

## Original Research

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# The Impact of Natural Hazards on Older Adult Health: Lessons Learned From Hurricane Maria in Puerto Rico

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## Abstract

**Objective:** With natural hazards increasing in frequency and severity and global population aging, preparedness efforts must evolve to address older adults' risks in disasters. This study elucidates potential contributors to the elevated older adult mortality risk following Hurricane Maria in Puerto Rico through an examination of community stakeholder preparedness, response, and recovery experiences.

**Methods:** In April 2018, qualitative interviews (n = 22) were conducted with stakeholders in 7 Puerto Rican municipalities. Interview transcripts were deductively and inductively coded and analyzed to identify salient topics and themes representing participant response patterns.

**Results:** The hurricane's detrimental impact on older adult health emerged as a prominent finding. Through 6 months post-hurricane, many older adults experienced unmet needs that contributed to declining physical and emotional health, inadequate non-communicable disease management, social isolation, financial strain, and excess morbidity and mortality. These needs were predominantly consequences of lengthy public service gaps, unsafe living conditions, interrupted health care, and the incongruence between preparedness and event severity.

**Conclusions:** In a landscape of increasing natural hazard frequency and magnitude, a pattern of older adult risk has become increasingly clear. Study findings compel practitioners to engage in natural hazard preparedness planning, research, and policy-making that considers the multiple facets of older adult well-being.

## Introduction

The increasing occurrence and severity of natural hazards are raising the stakes for public health preparedness worldwide.<sup>1,2</sup> Impacts from these hazards create disproportionate risk for racial/ethnic minorities, those with lower socioeconomic status, disabilities and/or chronic medical conditions, and adults over age 65.<sup>3,4</sup> As populations are living longer lives, disaster preparedness landscapes are changing, and there is a pressing need to revisit risks and protections for older adults.<sup>5–7</sup> This is particularly relevant in places like Puerto Rico, which has experienced accelerated population aging in recent years.<sup>8</sup> Between 2010 and 2017, the proportion of Puerto Rico's residents ages 65 and older increased from 14.7% to 19.7%.<sup>9,10</sup> In this context, Hurricane Maria made landfall in September of 2017, signaling an important turning point in conceptualizing potential impacts of natural hazards and the implications for older adults.<sup>11,12</sup> Maria devastated Puerto Rico's infrastructure, triggered widespread flooding and landslides, and disabled electrical, telecommunications, and health care systems.<sup>13–16</sup> In the aftermath, recovery was slow and was characterized by setbacks in restoring basic services, taking a significant toll on older adults.<sup>17,18</sup>

Research demonstrates that older adults typically suffer disproportionately from the secondary effects of disasters and experience higher mortality rates.<sup>19–31</sup> It is useful, however, to examine specific disaster events to identify common and unique contributors to mortality risk. The experiences following Hurricane Maria offer important lessons in this regard. A study at George Washington University (GW) estimated a total excess mortality of 2975 following Hurricane Maria between September 2017 and February 2018, with approximately 85% of excess deaths occurring among adults ages 65 years and older.<sup>32–36</sup> While there have been attempts to clarify mortality contributors, in this case,<sup>37</sup> incomplete death certification data discourage the reliance on vital statistics alone.<sup>33</sup> This paper presents additional GW study findings from a secondary analysis, elucidating factors and circumstances that may have contributed to elevated mortality risk, and which have not been well documented to date. Recommendations that consider these potential mortality contributors are also offered.



Figure 1. Map of sampled municipalities.

## Methods

As part of the GW study,<sup>33</sup> in-depth individual interviews ( $n = 22$ ) with participants from 7 Puerto Rican municipalities were conducted. Puerto Rico has 6 geographic regions and 72 municipalities, or “communities,” each with local governments and disaster management teams. Interviews explored local preparedness, response, and recovery efforts experiences from the perspective of representatives with specialized knowledge given their occupation/role in preparedness, local governance, or community leadership. Participants included municipal mayors, community leaders (ie, local civic organization leadership), first responders, faith leaders, health care providers, and non-profit organization staff. Municipalities were sampled purposively to represent all 6 regions and to exemplify a range of experiences given municipal diversity in socioeconomic status, political affiliation, terrain (mountainous vs coastal), geographic isolation, and health facility proximity. Additional sampling considerations included the ability to contact potential participants and access communities given persistent telecommunication outages and roadway blockages. Figure 1 illustrates approximate locations of sampled municipalities.

Audio-recorded interviews in Spanish lasting approximately 1 hour were conducted in April 2018 (using a semi-structured protocol), which were transcribed in Spanish. Interviews were conducted by 2 bilingual investigators who are highly skilled in qualitative methodologies. All study protocols were approved by the GW Institutional Review Board. Data coding was accomplished using NVivo software (QSR International Pty Ltd. (2018) NVivo Version 12). Spanish transcripts were coded deductively, based on a priori areas of inquiry, including local preparedness, response, and recovery experiences. Simultaneously, transcripts were coded inductively, capturing topics that arose during interviews but were outside a priori inquiry areas. To ensure coding reliability, each interview was coded by 1 investigator and reviewed by a second for discrepancies, with discrepant text segments resolved by agreement. Node reports were produced, consisting of Spanish language transcript excerpts by code. Node reports were analyzed to identify salient topics and themes representing response patterns, and, as such, common and unique experiences were elucidated.<sup>38,39</sup> Illustrative quotes were translated to English for publication.

## Results

The hurricane’s impact on older adults and, in particular, non-communicable disease (NCD) management, emerged as frequently discussed topics across municipalities. Thematic findings are presented below, introduced by theme chronologically from pre- to post-hurricane. Previous analyses from this data set are published elsewhere.<sup>33,34</sup>

### *Extensive preparedness measures were undertaken to protect older adults*

When asked about hurricane preparedness measures, disaster managers and municipal government personnel described advanced planning and cooperative efforts across numerous sectors, including risk assessments, evacuations, and coordination of older adult care:

... by September 19<sup>th</sup>, we already had an established plan of how we were going to confront the atmospheric phenomenon where all directors sat together with the mayor... emergency office, family department, housing department... a workplan was made...

– Municipal Social Worker

Participants also reflected on several local efforts to assess and address risks, including the identification and outreach to high-risk individuals, evacuations, medical transports, and relocations to shelters in the week prior to the hurricane:

Our directors went to different communities, we activated all neighborhood leaders, [and they said] “look, if you know a person’s situation, that their house is not stable or a person living alone, let us know,” so that the mayor’s office sent someone there to remove them... – Municipal Mayor

I monitored residences the day before and managed calls in the [Center for Operations in Emergencies]. I went to houses to educate families moving older adults, and explain that medications should be taken, diapers, all basic necessities, to refugees. – Municipal Social Worker

A common needs assessment strategy was a community-based census to identify high-risk individuals on the basis of advanced age, limited mobility, special needs, and those living in households unlikely to withstand the storm, flooding, or landslides. Community leaders played an important role in this process in the days before the hurricane’s landfall:

*Emergency Management requested a census that was voluntary. They were counting children . . . older adults, bedbound people, people with special needs. – Community Leader*

*There was a census of older or disabled people, so if they had to be evacuated, they did it with time, and for people living alone they tried to take them to a refuge so they had support . . . they knew where every person was, which neighborhoods were prone to floods, landslides . . . – Community Leader*

Respondents described the relocation of older adults to refuges equipped and staffed to comprehensively meet their needs. Some communities dedicated specific refuges for individuals with more complex needs or who required specialized medical equipment or care. One community leader described how resources were prioritized for these refuges:

*. . . these refuges also made a work plan where they should have a social worker, nursing, recreation, and all required equipment, cots, basic necessities. We had ambulances to move those who were bedbound to refuges. – Municipal Social Worker*

*One of these schools was converted into a refuge solely for people who needed special equipment such as therapy machines, respirators, bedbound and older people that didn't have care during the event . . . all of these people went exclusively to this refuge.*

– Community Leader

Study respondents affirmed their commitment to older adult safety, which even took precedence in scenarios where older adults were reluctant to evacuate their homes:

*We sheltered an older couple . . . older adults are particular - they don't want to abandon their residence, no matter the risk. It's a mess to move them! "No, no, no!" We had to go there . . . in the middle of the water, the wind, with an umbrella flipped up, in order to move those two 83-year-old individuals. – Community Leader*

*. . . we had to evacuate against their will from their residence because the structures . . . were not going to withstand the hurricane. – Municipal Police Commissioner/Director of Emergency Management*

### **There was a lack of clarity on guidelines to protect older adults in natural hazards**

Regardless of the extensive efforts to protect older adults across municipalities, one emergency manager study participant acknowledged that they were underprepared to do so without specific guidance on caring for this population in disasters settings:

*There's not information about how to prepare older adults, how to treat them after an emergency like this. We have how to treat adolescents and children . . . how do we prepare our grandparents? . . . they need different conditions . . . that wasn't there.*

– Municipal Police Commissioner/Director of Emergency Management

### **Direct deaths during Hurricane Maria were more common among older adults**

When discussing direct deaths, although relatively few in number, participants most often described this occurrence among older adults during the storm:

*We had deaths because of shock. There were three heart attack deaths during the storm among older people . . . from seeing and feeling this phenomenon . . . It was like a noise – how do I describe it? . . . it was so strong. – Police Lieutenant*

*In terms of deaths during the hurricane, we had two cases of older adults – one heart attack and one respiratory arrest. When the wind started to blow really hard, they died, and these people were more or less 4-5 days in their homes, dead. – Municipal Emergency Medical Services Director*

### **Approximately 1 week post-hurricane, resource shortages and the lack of basic services took an increasing toll on older adults**

Municipal leadership and disaster managers recounted their efforts to deliver basic necessities and medical care to older adults' homes and retirement facilities immediately post-hurricane, prioritizing those with limited mobility and chronic medical conditions:

*We have [a center] where people over 60 are given breakfast and recreation and that group can't get to the center – we brought food to their houses. – Municipal Mayor*

*We went to their residences. We had various bedbound people, dialysis patients that were unable to get to our offices. – Municipal Director of Emergency Management*

However, after 1 week, many communities were still unable to establish communication with the Government of Puerto Rico, had inaccessible roadways, and had not been reached with additional resources. Communities spent months without electrical power and critical resources for elder care:

*. . . thousands of people were left without communication, and the ones who suffered the most were older adults, people needing medical attention. – Non-profit Organization Director*

*In the neighborhoods I visited, there was desperation . . . they saw their mom in her bed, without a respirator, suffering. They ran out of IV fluid and she wasn't able to drink water herself. They even put wet washcloths in her mouth . . . we are talking about day 7 [post-hurricane]. – Municipal Emergency Medical Services Director*

### **During recovery, prolonged residents in unsafe housing and electrical outages led to older adults' worsening physical and emotional status**

Seven months post-hurricane, study participants highlighted cases where older adults had continued living in unsafe conditions for extended periods, with excessive heat, and in houses with plastic tarps for roofs:

*. . . the hurricane with its magnitude took off roofs, damaged houses, including older people, they are sleeping underneath tarps . . . there are still houses with tarp roofs . . . it is a latent problem. – Municipal Mayor*

According to 1 respondent, many older adults experienced financial barriers to repairing homes and difficulty securing aid approval from the Federal Emergency Management Agency (FEMA):

*The sad thing is that many people didn't receive FEMA aid – they didn't qualify . . . we are people who work and we can, little by little, return to normalcy . . . but there are a lot of older people who can't do that. – Health Care Professional*

These unsatisfactory living conditions were described as contributors to declining older adult physical and emotional health, especially for those with complex medical needs:

*Since there was no electricity, no water service, health conditions deteriorated a lot. I'm talking about people who are diabetic, hypertensive, have Alzheimer's, Parkinson's, dementia. Emotionally, there was a lot of harm. – Community Leader*

*The process of forming ulcers for bedridden people began to worsen with the heat and no air [conditioning]. I sent paramedics to treat ulcers. It's not their job, but... otherwise, they wouldn't have this service.* – Municipal Emergency Medical Services Director

### **Some older adults relocated outside of Puerto Rico to mitigate consequences of inadequate conditions and the lack of services for NCD management**

In the months post-hurricane, with resources in short supply, living conditions worsening, and unmet medical needs, some older adults relocated outside of Puerto Rico when given an opportunity. Logistics were complicated by the lack of medical transport services:

*There have been lots of cases of older adults living in housing that is not apt, and obviously that impacts their health. There was a case of an emergency relocation, a patient with a terminal illness and no roof or tarp. They spent 2 months living in those conditions and it was so much that the person cried every day. This is what happened in many communities.* – Non-profit Organization Personnel

*I think that among those that left the island, over 50% were associated with a chronic condition. Their family members brought them because conditions were going to make their health deteriorate... in Puerto Rico chronic conditions are prevalent among older adults... the majority have three or more conditions.* – Former Puerto Rico Department of Health Personnel

*There is an ambulance service but the companies didn't do their jobs... I transported two families to the airport... facilitated getting respirators for the plane, endless coordination. They were bedbound older adults.* – Municipal Emergency Medical Services Director

### **While some elders decided to remain in Puerto Rico post-hurricane for familiar surroundings, others who stayed, or did not have relocation options, experienced inadequate social support and loneliness**

When presented with the choice to leave Puerto Rico, 1 municipal mayor attributed decisions to stay to the anticipation of emotional stability with familiar surroundings:

*Older adults are used to the lifestyle here... they say even though they don't have luxury, this is mine. They are not in another place as renters, but on their property, in their neighborhood, with their people. Many people prefer that for emotional stability... it's not the same being surrounded by new people someplace else... – Municipal Mayor*

Consequently, a common scenario was the migration of family members to the US mainland to meet school-aged children's needs or secure employment, sometimes leaving older family members behind. Respondents described cases where older adults lived alone without adequate social or financial support, presenting challenges to securing basic necessities and requiring them to perform activities of daily living under difficult circumstances, such as washing clothes by hand or carrying water buckets up flights of stairs. Older adults living alone in rural areas were identified as especially isolated and with unmet needs:

*In our area, a lot of people are older and alone... Many families with children left... now, the majority of people that remain are older.* – Health Care Provider

*There was a lot of deterioration in older adults from being alone... their kids left to the U.S. In communities furthest from the urban center, how do they get supplies, water? An older adult with no relatives had to get water... it's*

*too hard to carry the bucket upstairs and wash clothes by hand.* – Municipal Social Worker

Participants also described the impact on older adults' emotional health, which included feelings of loneliness, depression, and anxiety. Older adults' sleep patterns were reported to be disrupted, which was attributed to emotional distress from extended electrical outages and spending months in total darkness after sundown:

*Here, principally who was affected were older adults... they were affected emotionally. We have a lot of older adults alone that talk about the sound, how they felt alone listening to the wind. They close their eyes and "what I hear is Maria, it rains and for me, it's Maria. When I go to bed, I am alone. What do I do?"* – Municipal Social Worker

*I, myself, attended to people crying because without electricity, it's anxiety, it's an attack of stress.* – Municipal Mayor

*You see a lot of older people whose sleep was disrupted... they sleep during the day because they are awake at night. When the moment comes for the sun to set at six, that creates a lot of anxiety for them. Here, there were a lot of sectors without electricity until February [2018].* – Community Leader

### **Attempting to meet basic needs during a lengthy recovery placed considerable financial strain on older adults**

Respondents described financial strain for older adults during hurricane recovery, including difficulty receiving electronic social security benefits due to power outages and challenges paying for additional supplies and resources on fixed incomes:

*For older adults, their social security is \$800, \$900, but from that they have to pay for food, housing, gasoline for the generator, medication. They become stressed, the money is falling short, and it's like, either I pay for gas for the generator or I pay for medication... it is an enormous stressor that they've had.* – Municipal Mayor

### **Most indirect deaths were among older adults, and occurred during the extended recovery as a consequence of electrical outages and the lack of basic services and health care**

Despite preparedness efforts, many Puerto Ricans had not anticipated such an extended recovery period, which was detrimental for older adults. Respondents described numerous cases of older adult deaths in the weeks to months following Hurricane Maria from the degradation of living conditions and lack of services:

*There were deaths... after the hurricane from a lack of services... The needs were so great and there were factors that contributed to deterioration of the health of our older adults... – Municipal Social Worker*

*This is a small town, here we all know each other. Here, there were weeks where I was saying "My God, what is happening, you know, every day someone passes away!" Generally, older people with some type of condition.* – Municipal Police Commissioner/Director of Emergency Management

Respondents identified the most important factors contributing to older adult mortality as extended power outages, limited access to generators, and eventual fuel shortages to power generators. Individuals with chronic health conditions and complex medical needs were most severely affected:

*After so much time waiting, older adults without electricity, somewhere to store medications, ability to do therapies, connect to machines they needed... we saw the town's mortality rate increase. There's a direct cause from the hurricane's effects on emotional conditions and health, especially for older people.* – Municipal Mayor

*[This city] has 13 neighborhoods . . . 8 are dark . . . There is a 97-year-old woman with no electricity . . . her health condition worsens without a fan and feeding machine. These people will probably lose their lives and it has to be related to Maria. The electricity problem is from Maria. – Health Care Provider*

*One example I remember, a man, a veteran died from the lack of electricity because his respirator stopped working. They tried to do it manually, but couldn't. – Municipal Mayor*

*No, we are talking about many more [deaths] . . . people that were bedridden, receiving a type of treatment, using respirators . . . people that didn't receive chemotherapy and they passed away. Treatments were inadequate . . . and their bodies gave out. – Municipal Police Commissioner/ Director of Emergency Management*

## Limitations

Certain limitations should be considered when interpreting study findings. Sample size was determined according to original GW study aims and rapid assessment methodology. It is plausible that accounts from sampled communities do not represent all potential experiences, and that saturation may not have been reached specifically regarding elders' experiences. However, we observed considerable similarities and repetition in participant accounts across communities, which were consistent with observed impacts. Additionally, sampling was affected by persistent telecommunication outages and roadway obstructions. Consequently, municipalities with slower restoration may be underrepresented. To minimize potential bias, sampling criteria incorporated community attributes likely to elicit diverse hurricane impact experiences.

## Discussion

Hurricane Maria was a humanitarian crisis that disproportionately affected older adults, as evidenced by mortality estimates.<sup>33</sup> In this case, understanding the circumstances surrounding older adult mortality and morbidity is vital for future preparedness; furthermore, despite Puerto Rico being an archipelago, the population affected by Hurricane Maria shares many features with communities across the United States, including relatively high poverty, increasing NCD prevalence, and older adults living in communities with aging infrastructure.<sup>40–42</sup> However, current guidelines to protect older adults in disasters have been formulated based on extant disaster research, which fails to fully capture the convergence of these risk factors. Epidemiological and sociodemographic trends in the United States, when considered together with global climate patterns, signal the relevance of key lessons from the experiences of Hurricane Maria.

This study contextualizes GW study findings estimating that 85% of excess deaths from Hurricane Maria were among older adults,<sup>32</sup> and contributes to the literature addressing older adult health in disasters. Numerous studies have highlighted elevated risk of mortality and morbidity in disasters due to impairments, isolation, economic and transportation limitations, and inadequate NCD management.<sup>4–7,29,30,43–53</sup> In concordance with these studies, findings suggest that Puerto Rican older adults experienced isolation, financial barriers, and challenges to meeting daily needs. After hurricane landfall, half of Puerto Rico lacked potable water, 95% of cellular phone services were disabled,<sup>54</sup> and 30% of hospitals were non-operational,<sup>55</sup> which was followed by the longest electrical blackout in US history.<sup>16,56</sup> While direct deaths were relatively rare,

an important contributor to indirect deaths was inadequate NCD management among older adults due to cascading infrastructure and service failures. Furthermore, approximately one-fourth of Puerto Rican older adults lived alone in 2017,<sup>57,58</sup> and consistent with other studies, findings raise concerns for emotional well-being and social support in these high stress, uncertain contexts.<sup>6,57,59–65</sup>

While research shows that older adults are less likely to adequately prepare for natural hazards or heed warnings,<sup>4,66–82</sup> study participants described several community-level preparedness measures to protect older adults. Regardless, communities had not foreseen an extended recovery, indicative of broader disaster planning and risk communication inadequacies, which are not keeping stride with growing magnitudes of natural hazards and shifting demographics.<sup>1,2,7,34,52,83,84</sup> Hurricane Maria's severity and impact were exceptional, yet it was only 1 from a list of hurricanes that has disproportionately affected US older adults in recent years.<sup>19–21,24,26,27,43,46,48,61,77,81,85</sup> Hurricane Katrina in 2005 was a major impetus for the development of recommendations and trainings to better protect older adults, especially those with NCDs and low-income individuals.<sup>5,29,31,86</sup> However, 15 years later, there is either a lack of clarity regarding guidelines for older adults confronting large-scale natural hazards, or prior recommendations have not been adequately implemented, and Hurricane Maria brought to light the dire consequences of these deficiencies.

Based on study findings, the following recommendations are offered:

### *Expand disaster planning for older adults to include catastrophic impact scenarios*

Current guidelines and recommendations related to disaster planning, communication, training, registry and tracking systems, and older adult preparedness are misaligned with the realities of catastrophic disaster contexts.<sup>4,5,86–90</sup> The experiences following Maria call for the expansion of individual and community disaster preparedness guidelines to anticipate catastrophic events with significant, widespread impacts and lengthy recoveries.<sup>5,84</sup> Study findings support recommendations calling for extended supportive services for older adults and those with chronic conditions,<sup>91</sup> including nutrition, housing, and electrical supply assistance.<sup>92</sup> Findings also indicate that recommendations concerning the use of electronic registry/tracking systems for older adults, electronic medical and prescription records, telehealth, and crisis and emergency risk communication best practices must also incorporate multiple, long-term contingencies to account for electrical and telecommunication outages that can disable these strategies.<sup>4,6,93</sup>

### *Expand training to include older adult needs in catastrophic disasters*

Although previous recommendations have proposed training emergency managers in older adults' disaster needs and involvement of aging experts in all aspects of planning and response,<sup>5,94,95</sup> study findings raise concerns about how widespread and/or effective such training may be, and whether it addresses extreme disaster scenarios. Future disaster planning at all levels should address physical, emotional, social, and financial needs of older adults<sup>96</sup>; involve aging experts; and emphasize training of local disaster managers, frontline workers, and community leaders, especially given impending geriatrics workforce shortages.<sup>97,98</sup>

### **Build local capacity to support older adults in catastrophic disasters**

The experiences of Hurricane Maria emphasize the importance of future research, policy, and practice that seek to build local community capacity for older adult protection and NCD management,<sup>51</sup> including thorough age-friendly community planning<sup>91</sup>; enhanced financial, medical, and social support safety nets<sup>53,66,67,75,94</sup>; and advancements in public health surveillance that monitors real-time disease burden and risks.<sup>4,32,33,99</sup> These efforts should leverage the vital role of local community leaders and organizations in supporting elders.<sup>75</sup>

### **Conclusions**

With increasing severity of natural hazards, a pattern of disproportionate older adult risk has become undoubtedly clear. It is widely recognized that older adults are a high-risk group in disasters, yet we are still underprepared to meet their needs. Findings from this study expand considerations for disaster research and practice to include older adult health in catastrophic contexts with severe impacts and lengthy recovery periods.

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