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Public Housing on the Periphery: Vulnerable Residents and Depleted Resilience Reserves post-Hurricane Sandy

Diana Hernández · David Chang · Carole Hutchinson · Evanah Hill · Amenda Almonte · Rachel Burns · Peggy Shepard · Ingrid Gonzalez · Nora Reissig · David Evans

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Abstract Hurricane Sandy was the greatest natural disaster to ever impact public housing residents in New York City. It affected approximately 80,000 residents in 400 buildings in 33 developments throughout the city. The storm left residents without power, heat, or running water, yet many chose not to evacuate. This qualitative study was conducted to understand the impact of Sandy among this socially, physically, and geographically vulnerable population. It is the first known study to examine the impact of disasters in high-rise, high-density public housing as a unique risk environment. Findings demonstrate (1) broad impacts to homes, health and access to resources, (2) complex evacuation decision-making, (3) varied sources of support in the response and recovery phases, and (4) lessons learned in preparedness. Results are contextualized within an original conceptual framework—"resilience reserve"—that explains the phenomenon of delayed recovery stemming from enactments of resilience to manage chronic hardship leaving vulnerable populations without the requisite capacity to take protective action when facing acute adversity. We discuss recommendations to establish and replenish the resilience reserve that include personal, institutional, and structural facets.

Keywords Resilience · Public housing · Health · Disaster preparedness · Natural disasters · Poverty · Vulnerable populations

D. Hernández (✉) · C. Hutchinson · E. Hill · A. Almonte · R. Burns · D. Evans
Sociomedical Sciences Department, Columbia University, New York, NY, USA
e-mail: dh2494@cumc.columbia.edu

D. Chang · P. Shepard
WE ACT for Environmental Justice, New York, NY, USA

I. Gonzalez
Office of Emergency Preparedness and Response, Department of Health and Mental Hygiene, New York, NY, USA

N. Reissig
Formerly at Family Services Department, New York City Housing Authority, New York, NY, USA

Introduction

Increasing global urbanization, climate change impacts, and social inequality form the basis of a new public health reality [1, 2]. In 2012, these three issues converged when Hurricane Sandy struck New York City (NYC), home to the largest number of public housing residents in the nation. This unprecedented event marked a critical shift in how natural disasters interface with dense coastal cities, large residential buildings, and vulnerable inhabitants. Public housing residents are uniquely at-risk in the face of disasters given that they are dependent on government resources for the provision of housing and other social safety net benefits. During Sandy, cumulative physical and social adversities afflicted this population. The risks for public housing residents nationwide remain an ongoing threat as extreme weather events occur more frequently and less predictably thereby exposing the fault lines of inequality [3–5].

The New York City Housing Authority (NYCHA) is the largest public housing provider in the nation with

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nearly 400,000 residents in 2,462 buildings in 326 developments throughout the city's five boroughs [6]. Almost half (47%) of all NYCHA residents meet the US social vulnerability index, which assesses socioeconomic variables that reduce residents' ability to prepare for, respond to, and recover from emergencies [7]. Though one in two families work, all residents are at or near the federal poverty level with an average household income of $24,336. Many (40%) receive government support such as social security, disability, or veteran's benefits, and 13% receive public assistance. Approximately 38% of households are headed by an elderly resident (age 62+), while 27% of residents are under age 18 [6]. The majority of older NYCHA residents report fair or poor health (61%), many have a history of diagnosed depression (19%), and most (80%) have been diagnosed with two or more chronic diseases (i.e., diabetes, hypertension, high cholesterol, arthritis, or osteoporosis) [7].

Superstorm Sandy was "the most costly and destructive disaster" to ever impact NYCHA developments and residents [8]. The storm directly affected 80,000 residents from over 400 buildings [8]. As many NYCHA developments are within one mile of the city's coastline, several properties experienced flooding, water damage, and outages of essential services including power, running water, hot water, and heat (see Fig. 1) [9]. In NYCHA sites affected by storm surge, flood damage to equipment delayed access to building systems long after electricity and natural gas services were restored. [10]. During Sandy, the storm surge not only encumbered apartments on the lower floors but also affected critical systems in the buildings (i.e., boilers and elevators), thereby affecting large numbers of residents. Further, with nearly 700 inoperable elevators, many elderly and disabled residents were trapped on higher floors for days and weeks [11]. Many residents did not evacuate [12] or returned soon after the storm to homes that were not fully livable due to the outages [13]. Delays and shortfalls in relief funds have presented an ongoing challenge in fully executing repairs and critical upgrades in NYCHA properties years after the storm [8].

The present study is novel in that it focuses on high-rise, high-density public housing as an underexplored risk environment during natural disasters. Specifically, this paper highlights a triple challenge—densely populated high-rise buildings located in shoreline communities and inhabited by socioeconomically and medically vulnerable residents. Our study participants are set apart from other populations that experienced Sandy by their residence in government-owned housing. For NYCHA residents, living in "housing of last resort" marks a bureaucratically bound existence on the social and geographic periphery of the city. Considered problematic, many public housing complexes were built along the city's waterfront, in locations deemed undesirable at the time of construction. Thus, the geographic position of several NYCHA complexes in coastal communities renders this population more susceptible to shoreline threats [14]. Furthermore, the altitude and population density in high-rise public housing dwellings intensifies disaster impact, response, and recovery. Meanwhile deep poverty, poor health, and racial/ethnic minority status relegate residents to the margins of society and at symbolic distance from the city's core resources and privileges [15]. This marginalized position represents cumulative risks that necessitate adaptive resources independent of disaster contexts; however, during climate-related catastrophes such as Sandy, the combined social, physical, and geographic vulnerabilities have a compounding effect with long-lasting consequences.

Our study is guided by previous research on resilience and how vulnerable populations cope with disasters [16–20]. In the disaster literature, resilience has been theorized and measured at varying levels of analysis, from individuals to systems, though the community level has garnered much of the attention. Both pre-disaster resistance and post-disaster adaptation serve to protect against health risks and resume normalcy following an adverse event [21]. Prior research has found that community-level resources, such as economic development and social capital, which includes perceived social support and collective efficacy, promote resilience before and after a disaster [22, 23]. Some have argued that reducing inequities, creating organizational linkages, and having trusted sources of information in the face of disaster can help build community resilience [21, 24].

In extension of this literature, we offer a lens into a more proximal environment—residential buildings—that, albeit overlooked, also present challenges and opportunities for resistance and resilience. In fact, to the best of our knowledge, this is the first study to examine high-rise, high-density housing as a standalone meso-level environment in the context of disaster with a focus on public housing in a major metropolitan area. In our diversion from existing research, we demonstrate a coalescence of population density, high-rise housing structures, social vulnerability, and governmental ownership and oversight of residential buildings that is novel and important to understand in New York City and other urban contexts.

Building on the evidence for the salience of resilience and disaster recovery among vulnerable groups, this study examines perceptions and enactments of resilience among NYCHA residents in the aftermath of Sandy to understand how they responded to and recovered from this disaster while negotiating pre-existing hardship. In this paper, we present an original framework—*resilience reserve*—to characterize how marginalized groups traverse the post-disaster context with already depleted capacities. A resilience reserve is here defined as, "an inventory of potential capacity to confront unanticipated challenges." The constant need to draw down on the resilience reserve makes it difficult to muster the additional will and capacity to adequately manage the impact of a disaster like Sandy. Further, a depleted resilience reserve renders vulnerable populations more susceptible to lingering impacts and delays in fully recovering from crises. The origin of this concept emerged from the study findings below, which demonstrate that NYCHA residents were living on the edge—in many senses—before Sandy struck. For many, the adaptive resources they so skillfully honed to manage material deprivation and other vulnerabilities were insufficient to effectively and efficiently respond to this acute form of adversity.

Methods

Research Team

This study represents a community/academic partnership between the Columbia University Center for Environmental Health in Northern Manhattan (CEHNM), WE ACT for Environmental Justice (WE ACT), the New York City (NYC) Housing Authority (NYCHA), and the NYC Department of Health and Mental Hygiene (DOHMH). NYCHA and DOHMH served as project advisors and provided input regarding how to frame questions about residents' responses to the storm. NYCHA also facilitated contact with regional administrators in the housing developments, who then linked the research team with residents. CEHNM and WE ACT designed the study, jointly developed the focus group guide and analyzed the data. Columbia researchers (DH and DE) trained an environmental health coordinator from WE ACT (DC) to facilitate the focus groups. The Columbia University and DOHMH Institutional Review Boards and the NYCHA Legal Department approved this study.

Research Sites

The research team identified heavily impacted public housing developments in three Sandy-affected communities—Coney Island, Brooklyn; Red Hook, Brooklyn; and Far Rockaway, Queens (see Fig. 1). Figure 1 illustrates geographic details as well as key demographic information for developments at each location.

Participant Recruitment

NYCHA staff organized meetings with tenant association leaders at each development to devise a specific outreach and recruitment plan. In some developments, the tenant association leader identified their neighbors and residents employed part-time by NYCHA, known as Resident Watch or Floor Captains, to participate in focus groups. In other developments, the focus group facilitator (DC) directly recruited participants at monthly tenant association meetings and other tenant gatherings. Consequently, the study sample included residents with different degrees of involvement in tenant associations.

Sample

Most participants were women ($n = 65$; 87%) that ranged in age from 18 to 80, with roughly 73% aged 55 and over. The focus group facilitator noted that 81% of the participants were Black/African American, 12% of the participants were Hispanic/Latino, and 7% of the participants were White/Caucasian. Participants reported living on both lower and upper floors in their respective buildings.

Data Collection

Data for this project was collected between March and August of 2015. The research team conducted a total of eight focus group sessions with 74 residents across the three target areas: Far Rockaway (29 participants), Coney Island (21 participants), and Red Hook (24 participants) (see Fig. 1). Focus groups were composed of 4 to 15 participants. Most were held in the evening, while one was conducted in early afternoon. Focus groups averaged 90 min, with 30 min allocated for

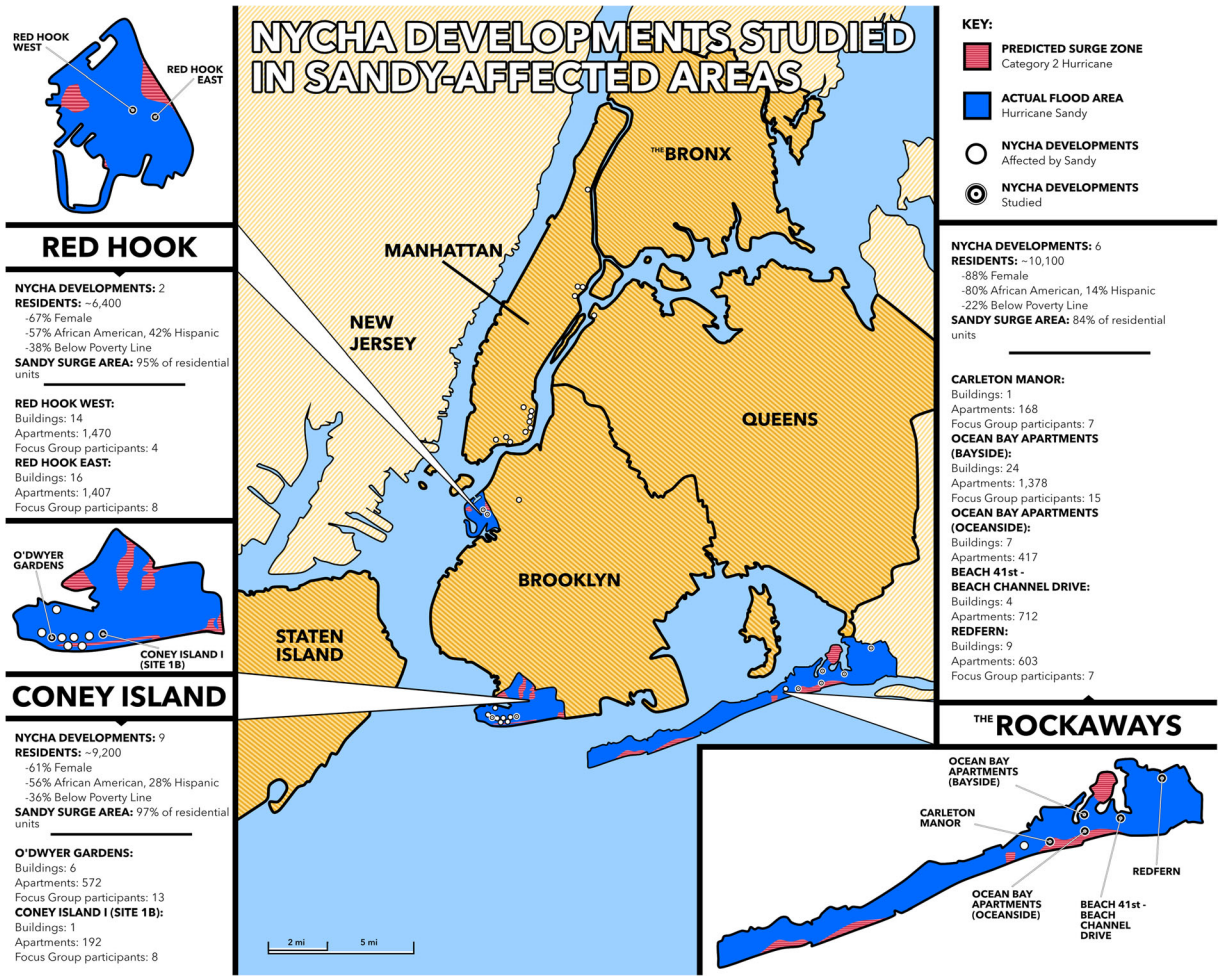


Fig. 1 Heavily Impacted NYCHA Developments in Sandy-affected areas and the three study sites (Coney Island, Brooklyn; Red Hook, Brooklyn; and Far Rockaway, Queens)

refreshments. Topics included: (1) experiences and impacts of the storm, (2) response and recovery efforts such as communication and interaction with first responders, (3) evacuation decisions, (4) the social organization of buildings, (5) resident engagement before and after the storm, and (6) Sandy's implications on preparedness for future storm events. Each participant provided written consent and received a $25 cash incentive. Focus groups were digitally recorded and professionally transcribed.

Data Analysis

Transcripts were analyzed using ATLAS.ti Scientific Software Development (version 1.0.43 for Mac). The process entailed an inductive analytical approach, which helped to uncover complex processes within the unstructured textual data through comprehensive coding. Under the direction of senior researchers (DH, DE, and CH), the focus group facilitator (DC) and two undergraduate research assistants (EH and AA) systematically applied codes from a standardized codebook to all transcripts. Key segments of the transcripts were first categorized by broad thematic codes and later analyzed in more depth to identify subcategories within each theme. Each transcript was coded by at least two coders to ensure consistency and to resolve any discrepancies. The main themes— (1) impact of the storm, (2) evacuation decisions, (3) response and recovery, and (4) lessons learned on preparedness—were drawn from the interview guide; vulnerability, resilience, and the lingering emotional toll were emergent themes.

Results

Hurricane Sandy affected the physical and social environments of public housing residents in significant ways. Residents attempted to navigate challenging circumstances by relying on collective resources and outside help, and this traumatic experience provided insights for disaster preparedness in the future.

Impact

Hurricane Sandy had wide-ranging impact on NYCHA residents spanning their health, homes, and access to resources (see Table 1). Many NYCHA residents experienced power outages, flooded streets, and damaged building infrastructure. Sandy struck in late October when the average daily temperature was between 40 and 50 degrees Fahrenheit [25]. Subsequent to the heavy winds and rainfall, a snowstorm ensued within a few days of the hurricane [26]. Despite cold temperatures, residents lived without electricity or natural gas for heat, hot water, or cooking. They also lacked access to power, went without lighting, refrigeration, elevator service, and were unable to charge cell phones or power medical devices and household appliances. This acute form of energy insecurity ranged from a few hours to several weeks after the storm [27, 28]. Water damage remained a persistent problem as it led to long-term property damage, including mold growth and pest infestation. Despite such adverse living conditions, residents also feared being displaced if their

Table 1 Impact: physical, social, health, and emotional consequences of Sandy

Physical, Social and Health Impacts	Exemplary quotes
Housing issues Lack of basic resources; safety concerns; physical damage; housing hardship and energy insecurity	"*My biggest challenge was living on the sixth floor. No electricity. No heat. Walking up and down the stairs. We had to use extra clothes. Sleep in coats. Sleep with socks on.*"
	"*We were afraid...there was no security. Anybody can walk the halls. Doors were being tampered with.*"
	"*You couldn't walk outside [your building] …You don't know if someone was gonna rob you or not. They were taking gas from the car, [from] the tanks of others.*"
	"*Yeah, 'cause we're still suffering. We still have mold in our apartment.*"
	"*We were so afraid to expose our apartments [to inspectors] because the Department of Health was coming and…looking at the apartments and seeing severe mold and mildew, and they were not allowing the residents to go back in.*"
Resource barriers Challenges accessing basic needs (transportation, health care, food, and other essentials)	"*A lot of us didn't have proper transportation, it was shut down. You had to really juggle in terms of even if you had to go to some place and you had a car, you had to look where you could get gas.*"
	"*Coney Island [Hospital] just shut down, we had to take him to a doctor that was nowhere close to here.*"
	"*The [nearby] pharmacy had closed because they got flooded. If you're running low on your medication you can't get a refill unless it's the due date. And then you'd better know who to contact in order to get a refill.*"
	"*If anybody had a couple of dollars, the price gouging took that. If you did have a food stamp, that went when you could get into the store.*"
Health impacts and emotional toll	"*I had no electricity and no way of getting my nebulizer to work.*"
	"*I still have flashbacks when the lights go out. I've never been so cold in my life.*"
	"*Nobody was on my floor but me and it was devastating...I for one felt helpless, and I wanted to help, but I was helpless. I think NYCHA could have did a better job.*"
	"*I'm nowhere near over Sandy.*"
	"*Our elderly folk haven't recovered from this… some [still have] panic attacks…*"

apartment was condemned by city inspectors and felt threatened by permanent eviction.

Access to transportation and the ability to purchase goods and services was severely hindered during and after Sandy. Residents described significant challenges in getting in and out of their communities because local public transportation was limited or shutdown. Others were unable to use their personal vehicles because of water damage or gasoline shortages. The storm presented impediments to accessing a range of goods and services including medical attention. Hospitals and pharmacies were impacted by the storm, thereby restricting residents' ability to link to care and treatment services [29]. Fortunately, Sandy occurred in late October, so residents who were dependent on government aid could access cash within days of the storm as most safety net income supports are dispensed at the beginning of the month. Still, some participants could not make purchases due to power outages in stores, while others reported price gouging.

Health and safety were also of significant concern. Residents who refused to evacuate felt unsafe in their homes and surrounding neighborhood due to damaged property and fewer residents and staff in the vicinity. Participants described symptoms characteristic of post-traumatic stress, such as having "flashbacks" and feeling "alone and afraid," demonstrating the long-term mental health impacts of the storm [30]. Specifically, residents reported symptoms of anxiety, panic attacks, and general distress from the experience and its aftermath nearly three years after the storm when they were interviewed for this study.

Evacuation Decisions

Decisions to evacuate were based on a mix of personal and external factors, such as previous storm experience, family/caretaking responsibilities, medical needs, and seeking comfort and safety (see Table 2) [31]. Hurricane Irene, the year prior, was less severe than predicted; therefore, many participants underestimated Sandy's impact. This led participants to underprepare and deem warnings to evacuate "false alarms." Respondents with children, elderly, or medically compromised family members elected to stay in their homes for convenience and perceived security. Some participants feared threats to personal safety and property theft due to power outages and preferred to stay close to their belongings. Indeed, many never considered evacuation a viable option despite hardships.

Additionally, the safety and conditions of temporary evacuation sites were also a critical deciding factor. While some residents felt that they would better access medical services and power for heat and electricity, others considered the emergency shelter sites unsafe, uncomfortable, or unsuitable for themselves and their

Table 2 Evacuation decisions: key considerations for tenants

Evacuation Decisions	Exemplary quotes
Reasons to stay	"*I'm not gonna go to a strange place, sit around a bunch of strange people. I just couldn't do it. I don't know if these people have mental health issues. I have to sit around smelling people, [wondering] who bathes, who don't. People bringing their dogs. And the same thing. With the cots and at my age I'm like, nah, I'll stay home.*"
	"*Seniors right, they were asking if we were going to evacuate. My father, he just didn't wanna go anywhere… [seniors are set] in their ways and they want to feel comfortable.*"
	"*I chose to stay because I had my house full of girls [and] you can't trust no one.*"
	"*I stayed, and that was the worst thing I ever did was stay with my son. I mean walking up and down the stairs and he had asthma and I didn't think it was gonna be that bad.*"
	"*It wasn't that bad for Irene. [That experience] gave me a false sense of security, and I said, 'Well, this one is gonna be just like the first one,' so I stayed home because of Irene. Irene, they said everybody go, and it wasn't nothing but a rainstorm. I didn't expect when I woke up the next morning [after Sandy] and I looked out the window—I was devastated.*"
Reasons to leave	"*I couldn't stay here. I get asthma and – that cold was too much on my body.*"
	"*Well, I went because my mother was so concerned about me. So, I just went to my mother's house.*"
	"*When they say evacuate and you know your child has asthma or something, go to the shelter because the shelter has doctors and medicine and they'll go get it for you.*"

family members. Only a few participants who had family members living in unaffected areas that insisted that they evacuate were inclined to do so prior to the storm. Most participants opted to stay in their homes.

Response and Recovery after Sandy

A common theme that emerged from the data was "help" (see Table 3). Although help was provided, there were significant issues with aid, donations, and government support in the immediate, interim, and long-term response to Sandy-related conditions. Participants were grateful to volunteers and first responders for their kindness and generosity. However, they also noted that services did not properly accommodate this population's pre-existing social, medical, and economic circumstances. For instance, respondents reported receiving food items that were inedible because they did not

Table 3 Internal, external, and mutual support in the response and recovery phases

Sources of Help During Response and Recovery	Exemplary quotes
Internal help Received from NYCHA during and after the storm	*Commendations* "*Housing was very good. NYCHA staff evacuated all of my sickly and elderly people who were afraid to go.*" "*NYCHA staff brought pillows, cots, and they stayed. They would bring us medicine and make sure we had something to eat.*" *Disappointments* "*Our building was not listed to be monitored… it was [shown] to have been evacuated.*" "*…these two buildings [were being supervised by] one person and that's too much. They're not hiring people.*" "*NYCHA came to my house about three or four months after. They seen all the mold and stuff like that…said they're gonna send somebody to get the mold, and they're gonna have someone paint. They never came back.*" "*We negotiated because [NYCHA] didn't want to give nothing. They wanted to evict some people, you know?*"
External help Received from outside organizations	*Volunteers* "*That the volunteers sent food, clothing supplies, and medicine. It did bring the best outta people.*" "*People was sending us food but you know it was rotten…they were using us to get rid of the junk they didn't need.*" *Non-Profits* "*…the Catholic church...they were making breakfast for everybody with all the food they had there.*" "*…they had clothes. A lot of people got clothes. At least they had clothes to give people, 'cause you couldn't wash at the time.*" *Government* "*Family service [The Office of Children and Family Services] reached out to a lot of doctors, pharmacies, they came and filled a lotta people prescriptions that was low on insulin and pressure medicine.*" "*FEMA blessed me with $2400.00.*"
Peer support Given or received between residents	"*Yes, everybody had to take everything out of their freezer, so we had the biggest barbecue ever outside. We cooked for some of the people in the building especially the ones that didn't have nobody, so we shared the food.*" "*I knew where everything was coming from because [NYCHA] made me the point person. There was things that I knew that nobody else knew. I couldn't break down, 'cause if I broke down it would have broke down communication.*" "*Those young men and women [my neighbors] went up these stairs and carried water.*"

comply with dietary requirements, such as low sodium for hypertensive residents. Additionally, some donated food items were rotten or expired and goods such as furniture and clothing were damaged, worn down, or otherwise unusable. These experiences were perceived as insults to dignity and added to residents' disaster-related frustration and trauma.

Attitudes about the government response to Sandy, including NYCHA, were mixed, though relief efforts were generally described as inadequate. Some residents felt "abandoned" and were disheartened by what they perceived as empty promises and unfair treatment. Many residents reported lapses in communication during and after the disaster, and lacked information on evacuation plans or status updates on electricity, heat, and water restoration. Financial aid helped some residents cope with the disaster by providing the means to repair or replace damaged property. However, participants expressed concerns with the unfair distribution of relief funds. Residents who lived on the lower floors, and were more directly impacted by flooding, felt strongly that they were not reimbursed for the full value of their damaged property compared to people living on higher floors, causing tension between neighbors and significant rifts within buildings. In addition to the dissatisfaction with government aid, residents were also affected by long delays in addressing conditions in their unit and the building. The worsened conditions and power outages further distressed residents exacerbating dire housing circumstances in already subpar buildings.

Despite the hardship and disappointment with external sources of help, residents supported each other during and after the storm. They described pooling resources including contributing perishable items to community barbeques, checked up on others, and were responsive to elderly and disabled neighbors. Resident leaders helped to screen donations, distribute goods, provide building security, and advocate for fellow neighbors. These actions demonstrated how some residents shouldered additional responsibilities to help fellow residents get through this ordeal.

Lessons Learned on Preparedness and Resilience

When asked about preparedness for future emergencies, participants described increased knowledge of applicable techniques. Many participants had since stockpiled supplies, including food, water, batteries, and flashlights. Unlike Irene, Sandy motivated them to adhere to future evacuation instructions. Many participants expressed regret for not evacuating and the impact of the experience led them to develop family evacuation plans. Indeed, Sandy offered a devastating lesson on the critical need for preparedness (Table 4).

Table 4 Tenant preparedness: readying for future extreme weather events

Lessons Learned and Recommendations	Exemplary quotes
Lessons learned in evacuation, long-term trauma, and preparedness	"*This time I would go. I wouldn't stay like I did before.*"
	"*If you have health issues or your children [do], [you should] go, because one thing is for sure. If they can't get in to help you, you can't get out.*"
	"*I already know when [another storm] comes and I panic, I ain't gonna know what to do.*"
	"*I'm so packed right now, God forbid they say a storm, I'm ready. Loaded down, locked, everything.*"
	"*So I think every one of us now [is ready to leave] I have a kit in my house, a big bin, like about this big.*"
Need for preparedness training and resources	"*[We need something that's] not a superficial training. A real training... We're visual, human beings. It would pay for them to show really realistic pictures or videos of disasters.*"
	"*There is a program we're trying to get out here called Amateur Radio through the Explorers. We'll teach the children how to build that radio from the bottom up and they'll teach the older ones…so if this ever happened again…it will always be a form of communication when everything goes down.*"
	"*We need tenant emergency support teams. I'm talking about 30 or 40 year olds that can sustain this physically. A group to say, listen, we want you to come in. We're gonna teach you how to do this, and when the call comes in we expect you to help, serve and keep our people safe.*"

Residents shared ideas on how to improve communication among themselves and with NYCHA by starting a radio station to broadcast information during emergencies. Others suggested implementing emergency preparedness training sessions that involve the community and provide meaningful, relatable information. Additionally, elderly participants hoped to ensure that those trained to respond would be physically capable of giving aid and that a younger generation of NYCHA residents would act as liaisons, leaders, and crisis responders.

Discussion

Our findings indicate that Hurricane Sandy's impact was an acute adversity for public housing residents and that their experience was shaped by cumulative social, physical, geographic, economic, and medical vulnerabilities. Although many participants demonstrated resilience, the storm exacerbated existing hardships, a factor that limited how residents could respond and delayed full recovery [32, 33]. First-hand accounts detailed residents' challenges with housing conditions, acute energy insecurity [28] and personal safety directly after the storm and encumbered access to healthcare and transportation. Residents' (un)willingness or inability to evacuate was mainly tied to health and caretaking responsibilities. It also stemmed from a somewhat founded distrust in what authorities were promising.

The types and sources of help received were varied and much appreciated; however, residents expressed concerns about the quality and equitable distribution of relief resources. Importantly, residents relied on each other and shared ideas about improving communications as well as preparing a younger generation of residents to respond to future emergencies. The long-standing emotional trauma was an emergent and palpable finding with several participants noting that they were not yet "over Sandy" and referencing symptoms of post-traumatic stress nearly three years after the storm. All said, Hurricane Sandy's impact on NYCHA residents added a new dimension of suffering for an already heavily burdened population. Below, we argue that the prolonged recovery of this population relates to resilience as conceptualized by two distinct bodies of literature related to disasters and chronic stress.

Misclassification of Resilience Among the Vulnerable

Previous research has shown that the socially vulnerable are more likely to be adversely affected in disaster events [34, 35] and are at increased risk of post-traumatic stress [36, 37]. The mental health effects caused by disasters are linked to the intensity of exposure and duration of the event [38]. The issue of personal resilience is regularly referenced as a means of resisting the psychological effects of a disaster as well as resuming a normal post-disaster life [22, 23]. However, as Morrow indicates, the roots of disaster vulnerability are in the social and economic circumstances of everyday living [39]. Therefore, an important consideration that is often omitted when discussing resilience among vulnerable populations in the disaster context is that they regularly exhibit resilience in confronting the challenges of everyday life. Following Hurricane Katrina, for example, the breakdown of social networks and senses of community at the individual and structural levels left poor families feeling insecure, distrustful, and unstable [40]. However, poor families, before Katrina, had already reported social isolation, financial insecurity, and health problems in the absence of comprehensive services [41]. Given that lower resource populations already cope with daily chronic stress [42], the added chaos of confronting a natural disaster can have significant impacts that have not been sufficiently accounted for in discussions around resilience following disasters.

The chronic stress literature conceptualizes resilience as a resource. Gallo and Matthews, for instance, suggest that individuals' *reserve capacity* exists to confront demands on coping abilities and note that an individual's reserve capacity can be low or high in correspondence with socioeconomic status (SES) [43, 44]. The authors posit that lack of access to material and social resources as well as a disadvantaged position in the social hierarchy translate into lower resource levels for low-SES populations [43]. The reserve capacity framework considers some of the impediments to "acquiring" resilience that exist for low-income populations, but it does not necessarily consider the "enactment" of resilience to confront daily stressors. The *resilience resources* framework has conceptualized resilience as a set of resources available at the individual, social, and community levels, which allow an individual to positively respond and adapt to stressors [45]. Individuals' resilience resources, help them to cope and manage despite daily stress and other demands [45].

This concept emphasizes an individual's capacity to cope with and endure chronic stress, instead of a personal ability to adapt to changing circumstances and acute adversity [45]. Furthermore, both frameworks—reserve capacity and resilience resources—regard low SES populations as not possessing sufficient resilience. However, this premise is flawed and consistent with an oft criticized deficits model. [46] Instead, we posit that resilience for low SES populations is not about low resource or capacity levels, but a process of continual depletion. Hence, it could be argued that vulnerable populations are *too* resilient rather than not resilient enough. As noted by Béné et al., "The chronic poor are (by definition) very resilient…clearly what the chronic poor need is not more resilience, but less poverty and marginalization."[47].

Importantly, poverty and disater are complex processes; resilience in such contexts is thus more than a resource, it is itself a process. Resilience is performed one way when implemented to address chronic stressors, though such enactments of resilience may not effectively translate or individuals may be too overwhelmed to react with enhanced potency during acute events.

The need to exercise resilience to handle daily hardship is taxing on individuals and collectively when vulnerability is concentrated among social groups. It has been recognized that resilience is generated at multiple levels; however, it can be equally exhausted by multiple sources, for instance, when it is deployed to juggle expenses on limited budgets, contend with chronic health conditions, and encounter everyday discrimination as is the reality for members of vulnerable populations [48]. According to the *conservation of resources* model, it is necessary to retain, protect, and build resources to protect against the negative consequences of actual or potential losses [49]. As loss begets loss, marginalized members of society often encounter steady and varied threats and corresponding losses (i.e. spiraling effect). This burdened position has implications for longitudinal trajectories following exposure to trauma or severe stress whereby symptoms may be minimal, increase then stabilize or result in heightened dysfunction [50]. What remains unclear in the literature is the trajectory of populations that, from the outset, are characterized by chronic hardship, significant adversity and corresponding stress responses relative to more privileged groups. These differences in starting positions may thus lead to more severe end points for the disadvantaged in the disaster context as a matter of the resilience process, not merely by resilience as a resource.

Resilience Reserve: a Conceptual Shift

As evidenced above, there is a need to connect an otherwise disjointed literature on resilience that conceptualizes chronic stressors, on the one hand, and acute stressors such as natural disasters, on the other. It is also imperative to conceptualize resilience not as a static resource but as a dynamic process of depletion and replenishment. Here, we present an original framework—*resilience reserve*—to describe how marginalized groups encounter the post-disaster context with depleted capacities stemming from the overutilization of resilience resources to cope with persistent deprivation. This concept emerged from resident accounts of enduring life on the social and economic margins long before Sandy struck. For many, the adaptive approaches they mastered to manage multiple vulnerabilities were insufficient when meeting an additional and acute form of adversity.

The *resilience reserve* is best defined as, "an inventory of potential capacity to confront unanticipated challenges." The constant need to withdraw from the resilience reserve makes it difficult to muster the added grit necessary to adequately absorb the shock of disaster. A depleted resilience reserve renders vulnerable populations more susceptible to lingering impacts and delays in fully recovering from crises. An analogy to the resilience reserve would be monetary reserves meant to buffer urgent financial matters. If a household is unable to regularly make ends meet and consistently uses "emergency funds" to pay monthly bills, the reserve is drawn down, if not completely unavailable, should a financial emergency arise. Therefore, it becomes challenging to withstand acute financial hardship and most likely prolongs its impact.

A shift toward social and economic security would alleviate the need to withdraw from limited resources by providing a greater ability to weather everyday hardships and the acute impact of disasters. In this way, the resilience reserve of vulnerable populations can be built up and regularly replenished allowing individuals to tap into it for emergencies, as intended. To create such pathways to personal resilience, households must be connected to a wide array of resources to ensure that individuals and households are regularly functioning at a

higher capacity. This can be achieved by increasing access to community-based health and mental health services, improving housing and educational quality, and creating pathways to long-term self-sufficiency [35].

Public Housing and Institutional Resilience

The future of public housing is now a matter of resilience at an institutional scale. Public housing nationwide faces mounting difficulty accessing federal resources to implement capital improvements to address deferred maintenance and corresponding pressure to privatize. Still, public housing remains a highly coveted and important resource as an income-based housing subsidy dating back to the era of a comprehensive safety net. Without question, residents and institutional resources are implicated in the sustainable future of public housing in New York City and around the nation.

Public housing residents played a critical role during Sandy and exhibited capacity to better determine the future of their housing environments. As such, residents should be further empowered, better prepared and more informed decision-makers during crisis; while also relying on a younger generation of leaders that can respond physically as well as coordinate efforts to benefit fellow residents. They should be actively engaged in the rebuilding process to provide not only employment opportunities but also to boost morale among neighbors. Enhanced social cohesion that promotes self-governance and inter-dependence rather than complete reliance on NYCHA is critical to meeting internal needs and holding the agency more accountable to residents. The fault lines in coordination among city agencies were exposed during this unprecedented storm and the City has since responded with comprehensive protocols to address emergency response and recovery. Residents should be thoroughly trained and made aware of these procedural guidelines. Practice drills with building-specific protocols should also be conducted periodically with particular attention to the needs of seniors, children and the medically vulnerable.

While the emphasis of this paper has largely centered on the resident experience, the delayed recovery has also affected NYCHA as an organization. In fact, many Sandy-affected properties have been powered by "temporary" boilers for several heating seasons since the storm. Not only are these boilers expensive to operate, they are also fairly unreliable as they were never intended for long-term use. Therefore, as an institution, NYCHA has also demonstrated a protracted recovery due to limited resources and competing priorities that parallel the resident experience of chronic stressors compounded by the acute effects of Sandy.

In order to remain a sustainable housing type, public housing agencies must increase institutional resilience by: (1) enhancing human resources, (2) implementing technological innovation, (3) investing in upgrades to facilities in flood-prone areas that incorporate weather-proof designs, and (4) embracing sustainable practices that reduce carbon emissions, operating costs, and promote residents' health. Furthermore, public housing must be better integrated into the social fabric of the communities they belong to, thereby extracting residents from a peripheral and stigmatized existence and providing options for everyday connections to the urban core and its many resources. Doing so stands to increase personal, institutional, and structural resource capacity for public housing residents and housing authorities, while simultaneously addressing the challenges of urbanization, climate change, and social inequality.

Study Strengths and Limitations

This study has considerable strengths. First, it represents a collaboration between a community partner (WE ACT), two city agencies (NYCHA and DOHMH), and an academic institution (Columbia University). The collaboration both built capacity for research among the non-academic partners and allowed for rigorous analysis and conceptual framing of how a unique disaster affected a population that has not been sufficiently studied. Second, our research captures the storm's longer-term impact, rather than the immediate aftermath of the storm. Focus groups were conducted nearly three years after Sandy, yet participants still reported being traumatized by the experience, representing the striking ability for trauma to endure.

A notable limitation of this study is that the majority of participants (73%) were older adults and seniors, a demographic not fully representative of the NYCHA resident population [6]. Additionally, our convenience sample was comprised primarily of residents who were engaged in their building's tenant association, per NYCHA recommendations. Only two of eight focus groups consisted of residents who did not know each other prior to attending. The other participants were

resident watch group members, floor captains, or affiliated with tenant association leaders through church or family ties. This may have biased our results to reflect the perspective of "engaged" residents. Finally, we interviewed residents at selected Sandy-affected properties and did not collect data from NYCHA or DOHMH staff involved in storm response, which would have added valuable, alternative perspectives.

Conclusion

This study explores how public housing residents in shoreline communities in NYC prepared for, experienced, and coped during Sandy and in its aftermath. Hurricane Sandy caused costly property damage and left many NYC public housing developments and residents without water, energy, and means of transportation for days and weeks after the storm [51]. Sandy's impact was especially acute for socially, physically, geographically, economically, and medically vulnerable groups, as reflected by this study's participants. The impact of the storm posed significant threats to resident health and safety, and indicated a need for improved disaster preparedness. The discussion presented the conceptual framework of the "resilience reserve" and offered ways to address the need for improved personal, institutional, and structural resource capacity to mitigate constant resilience depletion and enhance its renewal, particularly among public housing residents.

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References

1. Vlahov D, Galea S. Urbanization, urbanicity, and health. *J Urban Health*. 2002;79:1):S1–S12.
2. McMichael AJ. The urban environment and health in a world of increasing globalization: issues for developing countries. *Bull World Health Organ*. 2000;78:1117–26.
3. Gornitz V, Couch S, Hartig EK. Impacts of sea level rise in the New York City metropolitan area. *Glob Planet Chang*. 2001;32(1):61–88.
4. Trenberth KE, Fasullo JT, Shepherd TG. Attribution of climate extreme events. *Nat Clim Chang*. 2015;5(8):725–30.
5. Klinenberg E. *Heat wave: a social autopsy of disaster in Chicago*. University of Chicago Press; 2015.
6. New York City Housing Authority. NYCHA 2017 Fact Sheet 2017; https://www1.nyc.gov/assets/nycha/downloads/pdf/factsheet.pdf. Accessed August 4, 2017.
7. Parton HB, Greene R, Flatley AM, Viswanathan N, Wilensky L, Berman J, et al. Health of Older Adults in New York City Public Housing: part 1, findings from the New York City Housing Authority senior survey. *Care Management Journals*. 2012;13(3):134.
8. New York City Housing Authority (NYCHA). Recovery to Resiliency: NYCHA's Superstorm Sandy Recovery Program Fact Sheet. 2017; https://www1.nyc.gov/assets/nycha/downloads/pdf/nycha-sandy-factsheet.pdf. Accessed August 15, 2017.
9. New York City Housing Authority (NYCHA). *Recovery to Resiliency Report*. New York: NYCHA; 2015. http://www1.nyc.gov/html/onenyc/index.html. Accessed July 26, 2018.
10. Lane K, Charles-Guzman K, Wheeler K, Abid Z, Graber N, Matte T. Health effects of coastal storms and flooding in urban areas: a review and vulnerability assessment. *J Environ Public Health*. 2013;2013:1–13.
11. New York City Housing Authority (NYCHA) Performance Tracking and Analytics Department. Development Data Book 2013. 2013; http://www1.nyc.gov/assets/nycha/downloads/pdf/pdb2013.pdf. Accessed September 20, 2017.
12. Brown S, Parton H, Driver C, Norman C. Evacuation during Hurricane Sandy: data from a rapid community assessment. *PLoS Curr* 2016;8.
13. Manuel J. The long road to recovery: environmental health impacts of Hurricane Sandy. *Environ Health Perspect*. 2013;121(5):a152–9.
14. United States Environmental Protection Agency (EPA). What climate change means for New York. 2016; https://19january2017snapshot.epa.gov/sites/production/files/2016-09/documents/climate-change-ny.pdf. Accessed August 3, 2017.
15. Cutter SL, Emrich CT. Moral hazard, social catastrophe: the changing face of vulnerability along the hurricane coasts. *Ann Am Acad Pol Soc Sci*. 2006;604(1):102–12.
16. Cong Z, Nejat A, Liang D. The effect of emotional closeness and exchanges of support among family members on residents' positive and negative psychological responses after Hurricane Sandy. *PLoS Curr* 2016;8.
17. Apsan HN. Resiliency and continuity: Hurricane Sandy and The City University of New York. *Environ Qual Manag*. 2013;23(2):61–76.
18. Shipp Hilts A, Mack S, Li Y, Eidson M, Nguyen T, Birkhead GS. New York State Public Health System response to Hurricane Sandy: an analysis of survey feedback. *Disaster Med Public Health Prep*. 2016;10(3):454–62.

19. Neria Y, Nandi A, Galea S. Post-traumatic stress disorder following disasters: a systematic review. *Psychol Med*. 2008;38(4):467–80.
20. Reilly MJ, Degutis LC, Morse SS. Investigating the public health impact of Hurricane Sandy. *Disaster Med Public Health Prep*. 2016;10(3):301–3.
21. Norris FH, Stevens SP, Pfefferbaum B, Wyche KF, Pfefferbaum RL. Community resilience as a metaphor, theory, set of capacities, and strategy for disaster readiness. *Am J Community Psychol*. 2008;41(1–2):127–50.
22. Galea S, Brewin CR, Gruber M, Jones RT, King DW, King LA, et al. Exposure to hurricane-related stressors and mental illness after Hurricane Katrina. *Arch Gen Psychiatry*. 2007;64(12):1427–34.
23. Lowe SR, Sampson L, Gruebner O, Galea S. Psychological resilience after Hurricane Sandy: the influence of individual- and community-level factors on mental health after a large-scale natural disaster. *PLoS One*. 2015;10(5):e0125761.
24. Cutter SL, Barnes L, Berry M, Burton C, Evans E, Tate E, et al. A place-based model for understanding community resilience to natural disasters. *Glob Environ Chang*. 2008;18(4):598–606.
25. The City of New York Mayor Michael R. Bloomberg. *A Stronger, More Resilient New York*. 2013. https://www.nycedc.com/resource/stronger-more-resilient-new-york. Accessed July 26, 2018.
26. Zaineb M. Nor'easter 'Athena' bombards areas hardest hit by Sandy. Mother Jones November 7, 2012. http://www.motherjones.com/politics/2012/11/noreaster-slams-nyc-nj/. Accessed September 4, 2017.
27. Hernández D. Energy insecurity: a framework for understanding energy, the built environment, and health among vulnerable populations in the context of climate change. *Am J Public Health*. 2013;103(4): e32–e34.
28. Hernández D. Understanding 'energy insecurity' and why it matters to health. *Soc Sci Med*. 2016;167(Supplement C):1–10.
29. King MA, Dorfman MV, Einav S, Niven AS, Kissoon N, Grissom CK. Evacuation of intensive care units during disaster: learning from the Hurricane Sandy experience. *Disaster Med Public Health Prep*. 2016;10(1):20–7.
30. Subaiya S, Moussavi C, Velasquez A, Stillman J. A rapid needs assessment of the Rockaway Peninsula in New York City after Hurricane Sandy and the relationship of socioeconomic status to recovery. *Am J Public Health*. 2014;104(4): 632–8.
31. Elder K, Xirasagar S, Miller N, Bowen SA, Glover S, Piper C. African Americans' decisions not to evacuate New Orleans before Hurricane Katrina: a qualitative study. *Am J Public Health*. 2007;97(Supplement_1):S124–9.
32. Carbone EG, Wright MM. Hurricane Sandy recovery science: a model for disaster research. *Disaster Med Public Health Prep*. 2016;10(3):304–5.
33. Petkova EP, Beedasy J, Oh EJ, et al. Long-term recovery from Hurricane Sandy: evidence from a survey in New York City. *Disaster Med Public Health Prep* 2017:1–4.
34. Flanagan B, Gregory E, Hallisey E, Heitgerd J, Lewis B. A social vulnerability index for disaster management. *J Homel Secur Emerg Vol* 82011.
35. Tierney K, Gutmann A. Social Inequality, Hazards, and Disasters. On Risk and Disaster: University of Pennsylvania Press; 2006:109–128.
36. Lowe SR, Sampson L, Gruebner O, Galea S. Community unemployment and disaster-related stressors shape risk for posttraumatic stress in the longer-term aftermath of hurricane Sandy. *J Trauma Stress*. 2016;29(5):440–7.
37. Sharp MJ, Sun M, Ledneva T, Lauper U, Pantea C, Lin S. Effect of Hurricane Sandy on health care services utilization under Medicaid. *Disaster Med Public Health Prep*. 2016;10(3):472–84.
38. Neria Y, Shultz JM. Mental health effects of Hurricane Sandy: characteristics, potential aftermath, and response. *JAMA*. 2012;308(24):2571–2.
39. Morrow BH. Identifying and mapping community vulnerability. *Disasters*. 1999;23(1):1–18.
39. Hawkins RL, Maurer K. 'You fix my community, you have fixed my life': the disruption and rebuilding of ontological security in New Orleans. *Disasters*. 2011;35(1):143–59.
41. Hawkins R. Same as it ever was, only worse: negative life events and poverty among New Orleans Katrina survivors. *Fam Soc : J Contemp Soc Serv*. 2009;90(4):375–81.
42. Baum A, Garofalo J, Yali A. Socioeconomic status and chronic stress: does stress account for SES effects on health? *Ann N Y Acad Sci*. 1999;896(1):131–44.
42. Gallo LC, Matthews KA. Understanding the association between socioeconomic status and physical health: do negative emotions play a role? *Psychol Bull*. 2003;129(1):10–51.
44. Gallo LC, KEdl M, Shivpuri S. Socioeconomic status and health. *Curr Dir Psychol Sci*. 2009;18(5):269–74.
45. Schetter CD, Dolbier C. Resilience in the context of chronic stress and health in adults. *Soc Personal Psychol Compass*. 2011;5(9):634–52.
46. Wadsworth ME, Santiago CD. Risk and resiliency processes in ethnically diverse families in poverty. *J Fam Psychol*. 2008;22(3):399–410.
47. Béné C, Newsham A, Davies M, Ulrichs M, Godfrey-Wood R. Resilience, poverty and development. *J Int Dev*. 2014;26(5):598–623.
48. Williams DR, Yu Y, Jackson JS, Anderson NB. Racial differences in physical and mental health: socio-economic status, stress and discrimination. *J Health Psychol*. 1997;2(3):335–51.
49. Hobfoll SE. Conservation of resources: a new attempt at conceptualizing stress. *Am Psychol*. 1989;44(3):513–24.
50. Norris FH, Tracy M, Galea S. Looking for resilience: understanding the longitudinal trajectories of responses to stress. *Soc Sci Med*. 2009;68(12):2190–8.
51. Federal Emergency Management Agency (FEMA). *Mitigation Assessment Team Report- Hurricane Sandy in New Jersey and New York: Building Performance Observations, Recommendations, and Technical Guidance*.. FEMA P-942 / November 2013. https://www.fema.gov/media-library-data/1386850803857-025eb299df32c6782fdcbb6f69b35b13/Combined_Sandy_MAT_Report_508post.pdf. Accessed July 26, 2018.