event and a broader case definition by including intentional injury.

Conclusions

Ida's extreme rainfall in NYC inequitably impacted foreign-born and Asian residents who lived in mostly unregulated basement apartments. These deaths reflect interacting housing and climate crises, and their disproportionate impact on disadvantaged populations.²³ Given NYC's affordable housing crisis, people will continue to live in unregulated basements. Investments in safe and affordable housing are needed to reduce the number of people exposed to basement flash flooding. Climate adaptation actions, such as improving stormwater management infrastructure, informing residents about flood risk, and implementing Federal Emergency Management Agency recommendations to make basements safer can reduce inland flooding exposure. Emergency notification measures that reach basement residents, including those with limited English, can mitigate risk. As climate change increases extreme precipitation events, multi-layered efforts are needed to keep residents safe.

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