



Factors associated with resilience in the context of multiple consecutive disasters: A qualitative study of survivors of World Trade Center, Hurricane Sandy, and COVID-19 disasters

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ARTICLE INFO

Keywords:

9/11
Multiple disasters
Consecutive disasters
Multisystem resilience
Modified grounded theory
Coping mechanisms
Acknowledgment, reframe and tailoring (ART) model
Disaster recovery

ABSTRACT

Research on recovery after consecutive major disasters with traumatic effects remains limited. Understanding factors that promote resilience can enhance preparedness, response, and recovery for those facing multiple disasters. This study utilized a modified grounded theory approach, framed by Bonanno's, and the Acknowledgment, Reframe, and Tailoring model, to examine resilience trajectories/pathways among a cohort exposed to the September 11, 2001-attacks, 2012 Hurricane Sandy, and 2020 COVID-19 pandemic. Twenty-four purposively selected participants with 2+ disaster exposures completed in-depth semi-structured interviews. Individuals with posttraumatic stress disorder (PTSD) were compared to similarly exposed individuals without PTSD to identify factors that promote resilience. Analysis revealed three resilience trajectories: sustained resilience, conditional recovery, and chronic vulnerability with deep-seated resilience. While individual coping strategies (problem-focused, faith-based, or avoidant/maladaptive) were important, the "rebound" process was supported by consistent multi-level supports, including family and social support, community engagement, and institutional/socioecological resources. Participants with sustained resilience utilized proactive coping with institutional support, whereas those with chronic vulnerability faced institutional service failures, relying on personal grit and community support to bounce back. These findings support an ecological model of resilience, indicating that disaster preparedness, response, and recovery must extend beyond individual-level interventions to include strengthened social, community, and institutional supports.

1. Introduction

Large-scale disaster events have significant public health impacts on morbidity, mortality, and costs [1–3], and can include both natural (e.g., hurricanes, wildfires, pandemics) and human-made (e.g., terrorist attacks) events. Disasters are generally characterized by their sudden or prolonged disruption of community functioning and the need for external assistance [4]. They encompass a wide range of events, including the COVID-19 pandemic, which is recognized as a public health disaster due to its scale, complexity, and societal impact [5,6]. Historically, disasters have been viewed as rare and sporadic events. However, since the beginning of the 21st century, there has been an increase in climatological disasters, such as wildfires, cyclones, outbreaks, and epidemics related to novel and re-emerging pathogens [7,8].

For example, in the United States (U.S.), between 2020 and 2024, there have been 115 (23 per year on average) billion-dollar weather-related disasters, resulting in numerous deaths [9]; this represents a sharp increase from the 2010–2019 period, which averaged 13 such events per year [10]. The COVID-19 pandemic alone resulted in 1.2 million U.S. deaths and over 110 million infections [11].

Due to the rising incidence and severity of disaster events in the U.S. and worldwide, individuals are increasingly likely to experience multiple disasters over their lifetimes, often within a very short timeframe. This has heightened interest in research focused not only on the impact of multiple disaster events, such as cascading, compound, recurrent, and consecutive disasters [2], but also research focused on reducing exposure to further mitigate consequences in their aftermath. Consecutive disasters, known as discrete, temporally separated events impacting the

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<https://doi.org/10.1016/j.pdisas.2026.100545>

Received 13 November 2025; Received in revised form 23 February 2026; Accepted 3 March 2026

Available online 4 March 2026

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same population, can adversely influence communal and individual capacity to “bounce back” as the recovery process from the previous event may not yet be fully completed [2,12].

For instance, the September 11, 2001 (9/11), terrorist attacks in New York City (NYC) resulted in approximately 3000 deaths and had lasting physical and mental health impacts on directly affected survivors over their lifetime, as well as the general public [13–15]. Just slightly more than two weeks later, NYC experienced the 2001 anthrax attacks on news media headquarters [16]. Year after year, NYC has experienced a wide range of major emergencies and disasters, with many occurring between the 2001 terrorist attacks and the COVID-19 pandemic, such as the lengthy 2003 and 2006 power outages, heatwaves, winter storms, wildfire smoke incursion, and hurricanes, including the devastating cyclone, Hurricane Sandy, which occurred on October 29, 2012 [17,18]. Many individuals who had experienced the 9/11 attacks were directly impacted by Hurricane Sandy, which led to widespread power outages and extensive damage to homes, leading to temporary or permanent evacuation. Then, in early 2020, the COVID-19 pandemic resulted in illness, death of family members and friends, isolation, and employment disruptions. The focus of this research on disaster resilience is on survivors who were exposed to the three most consequential disasters in NYC over the past two decades: 9/11, Hurricane Sandy, and the COVID-19 pandemic.

Several studies of disaster survivors have shown that stressors related to disasters and subsequent stressful life events (SLEs) (e.g., death of a spouse) are linked to an increase in mental health problems [19,20], including long-term dysregulation of stress management [21]. Major disaster events with high death tolls are more prone to result in psychopathology, as survivors typically experience trauma [22]. However, there have been fewer studies specifically examining the psychological effects of two or more community-wide disasters on the same population. Previous research on the impacts of 9/11 has examined how post-disaster SLEs affected the mental health of 9/11 responders and community residents, specifically focusing on conditions such as post-traumatic stress disorder (PTSD), depressive symptoms, and overall health status [23,24]. Additionally, subsequent disasters, such as Hurricane Sandy, can trigger previously dormant PTSD symptoms by recollection of trauma associated with 9/11 [24–26]. SLEs that include threat or disruption to social relationships, including loss of life, have been associated with increased anxiety, lower levels of life satisfaction, and higher rates of mental illness [27].

Conversely, multiple disaster exposures can foster resilience, a dynamic process for enhancing the capacity to navigate to and negotiate for resources that sustain and adapt well-being in the face of adversity, and which may also promote collective community efforts leading to improved disaster planning and better outcomes at both the individual and community levels [28,29]. Several theoretical models, including the Acknowledgement, Reframe, and Tailoring (ART) framework by Farchi & Peled-Avram, explain resilience as a non-linear, phase-based process of adaptive coping strategies, such as acknowledging adversity, reframing the adversity by problem solving and emotional regulation, and finally tailoring resources to recover from and adjust to successive disasters [16,29–31]. According to Bonanno and colleagues' proposal, resilience is a phase-based process wherein the individual's heterogeneity of prior lived experience and exposure are taken into consideration in defining and measuring resilient outcomes after adverse circumstance [32–34]. An individual is able to achieve and maintain one's equilibrium essential to healthy mental and physical functioning in the aftermath of trauma (i.e., psychological resilience) while meaningfully drawing in multilevel resources across familial, communal, and institutional ecosystems to support this aim [29,35].

The current study documents the lived experiences of 9/11 survivors who have lived through multiple consecutive disasters (Hurricane Sandy and the COVID-19 pandemic) at varying levels of exposure and intensity. The main questions we sought to address were how 9/11 survivors defined their exposure to each potentially traumatic event, and

how they themselves defined the impact of cumulative exposure to all three consecutive disasters on their health, socioeconomic outcomes, coping strategies, and resilience processes over time. Utilizing in-depth qualitative interviews, we captured three consecutive disaster experiences, recovery trajectories, and meaning-making processes that are not easily assessed using survey data alone. We explored how multi-level factors (individual, social, and institutional) facilitated or hindered the ‘rebound’ phase of resilience among survivors of these disasters of resilience among survivors of these disasters. Understanding why certain individuals exposed to repeated major disasters were able to rebound could have significant implications for public health policy and practice [36]. By delineating different recovery pathways, this research aimed to identify targeted points for intervention to bolster adaptive capacities and risk-mitigation strategies for populations facing accelerating rates of consecutive disaster exposure.

2. Methods

2.1. Study design

A descriptive qualitative study using thematic analysis was conducted to document and identify resilience patterns in multiple-exposed disaster survivors enrolled in the World Trade Center Health Registry (WTCHR, “Registry”). Data was collected through in-depth interviews using semi-structured guidelines (Appendix A).

Ethical approval for the study protocol and all the study materials was granted by the New York City Department of Health and Mental Hygiene's Institutional Review Boards (IRB Reference No. 22–046). All participants provided verbal informed consent prior to the interviews. Participants were informed that participation was voluntary and that they may withdraw at any stage of the interview with no adverse consequences. The study was documented in accordance with the Consolidated Criteria for Reporting Qualitative Studies (COREQ) checklist [37].

2.2. Participants

Participants were recruited through the WTCHR, a closed longitudinal study cohort of 71,423 individuals exposed to the 9/11 disaster. Enrollees include individuals who evacuated the WTC Complex on September 11, 2001, as well as rescue and recovery workers during or subsequent to the event, residents, passersby, area workers, students, and staff from schools south of Canal Street. Enrollment began with a baseline interview (Wave 1) from 2003 to 2004, followed by four subsequent survey waves (Wave 2 (2006–2007), Wave 3 (2011–2012), Wave 4 (2015–2016), Wave 5 (2020–2021) [14]. More detailed information on the WTCHR recruitment process is available elsewhere [13,38]. At the time of this study, two disaster-specific in-depth surveys had been conducted, including the Hurricane Sandy survey (2012–2013) for residents in flood zones during Sandy and the COVID-19 survey (2020–2021) during the pandemic's initial phase [24,25].

A total of twenty-four participants were included in this study (Table 1). Maximum variation sampling [39] was used to recruit participants who met the following criteria: 1) completed Wave 1 survey and either of two most recent survey waves (Wave 4 or 5), 2) completed one or both disaster-specific surveys, 3) were not deceased or withdrawn from the Registry cohort, and 4) were 18 years or older at the time of study enrollment. Potential participants were also screened for disaster exposure experiences, including varying intensity of 9/11 exposure, residence in a flood zone during Hurricane Sandy, and COVID-19 infection. Severity of adverse outcomes, such as PTSD (measured on WTCHR surveys using the PTSD Checklist) [40], was also considered to provide a range of mental health outcomes.

Purposive recruitment [39] resulted in three groups as follows: *Group 1*: Experienced all three disasters and never developed PTSD ($n = 6$ (P1–P6)); *Group 2*: Experienced 9/11 and any one of the other two disasters under study and had a history of PTSD ($n = 4$ (P7–P10)); and *Group 3*:

Table 1

Comparison of sociodemographic characteristics among the qualitative study participants and the Registry survey Wave 5 participants.

Characteristics	Study participants (N = 24)		Wave 5 survey (N = 28,356)	
	n	Percentage (%)	n	Percentage (%)
Mean age (standard deviation)				
At 9/11	39.6 (8.3)		41.2 (12.0)	
During hurricane sandy in-depth interview	51.3 (8.4) *		54.9 (10.7) *	
During COVID-19 survey	59.3 (8.4)		61.8 (11.3) *	
Sex				
Male	12	50.0	17,326	61.1
Female	12	50.0	11,030	38.9
Race/Ethnicity				
Non-Hispanic White	18	75.0	20,616	72.7
Hispanic	4	16.7	2962	10.4
All others ¹	2	8.3	4778	16.9
Education at Wave 5*				
Up to High-school graduate	5	22.7	4098	14.7
Some college degree and beyond	17	77.3	23,827	85.3
Income at Wave 5*				
Less than \$75,000	7	35.0	8413	31.4
\$75,000 - < \$150,000	10	50.0	9892	37.0
\$150,000 or more	3	15.0	8448	31.6
Rescue and Recovery worker				
Yes	10	41.7	13,125	46.3
No	14	58.3	15,231	53.7

Note: WTCHHR = World Trade Center Health Registry; *Due to missing values, category totals may not sum to total population; [†] The mean age at the Hurricane Sandy interview was calculated for 21 of 24 enrollees. In wave 5, the mean age was for 3380 of 28,356 enrollees. For the first COVID-19 survey, the mean age included 20,641 enrollees.

1 "All others" includes non-Hispanic all others (Black, Asian, American Indian, Alaskan Native, Multiracial, unknown).

Experienced all three disasters and had a history of PTSD ($n = 14$ (P11-P24)). This three-group structure was essential for us to allow for comparative exploration of adaptation. By stratifying participants based on both cumulative exposure and heterogeneity based on history of PTSD, we aimed to identify differential patterns of resilience and vulnerability, aligning with established research on trauma moderation in disaster mental health [24,34].

2.3. Data collection

Data were collected from May 2023 to September 2023. Recruitment letters were sent to selected enrollees. The recruitment letter briefly described the study's purpose, the methods to be used, the risks and benefits of participation, and the amount of the participation incentive. WTCHHR staff directly contacted a subset of enrollees who received recruitment letters to provide a brief introduction to the study, including the types of questions they might be asked and the expected length of the interview, and to obtain informed consent from interested participants. Interviews were then scheduled [41,42]. Eighty-eight enrollees received recruitment letters for the interviews; we reached out to 42 WTCHHR enrollees; of these, 10 individuals refused to participate, and the rest did not participate for personal reasons or scheduling constraints, leaving a final count of 24 participating enrollees.

The interview consisted of 6 general topics (Appendix A), including participants' experience with 9/11, Hurricane Sandy, and COVID-19. Open-ended questions also addressed coping strategies. More details about the key contents of the semi-structured interview questionnaires'

table are provided in Appendix A. On average, each interview lasted approximately 1 h. Prior to the actual interviews, pilot interviews were conducted to ensure that all necessary elements were included to capture the intended information. The senior author of this paper, RRG, conducted all of the interviews. All interviews were conducted over Zoom in either audio or video mode, at the enrollee's preference. Each interview was digitally recorded and transcribed. Each participant who took part in the interview received a \$50 gift card in appreciation for their participation.

2.4. Data analysis

A coding protocol, including an initial set of fundamental topics, was developed. We used a modified grounded theory (mGT) approach, a systematic qualitative method in which theories are developed inductively from the data, while also incorporating our prior understanding of resilience and disaster impacts based on previous research highlighting the long-term physical and psychological consequences of disaster exposure among WTC survivors [25,43,44]. This modification involved the use of an initial theoretical framework (based on the ART and Bonanno's models) to orient the analysis toward specific constructs (i.e., adaptive phase, outcome heterogeneity), rather than approaching the data with no preconceived concepts [29,33,34]. All the transcripts were analyzed to explore using initial, intermediate/axial, and advanced coding [42,44].

In the initial coding phase, two analysts (ASD and RRG) performed open or unrestricted coding of the transcripts to identify key themes and any unanticipated topics emerging from the interviews. For the first six of 24 transcripts, ASD and RRG independently coded the same transcript to compare disaster incident exposure intensity and resilience factors. The inter-rater reliability (IRR) was calculated using Cohen's Kappa, where coded segments for each of the transcripts from each of the analysts were defined as the unit of analysis [45]. The score of IRR was 88%, indicating strong agreement. A detailed excerpt of the IRR protocol and calculation is provided in Appendix B to ensure methodological transparency. Then, for the remaining 18 transcripts from Groups 2 and 3, the two analysts/coders each completed coding the remaining transcripts.

During the intermediate coding phase, analysts used axial coding to find linkages between open codes and to develop conceptual categories of resilience mechanisms. Constant comparison procedures were utilized throughout this phase, systematically comparing data segments within and across transcripts, and between the three analytical groups to refine categories and identify emergent patterns. Participant narratives were analyzed across three defined exposure and PTSD groups to explore patterns of coping, recovery, and resilience.

Finally, selective advanced coding was utilized to systematically analyze participants' quotes, focusing on resilience and the strategies for coping among participants. Data integration from all completed interviews continued until key storylines emerged, and the analyses were then incorporated into appropriate theoretical codes. Theoretical integration was organized around the three groups. This group-based comparative approach led to the identification of factors that supported or hindered adaptation to cumulative disasters. Discrepancies in coding were discussed and resolved by the tiebreaker analyst (JM). The process was repeated until all three analysts accepted the final coding.

3. Results

Of the 24 participants, there were equal numbers of men and women. Similar to participants from the Registry's most recent Wave 5 survey [14], more than three-fourths were non-Hispanic white (75% vs. 73%), and had some college education or higher (77% vs. 85%). Rescue and recovery workers comprised 42% of the sample. The average age during the 9/11 disaster was 40 years (SD = 8.3).

3.1. Contextualizing disaster exposure

Participants from all three groups described varying degrees of physical and emotional exposure across the three disaster events, which formed the context for the subsequent coping and resilience process. No clear pattern of intensity across groups could be discerned with respect to measures of PTSD, however, these narratives illuminate how proximity, duration, and types of exposures influenced our enrollees' overall adaptation process.

For example, one participant vividly recalled witnessing the plane strike the Twin Towers: *"I was by myself at the point a plane crashed into the building. I actually saw it go into the building... hanging out [of] the building"* (P10; Group 2; 9/11). Another individual recounted for acute physical danger: *"My feet were hot from burning, you know, being on burning metal. It was... it was still going. I got swallowed up by concrete that was pulverized and wet..."* (P17; Group 3; 9/11). Others described extensive damage to their property and eventual displacement per hurricane Sandy disaster: *"We lost the first floor with all of everything, all... all of our belongings. The second floor has the bedroom. But the next thing that happened was the rats, [and] the mold started creeping up. It was just the whole thing was a mess."* (P2; Group 1; Hurricane Sandy). Some individuals reflected on fear and health-related uncertainty during COVID-19: *"I didn't want to go to the hospital because everybody that was going to the hospital [at] that time... [and] nobody was returning home"* (P5; Group 1, Covid-19).

3.2. Group 1 (experienced all three disasters and no history of post-9/11 PTSD)

Despite significant WTC-related health conditions and major income disruptions from each of the three disasters, as a group, they consistently employed problem-focused and anticipatory coping strategies. These included early evacuation, seeking out and navigating medical systems to access health care, ensuring provisions for emergency use, and re-establishing daily living or work routines.

As stated by one participant: *"The foresight [for Hurricane Sandy] was this: I bought the pumps in the event... should I ever need to pump water out of the basement"* (P5). Increased disaster preparations since the WTC disaster were also reported by other participants, for example, *"... I do buy extra water for the basement. I do have a little extra food in case, you know, I'm always thinking like, if something happens"* (P6). These proactive behaviors reflected a strong personal belief in their ability to manage challenging situations, take meaningful action to protect themselves and their loved ones, and recover from the event.

Majority of the participants in Group 1 expressed finding strength by "thinking positively." For instance, one emphasized, *"I like to lean on the positive; life is too short"* (P2). Crediting their strong foundation of family and social support as a basis for their resilience, they noted, *"I've always had a very supportive family, loving family... I've my friends. I've never had any negative experiences with relationships in my life... been pretty happy and fortunate"* (P6). Other Group 1 participants reported similar optimistic outlooks, as one stated:

"Isn't this amazing? A life that we live. It's just... It's beautiful, and I want to live a long time, and I want to be, you know, as prosperous as possible with family and love and money, and financially, and you know, we always do the best we can. And again, it's just, it's been a really amazing life experience, even though all the bad things" (P5).

Four out of six Group 1 participants reported being helped and helping others. As one reported during their flight from one of the collapsing WTC buildings, *"Everybody was trying to get out of there, but the weight behind me knocked me down, and the next thing I thought... I'm going to be trampled on... and somebody grabbed my back collar and pulled me up. And it's like, oh, my God! I was so grateful. I don't even know who that was, but I think they saved me"* (P2).

Participants also mentioned that there was a sense of camaraderie with neighbors and tangible community support, as reported by one

participant who shared telephone chargers brought out by local restaurants in the aftermath of Hurricane Sandy: *"... pretty positive experience. Everybody pulled together halfway through"* (P1). These types of shared experiences elicited confidence... as the same person noted, *"We can take it"* (P1).

Group 1 participants generally navigated societal systems successfully. They accessed assistance from the Federal Emergency Management Agency (FEMA), mental health care, insurance, or workplace accommodations, and perceived New York City's infrastructure as an asset. As noted, *"The city [NYC] is tough, you know, like in a good way... I think the city was helpful"* (P3), reflecting the supportive role of NYC's services in shaping their recovery. Group 1 participants reported satisfaction by helping others through volunteer work, as noted by one individual, *"I joined the [local] fire department; I feel really good about that"* (P4).

Yet two participants of Group 1 also mentioned avoidant behaviors, as noted by one person who expressed reluctance to seek medical help, even though they had worrying symptoms, *"Because I don't want to hear any bad news, that's why, that's exactly why [I don't go to the doctor]"* (P2).

3.3. Group 2 participants (experienced one or two of the three disasters, including 9/11, and had a history of post-9/11 PTSD)

This group more commonly reported avoidant coping, faith-based coping, maladaptive coping, or simply having "good luck." As one participant stated in regard to visiting WTC Memorials: *"I don't ever go by the basin, where they have, you know, the footprints, I don't go there. You know, because it's just I, I can't. It's just too much for me"* (P7). Participants from Group 2 also reported coping by relying on their faith; as one expressed, *"Oh, I always feel God's responsible"* (P10), yet this same individual also later stated that their faith was no longer comforting, *"I don't enjoy things like I used to... I used to like to go to prayers"* (P10). One Group 2 participant also reported feeling that they survived because of "luck"; as the participant shared, *"I don't think I'm resilient. I think I'm lucky. I have got an angel on my wing"* (P8).

Despite frustrations in getting assistance following the disasters, especially after Hurricane Sandy, two out of four participants still carried a strong sense of communal identity and pride, bolstering their resilience: *"I just keep going... because I consider myself a New Yorker"* (P7).

On the contrary, one Group 2 participant reported serious behavioral problems after disaster exposures, as the person stated, *"Oh, God! I was a lunatic, and I would have meltdowns"* (P9). Following mandatory employee counseling after the disaster, the participant noted receiving more extensive treatment: *"I had a one-on-one therapist... and once a week I would go for group therapy. We would have dinner together with a bunch of social workers. And they would bring in dinner, and we would sit around talking. So, it was a place... it was a safe place"* (P9). That person also reported: *"My adrenaline knob is broken on 10... I tried gambling a little bit, but that didn't help"* (P9). Despite these challenges, this person also expressed a desire to give back: *"I want to be able to do it... I just don't know how to go about it"* (P9).

Finally, one Group 2 participants reported varied family dynamics, with some relational strain or caregiving demands. Conversely, other Group 2 participants credited family and long-standing workplace relationships as sources of continuity: *"My husband and my daughter and my mom... the people that I work with, we've all been through this together"* (P7).

3.4. Group 3 (experienced all three disasters and had a history of post-9/11 PTSD)

Group 3 frequently described long-term avoidance or maladaptive coping, including withdrawal from social settings, emotional detachment, substance use, and, in some cases, a past history of suicidal

ideation. Avoidant patterns often deepened over successive disasters. Anger was also expressed, especially with job instability and job loss. Resentment resulting from unrealized expectations in the post-9/11 era was common and sometimes worsened with the additional disaster experiences.

However, there were several reports of proactive coping strategies, such as Group 3 participants taking care of themselves; for instance, *"I went for my daily walk around the block; I did get better eventually"* (P23). With mental health effects from the disaster exposures commonly reported following the WTC disaster, these strategies also included identifying the need for and then accessing psychological care: *"I'm in trouble... a little bit of depression [but] seeing a social worker through the program... helped me a great deal [for] many years"* (P11).

Group 3 participants also reported many other destabilizing difficulties they were experiencing, such as serious illnesses (cancer, gastroesophageal reflux disease (GERD)), separation, divorce, job loss, and financial difficulties. As reported by one Group 3 participant who had eagerly looked forward to a new job, which was now rescinded, *"They shut it down because of Covid. I was very upset, but I realized that it was true, because I took the subway and... there was no one on the subway"* (P20). Others in this group also reported difficulty with employment, as one person said, *"it's been like, easy to get a job, but it's been hard to keep them"* (P17).

Seven out of fourteen participants with extreme exposure to all three disaster events described family upbringing and shared identity as foundational to overcoming hardships and resultant long-term healing from trauma. One Group 3 participant remarked, *"I was raised not to quit and to be a leader"* (P22); identity as a New Yorker was also important, as noted by the same participant:

"I have a great sense of compassion for my fellow New Yorkers. You know, born and bred. So, I feel a great sense of duty and attachment. All those factors go to resilience because there's this notion of, you're going to get through this. It's going to be really hard, but you're going to get through this. There's no giving up, because what's the alternative? What does giving up mean? And it doesn't even come into your mindset" (P22).

A few expressed the centrality of their faith in dealing with losses and giving them the courage to go on with their lives. One participant described their healing process: *"I just pray and ask God to give me the strength to just get up and do the things that I need to do, and that's basically how I deal with it"* (P20). Others exhibited self-preservation and autonomy to overcome obstacles, with one Group 3 participant remarking, *"Really, yeah, no one's going to save us. You got to save yourself..."* (P14). Another participant described their perseverance, *"So I believe, I've been struggling all the time that really, you know, it's just one more thing to do. It's just, you keep going,"* (P18).

While some described community fragmentation or the absence of community support, more than half of the Group 3 participants actively contributed to neighborhood rebuilding, participated in COVID response efforts, and engaged with spiritual communities. One participant in this group described cooking and cleaning for their father and neighbors during Hurricane Sandy. Another participant noted volunteering with mentally challenged individuals and participating in creative expression through poetry: *"I actually wrote a poem about the whole Trade Center thing...a cathartic kind of exercise"* (P15). These actions highlighted prosocial behavior — in fact, some participants found identity and purpose in community contributions. Some Group 3 participants wanted others to learn from their experience to encourage them not to give up, as one person from Group 3 stated, *"I hope that whatever I experience can be utilized to help others. That's also been a driving goal in my life... as the [parent] of a special needs child"* (P16).

Group 3 participants frequently described feelings of "institutional betrayal" — including bureaucratic delays, unfulfilled promises, and repeated trauma through system failure. As one participant reported: *"You know, we were told that the dust wasn't toxic; they said that it was safe to return to this neighborhood... It wasn't"* (P14). For some, there was resentment, as they lamented employment barriers despite participating

in recovery work: *"Looking at your resume, they don't know that I worked at the Trade Center. I don't put that on my resume"* (P17).

The coping themes revealed by the analyses are summarized in Table 2.

3.5. Synthesis of resilience trajectories

The analysis across the three groups revealed distinct resilience trajectories defined by the interplay between cumulative exposure, PTSD history, and the reliance on adaptive coping resources. Group 1 followed a path of sustained resilience, characterized by consistent proactive engagement across all phases of the ART model. Group 2 achieved conditional recovery, marked by fluctuating confidence and inconsistent resource utilization. In contrast, Group 3 demonstrated chronic vulnerability, where systemic barriers and institutional betrayal significantly hindered the Rebound phase, despite the presence of deep-seated perseverance and prosocial coping in some participants. The overarching differential outcomes and their association with the phases of the ART model are presented in the comparative matrix, Table 3.

4. Discussion

This study explored how individuals exposed to multiple large-scale disasters navigated their challenges through individual coping mechanisms, family and social support, community support, and institutional support. Our study contributes to a growing body of literature emphasizing that resilience is not solely an individual phenomenon but an outcome of interactions within broader ecological systems [35,46]. Additionally, as the participants were WTCHHR enrollees, the study sample had a well-established disaster-related health history rooted in 9/11 [13,14,38], allowing for a nuanced examination of how earlier disaster exposure may influence responses to subsequent events. Guided by ART's emphasis on acknowledging disaster promptly, proactive coping, and emotional regulation capability, and Bonanno's model of heterogeneous post-adversity trajectories [29,33,34], we identified three resilience pathways through which participants described "bouncing back": sustained resilience (Group 1), conditional recovery and strain (Group 2), and deep-seated resilience despite chronic vulnerability and institutional betrayal (Group 3).

Group 1 participants, who experienced all three disasters but never developed PTSD, demonstrated consistent access to various resilience supports. These included internal coping resources, cohesive family networks, neighborhood solidarity, and effective engagement with public systems. In contrast, Group 3 participants, who also experienced all three disasters and developed PTSD, often faced disruptions in one or more of these systems. These findings echo models of resilience, which suggest that resilience trajectories are not merely the absence of psychological distress such as PTSD, and can differ among individuals with similar disaster exposure, depending on accessibility, and interaction of multi-level supports from their environment [30,31,46]. Specifically, our results align with the ART framework, showing how consistent resource tailoring facilitates a rapid return to functional equilibrium (sustained resilience), emphasizing the processes of acknowledging the disaster an individual faced, reframing, and tailoring resources to support rebounding from the disaster [29–31]. Group 1 successfully executed all phases of the ART model, resulting in sustained resilience.

Results here highlighted that disaster exposure itself may not necessarily predict psychological outcomes, such as PTSD or recovery. Instead, outcomes may be shaped by the presence, accessibility, and alignment of multisystem resilience mechanisms, including material and social resources. This is referred to as "tailoring" [47], i.e., matching available resources to the specific needs required of the situation. This was true across all three disaster events, with resources ranging from help cleaning out a damaged home (whether from 9/11 dust or Hurricane Sandy) to meals delivered to one's door during illness from COVID-19. Comparing groups with similar disaster exposure but different PTSD

Table 2

Comparison of resilience mechanisms by participants with multiple disaster experiences based on grounded theory approach analysis (N = 24).

Resilience Domain	Group 1 All 3 Disasters, No PTSD (n = 6)	Group 2 Any 2 Disasters, and PTSD (n = 4)	Group 3 All 3 Disasters and PTSD (n = 14)
Individual Coping			
Problem-Focused / Active Coping	- Proactive preparedness and early action - Quick return to routines (e.g., work, caregiving) - Sought therapy or medical care when needed - Engaged in safety planning and community rebuilding	- Help-seeking sometimes delayed - Some used coping tools such as counseling but inconsistently	- Coping often overwhelmed by cumulative events - Employed functional strategies (e.g., rebuilding home s, working) despite severe distress - Some sought therapy or support groups, but others dropped out or couldn't access services
Faith-Based Coping	- Relied on spirituality as secondary source of strength and emotional expression within family or peer settings - Belief in personal growth through adversity	- Expressed deep grief, fear, and trauma narratives and relied heavily on faith for meaning making - Spiritual coping was central to adaptation	- Highly variable: some embraced faith, others questioned it - Emotional exhaustion common - Several participants overwhelmed by caregiving roles and trauma burden
Avoidant Coping	Minimal avoidance; generally confronted stressors	- Moderate avoidance: avoided reminders like museums, crowded places - Some disengaged from therapy or social roles	- Frequent avoidance and withdrawal - Some described hopelessness, self-blame, or suicidal ideation - Substance use, emotional shutdown, or disconnection noted by several individuals
Multi-systemic resilience supports			
Family and Social Support	- Strong, supportive family networks, framed as pillar of resilience - Mutual caregiving and emotional reciprocity	- Mixed: some supportive, others strained or absent - Familial illness/loss sometimes heightened vulnerability	- Often disrupted: spousal illness, death, or intergenerational caregiving burdens - Some relied on family, others felt emotionally or physically isolated
Community Support	- Actively involved in neighborhood aid and volunteerism - Described sense of solidarity during disaster responses - Community ties helped normalize recovery	- Limited involvement - Some situational support (e.g., during Sandy or COVID), but not sustained - Focus often on self and immediate family	- Highly varied: - while some described fractured or absent community support, several participants engaged actively in volunteering, mutual aid, or community leadership - Feelings of community abandonment coexisted with localized, adaptive community involvement - Predominantly negative appraisal: - Some felt betrayed by FEMA, Red Cross, NYC government - Institutional
Institutional Support	Viewed NYC infrastructure and services (e.g., hospitals, public safety) as resilience assets	- Mixed experiences: - Delays in aid, inconsistent trust in systems - Perceived NYC as	

Table 2 (continued)

Resilience Domain	Group 1 All 3 Disasters, No PTSD (n = 6)	Group 2 Any 2 Disasters, and PTSD (n = 4)	Group 3 All 3 Disasters and PTSD (n = 14)
	- Accessed and trusted FEMA, mental health services, or insurance systems - Used employer flexibility and urban resources effectively	overwhelming or risky post-disaster	- failures often retraumatizing - Several expressed desire to leave NYC or felt stuck and unsupported

Note: NYC = New York City; FEMA = Federal Emergency Management Agency.

outcomes revealed that sustained recovery appeared to depend more on interconnected support structures than on the magnitude of the trauma itself.

The findings also suggested that strong social infrastructure, institutional trust, and proactive disaster planning were central to recovery. These findings are supported by previous research, which indicated that resilience trajectories are shaped more by contextual buffering than the magnitude of exposure [33,34,48]. Group 1 participants often cited NYC's services as well as federal level, i.e., FEMA services, as reliable and accessible, while Group 3 participants voiced frustration over unfulfilled promises, poor communication, and administrative failures. This resonates with scholarly works that posit that social capital and institutional trust are critical for preventing the exacerbation of negative outcomes following disasters, as well as for recovery, and that failures in these areas can amplify trauma [49,50].

It has been stated that the "trajectory from disequilibrium caused by disasters to the point of stability is the very definition of resilience" [32]. Our results here suggest that the decision to keep moving forward and regaining equilibrium is aided by social support. Given the increasing threats from climatological and other disaster events, both structural and non-structural mitigation are needed to help prepare for, respond to, and recover from these events. Our results, as well as earlier reports, suggest that multi-systemic supports can result in more adaptive outcomes for the survivors of disasters [29,31]. Timely access to healthcare and mental health services is critical, particularly for individuals with prior trauma exposure. Recovery processes should be streamlined to reduce bureaucratic barriers, while community-based resources, such as neighborhood networks and volunteer programs, should be strengthened to provide social support and cohesion [29]. Furthermore, inclusive risk reduction principles must ensure that vulnerable populations, including persons with disabilities, are proactively integrated into disaster planning and response rather than addressed only after events occur [50].

Despite having post-9/11 PTSD symptoms, several participants in Group 3 displayed high functional engagement and prosocial behavior. They reported continued caregiving, participation in community rebuilding, or volunteering efforts. This reflects an emerging understanding in trauma research that PTSD and resilience are not opposites [51]. Functional capacity and the ability to rebound in specific life domains can persist even when psychological distress remains. While some participants in this study demonstrated an "illusion of control," or even "magical thinking" to compensate for loss of control over the exposure, oftentimes, the reality of the situation became clear when loved ones or social supports stepped forward and provided much-needed help. On the other hand, some individuals exposed to multiple disasters demonstrate strong adaptive skills, shedding light on the complex resilience process. For instance, for some individuals, 9/11 exposure has been shown to have had a positive influence on preparedness for Hurricane Sandy [43]. This suggests that protective behaviors can result following disaster exposure, thereby contributing to improved prevention strategies for future disasters [30,31]. Ultimately, the distinction between sustained

Table 3

Comparative matrix: Differential resilience trajectories across three groups based on Acknowledgement, Reframe, and Tailoring (ART) Framework (N = 24).

	(A) Acknowledgment phase & Adversity assessment	(R) Reframing/Strategizing (Social, Emotional)	(T) Tailor Resources & Rebound	Overall Outcome Trajectory (Bonanno's Trajectory)
Group 1: Proactive rebound	Rapid, realistic assessment, minimal denial	Optimistic outlook	Proactive Preparation Strong community/family cohesion	Sustained Resilience Resilience behaviors were fast to “kick-in”, most had complete recovery
	Seeking social problem-solving support	Sense of control Problem solving focus	Successful institutional navigation	
			Prosocial behavior Strong family ties act as the key in this group,	
Group 2: Conditional recovery and strain	Delayed acknowledgement in some cases	Fragile optimism		Delayed and fluctuating resilience Vulnerability to new stressors
	Periods of avoidance/denial	Reliance on luck/fate Fluctuating confidence and maladaptive coping (i.e., gambling)	Inconsistent help-seeking, including community support	
		Resentment & loss	Some had strong communal identity (pride on being New Yorker)	
Group 3: Chronic stress related to exposure and trauma & Institutional Betrayal Deep-seated, proactive coping	Chronic avoidance & trauma	Driven by duty/identity, but not true optimism	Systemic Hindrance	Chronic vulnerability resilience Systemic barriers to healing High risk of long-term psychopathology.
	Deep, cumulative trauma	Community fragmentation	Significant institutional betrayal/barriers (FEMA, employment)	
	Sense of being let down	Emotional detachment, anger, and maladaptive coping (substance use, withdrawal)		Partial Rebound Self-agency and recovery achieved despite systemic barriers; primarily through internal resources.
	Need for help recognized	Perseverance & Faith	Pro-sociality & Purpose	
	Identified need for psychological care (seeing a social worker)	Driven by identity, upbringing, and faith (“not to quit,” “born and bred”)	Active volunteering, engaging with spiritual communities, seeking purpose through helping others.	

FEMA = Federal Emergency Management Agency.

resilience, conditional recovery, and chronic vulnerability lay in the consistency and alignment of these supports; while Group 1 had a seamless web of support to assist them, Group 2 had inconsistent supports, and this led to fluctuating stability, while Group 3 had to rely on deep-seated personal grit to bridge the gaps left by institutional and social failures.

4.1. Limitations

This study focused on a subgroup of individuals from the 9/11 survivor cohort who experienced multiple consecutive disasters; therefore, findings may not be generalizable to compound, cascading, or recurrent disasters, where multiple events occur in rapid succession or interdependently, rather than with temporal separation [2]. Additionally, other disasters and SLEs (e.g., heatwaves, power outages, or personal life events such as bereavement, illness, or divorce) are highly relevant to resilience trajectories [52,53]; however, due to insufficient information, this study did not address those factors/disasters.

Additionally, while our sampling captured diverse participant experiences, the relatively small sample size of 24 individuals limits generalizability. However, data saturation was achieved, and the richness of qualitative insights provides important contextual understanding. Another potential source of bias is the use of self-reported data. Participants may have provided responses they perceived as socially acceptable. There is also the risk of recall bias, given the time elapsed from the disaster exposures (e.g., 9/11 or Hurricane Sandy). Long-term and recurrent PTSD was not measured in this study, and therefore, PTSD groupings may not be currently accurate. Finally, while the qualitative

approach allowed for meaningful comparisons using the ART framework and Bonanno's trajectory model, the classification of trajectories remains subject to researcher interpretation. Furthermore, while we utilize Bonanno's framework to categorize outcomes, these represent retrospective life-course trajectories reconstructed from participant narratives rather than longitudinal clinical modeling of symptoms over time. Future research among broader WTCHR enrollees could help validate and extend these findings.

5. Conclusion

While the definition of disaster resilience continues to be debated [51], recent scholarship provides an integrated model of how individuals and systems recover from disaster events and return to or maintain functional status [29]. This integration involves both individual resources combined with multi-level resources and supports. These supports or “tailoring” of needs with resources can allow the individual (or community) to “bounce back” to the pre-disaster state. The three distinct trajectories that were identified in our analysis, including sustained resilience, conditional recovery, and chronic vulnerability, demonstrated that recovery is not solely a product of individual traits but potentially a result of the consistency and alignment of external supports. We found that most survivors saw themselves as resilient, but their ability to recover depended on the stability of their relationships, communities, and institutions. Those with strong social networks and dependable public services recovered best. On the other hand, when institutions failed or betrayed them, people with ongoing vulnerability often had to rely on their own determination and faith to recover, but

only partially.

Our findings indicate that even after multiple disaster exposures, recovery is possible. Peri- and post-disaster interventions that support not only affected individuals but also affected communities will likely support recovery. Going forward, strengthening relational, community, and institutional systems will be important for supporting individuals' resilience in the face of the growing threat of disasters.

Primary funding

This publication was supported by Cooperative Agreement Number U50OH009739 from the National Institute for Occupational Safety and Health (NIOSH) of the Centers for Disease Control and Prevention (CDC). Its contents are solely the responsibility of the authors and do not necessarily represent the official views of NIOSH, the CDC, or the Department of Health and Human Services.

CRedit authorship contribution statement

Ananya S. Dhanya: Writing – original draft, Visualization, Validation, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Janna Metzler:** Writing – review & editing, Visualization, Supervision, Resources, Methodology, Investigation, Conceptualization. **Robert M. Brackbill:** Writing – review & editing, Methodology, Conceptualization. **Robyn R. Gershon:** Writing – review & editing, Writing – original draft, Visualization, Resources, Methodology, Investigation, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

We are grateful to the study participants for their important contribution to this study. We also thank Felix Ortega, Lydia Leon, Summer Stephanos, and Renato DaSilva for their assistance with recruitment mailings, interview scheduling, participant outreach, consent procedures, and technical support. We also thank Mark Farfel for his critical review of the manuscript and Julia Sisti for quality checking the analysis and providing methodological feedback. Additionally, prior to April 30, 2009, the Registry was supported by U50/ATU272750 from the Agency for Toxic Substances and Disease Registry (ATSDR), CDC, which included support from the National Center for Environmental Health, CDC; and by the New York City Department of Health and Mental Hygiene (NYC DOHMH).

Appendix. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.pdisas.2026.100545>.

Data availability

The data that has been used is confidential.

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