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Review Article

Mortality in Nursing Homes Following Emergency Evacuation: A Systematic Review

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A B S T R A C T

Objectives: To determine the risk associated with mortality among nursing home residents within 6 months following an evacuation because of man-made or natural disasters.
Design: A systematic review conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) Statement.
Setting: All peer-reviewed studies published in English, French, German, or Spanish between January 1, 2000 and December 31, 2015, examining mortality within 6 months of disaster evacuation from a nursing home.
Measurements: Extracted information included study and population characteristics, mortality measures, and risk factors. Studies were examined using the disaster management cycle that considers preparedness, response, recovery, and mitigation.
Results: The 10 included studies were published between 2010 and 2015 with one-half conducted in the United States. Only 3 studies detailed the preparedness stage, and 4 detailed the response stage of the disaster management cycle. Mortality was measured as an indicator of recovery and was found to be elevated at 1 month [from 0.03% (n = 1088) to 10.5% (n = 75)] 3 months [from 0.08% (n = 3091) to 15.2% (n = 197)], and 6 months [from 14.9% (n = 263) and 16.8% (n = 22)] postevacuation compared with pre-evacuation and sheltering-in-place. Studies identified vulnerable residents as being over 80 years of age, frail, dependent, male residents with multiple comorbidities and, made recommendations on disaster preparedness.
Conclusions: There is little research on the effects of evacuation on nursing home residents, which is surprising considering the elevated risk of mortality postevacuation. Evacuation seems to have a negative effect on the survival of nursing home residents independent of the effect of the disaster. Standard evacuation procedures may be less applicable to this vulnerable population because of extra challenges they face in disasters.

Older people are more vulnerable to harm from disasters than the general population because of their physical frailty and greater reliance on supportive care provisions.[1] This was evident during Hurricane Katrina that battered the US Gulf Coast in 2005, damaging communities and causing the death of around 1000 people[2] with older adults aged over 75 years accounting for almost one-half of deaths.[2–5]

A disaster occurs when a hazard impacts a vulnerable population causing destruction.[6] A hazard may be either natural (because of an

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environmental process or phenomenon) or man-made (resulting from technological or industrial conditions).[7] Human actions may cause natural disasters, conversely man-made disasters may arise as a result of natural disasters (such as a Tsunami causing a nuclear disaster).[7]

The severity and frequency of natural disasters are increasing owing to climate changes leading to higher temperatures, extreme precipitation, and violent wind and storms.[8,9] The number of man-made disasters are also increasing, linked primary to a growth in use and risks related to the management of hazardous substances, leading to disasters from nuclear explosions and chemical spills.[10,11] Rising levels of urbanization and population densities will also amplify impacts of disasters.[1,10–13]

Nursing home residents' exposure to disasters is, therefore, likely to become more frequent. Assessing the impacts of evacuation is a necessary first step toward informing the design of future disaster preparedness policies and our capacity to implement those.

The framework of modern disaster management consists of 4 stages aimed at reducing effects of disasters: preparedness; response; recovery; and mitigation.[14] The responsibility of planning and implementing this framework falls upon nursing home providers, who are expected to produce disaster management, emergency response, and evacuation plans, which may be assessed through accreditation programs.[15]

Accumulating evidence indicates that residents evacuated from nursing homes experience higher rates of mortality than those who shelter-in-place.[4,16,17] However, in most studies, it is not possible to determine which aspect of evacuation (egress, transfer, or relocation of residents) is associated with mortality, and whether prevention of harm is possible.

This systematic review aims to determine the incidence and risk associated with mortality among nursing home residents at 1, 3, and 6 months following an evacuation because of man-made or natural disaster.

Methods

This review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)[18] (Figure 1).

Search Strategy

The following databases were searched: Medline, Embase, Cochrane Database of systematic reviews, PsychINFO, CINAHL, Web of Science, and Scopus.

Key terms describing evacuation, death, and nursing homes were identified by 2 researchers with the assistance of an experienced professional biomedical science librarian to produce a master list (Appendix 1). The master list was independently reviewed by 2 researchers and used to conduct the final search. The list of key terms was adapted to each database (Appendix 2). Three researchers independently conducted the database search, and a bibliographic review of included articles was conducted to identify additional relevant studies.

Selection Criteria

The inclusion criteria comprised studies of original research published in a peer-reviewed journal between January 1, 2000 and December 31, 2015; available in English, French, German, or Spanish; where the population was nursing home residents; and examining mortality within 6 months of disaster evacuation from a nursing home.

Articles were excluded if they were a bibliography, case report, comment, conference abstract, dissertation, thesis, editorial, guidelines, tutorial, or interview.

Results were reviewed for eligibility by 2 researchers by title and abstract, then full text, and final selection was made by consensus between 3 researchers.

Data Extraction

Extracted information included study and population characteristics, evidence of disaster preparedness, response and recovery, mortality measures in evacuated and nonevacuated groups, risk factors for mortality, and study limitations. Reported measures of functional (Appendix 3) and physical impairment (Appendix 4) were standardized into mild, moderate, and severe grades.

Data Analysis

Data were analyzed to describe cause of death; risk factors associated with death; and any recommended prevention measures. These variables were examined using the disaster management cycle that considers: preparedness; response; recovery; and mitigation.[14] The quality of the studies was assessed using the National Institutes of Health quality assessment tool for observational studies.[19] Three researchers independently reviewed the studies, and any discordance was resolved by discussion.

Results

Study Characteristics

Of 5575 studies identified, 10 met the inclusion criteria (Figure 1) with the greatest contribution from the United States (USA) (n = 4) (Table 1). All were written in English, with the exception of 1 study[20] that was written in French. All except 3,[4,21,22] were cohort studies of fair quality according to the National Institutes of Health quality assessment[19] (Table 1). All studies collected data retrospectively and had a comparison group consisting of the same residents preceding evacuation and/or nonexposed residents.

Population Characteristics

Studies were heterogeneous in number of facilities examined, from 1[23] to 141[24] sites, and residents from 131[20] to 36,389 individuals.[17] Nonetheless, demographic characteristics were homogeneous, with most residents being female, over 80 years of age, with multiple comorbidities, and cognitive and functional impairment (Table 1).

Study Findings

Table 2 describes the study analysis using the disaster management cycle (preparedness; response; recovery; and mitigation).[14]

Only 3[23,25,26] studies discussed preparedness, of which 2[25,26] reported a lack of evacuation drills and inadequate disaster guidelines, in that, these did not include specific plans for older people accommodated in institutional settings. Characteristics of origin facilities, such as relevant qualifications, training in evacuation procedures, and orientation programs upon admission, were seldom described. Staff numbers were reported by 2 studies with staff to resident ratios of 1:2.8[23] and 1:1[21] persons on the day of evacuation.

Six studies[17,20,22,24,27,28] examined natural disasters, predominantly (n = 5) hurricanes in the USA (Table 2). Because of the small number of studies (n = 10) and the relative lack of information available on the disasters, any differences between man-made and natural disasters on the disaster management cycle could not be evaluated.

Four studies[21,23,25,26] provided information on nursing homes' response to the disaster, including procedures, duration of evacuation, and evacuation locations (Table 2). Only 1 study[23] described a positive disaster response, involving a detailed plan, support from emergency services, and evacuation to an emergency hospital, which resulted in zero deaths 3 months postevacuation. However, as this was a fire only involving 1 nursing home, it was possibly more manageable than the nuclear disaster effecting nursing homes within a 20-km radius, which was examined in the other studies.[21,25,26]

Mortality at 1, 3, and 6 months postevacuation was measured as an indicator of recovery. Nine studies indicated high levels of mortality following evacuation, with only 1 study[23] reporting no deaths

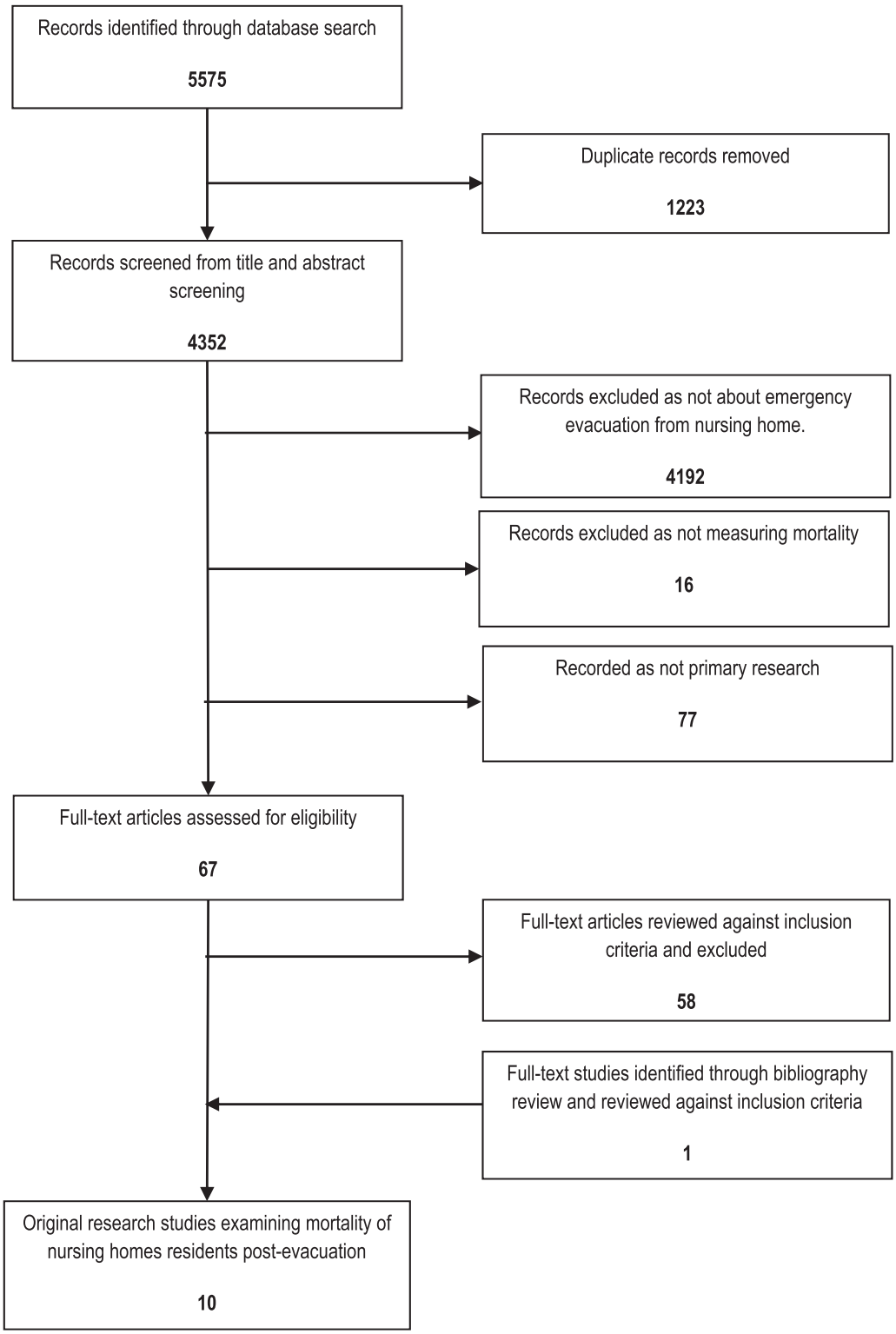

Fig. 1. PRISMA flow diagram of identification, screening, and inclusion of eligible studies.

Table 1
Methodology and Populations

Study	Aim	Methodology			Setting and Population									Quality rating*
		Country	Design	Follow-Up (months)	Exposed Residents (n)	Nonexposed Residents (n)	Nursing Homes (n)	Facility Size	Mean Age (Range)	Male (%)	Dementia/Cognitive Impairment (%)	Severity of Comorbidity	Functional Impairment	
Brown et al 2012[27]	Effects of evacuation during Hurricane Gustav on residents with severe cognitive impairment.	USA	R, Co	36	5036	16,219	119	–	83 (75–91)	26	18	Mild	Mod	8
Castle and Engberg 2011[22]	Mortality post-Hurricane Katrina in evacuated vs nonevacuated residents.	USA	R, Ca	4	439	46,035	87	–	79 (71–87)	28	–	–	Mod	8
Dosa et al 2010[24]	Mortality and hospitalization rates among nursing facility following Hurricane Katrina and to assess the rate of significant posthurricane functional decline.	USA	R, Ca	3	9260	19,280	141	–	–	25	21	Mild	Mod	
Dosa et al 2012[17]	Mortality associated with evacuation vs sheltering-in-place for NH residents exposed to 4 Gulf hurricanes.	USA	R, Co	6	36,389	76,696	–	–	–	25	22	Mild	Mod	8
Koning et al 2015[23]	Reports the outcome of a mass casualty incident caused by a fire in a NH.	NLD	R, Co	3	138	–	1	–	–	–	100	–	–	
Mantey et al 2012[20]	Mortality rates following emergency evacuation compared with previous years in same and 2 other NHs.	FRA	R, Co	96	131	–	3	–	86	30	65	–	Mod	9
Murakami et al 2015[21]	Assess evacuation-related risks and compare with radiation risks for nursing-home residents and staff.	JPN	R, Ca	3	191	198	3	–	–	23	–	–	–	
Nomura et al 2013[25]	Mortality risk associated with evacuation of elderly residents after the Fukushima Dai-Ichi nuclear accident.	JPN	R, Co	9	715	–	5	–	–	27	–	–	–	
Thomas et al 2012[28]	Mortality in forced mass transfer of the most functionally impaired NH residents vs nonevacuated residents	USA	R, Co	3	1295	367	119	–	84 (82–86)	24	46	Mild	Sev	8
Yasumura et al 2013[26]	Excess mortality in evacuated institutionalized elderly after the Fukushima nuclear disaster.	JPN	R, Co	8	1770	N/A	34	–	–	–	–	–	–	5

Ca, case-control; Co, cohort; FRA, France; JPN, Japan; L, large (>150 beds); Mod, moderate; NH, nursing home; NLD, The Netherlands; P, prospective; QuaEx, quasi-experimental; R, retrospective; S, small (<150 beds); Sev, Severe.
*Quality of studies according to the National Institutes of Health (NIH) quality assessment tool for observational studies.[19] The level of adherence to the 14 criteria is reported. Quality ratings score: poor = 0–4; fair = 5–9; good = 10–14.

Table 2
Study Findings

Study	Preparedness	Response		Disaster		Recovery Mortality n (%)				Mitigation	
	Evidence of Planning	Procedures	Destination of Residents	Hazard	Event	1 month	3 months	6 months	Evacuated vs Not Evacuated	Vulnerability Analysis	Recommendations
Brown et al 2012[27]	–	–	–	N	H	261 (6.7)*	582 (15)*	–	+	Severe cognitive impairment	Staff training Disaster preparedness programs
Castle and Engberg 2011[22]	–	–	–	N	H	–	38 (8.7)†	–	+	–	Disaster evacuation planning and drills Inspections by state surveyors Reimbursement for disaster-related expenses Staff training
Dosa et al 2010[24]	–	–	–	N	H	359 (3.9)	858 (9.3)	–	+	Severe functional impairment	–
Dosa et al 2012[17]	–	–	–	N	H	1088 (0.03)‡	3091 (0.08)‡	–	+	–	–
Koning et al 2015[23]	Evacuation plan	Emergency services, Emergency hospital	Hospital Evacuation shelter	M	Fi	–	0	–	NR	–	Improve communications between parties involved in disaster response
Mantey et al 2012[20]	–	–	–	N	Fl	7 (5.3)	17 (13)	22 (16.8)	+	Males, Advancing age (>80) Reduced mobility High dependency	–
Murakami et al 2015[21]	–	Voluntary evacuation	–	M	ND	§	–	–	NR	Males Advancing age High dependency	–
Nomura et al 2013[25]	Inadequate guidelines	Receiving facilities not prepared, Lack of supplies	–	M	ND	75 (10.5)	–	–	+	High dependency First time evacuating	–
Thomas et al 2012[28]	–	–	–	N	H	80 (6.2)	197 (15.2)	–	–	–	Most vulnerable residents observed after disaster
Yasumura et al 2013[26]	No planning Inadequate evacuation guidelines	Evacuation of 20 km area within 24 hours Several transfers	Hospital Gymnasium Public schools	M	ND	–	–	263 (14.9)‖	NR	Severe functional impairment Severe cognitive impairment	Improve evacuation guidelines Disaster evacuation planning and drills Increase of resources at relocation institutions Improved collection and reporting of health statistics

Fi, fire; Fl, flood; H, hurricane; M, man-made hazard; N, natural hazard; ND, nuclear disaster; NR, statistical analysis not performed. Recovery postevacuation vs no evacuation: +, significant difference in mortality incidence; –, no significant difference in mortality incidence.

*Residents with severe cognitive impairment.

†Mortality at 4 months postadmission.

‡Mortality accumulated for all hurricanes.

§The total loss of life expectancy of residents due to evacuation-related risks was 11,000 person-days.

‖Mortality over 7 months, excluding 32 victims of the tsunami.

postevacuation (Table 2). One month postevacuation mortality was reported by 6 studies,[17,20,24,25,27,28] ranging from 0.03% (n = 1088)[4] to 10.5% (n = 75)[25] Six studies[17,20,22,24,27,28] reported mortality at 3 months postevacuation ranging from 0.08% (n = 3091)[17] to 15.2% (n = 197)[28] Six-month postevacuation mortality was reported by only 2 studies as 14.9% (n = 263)[26] and 16.8% (n = 22).[20] The statistical significance of these findings was not evaluated because of the small number of studies.

Only 1 study[20] examined mortality at all 3 time intervals, reporting an initial increase (n = 7, 5.3%) 3 times the expected mortality (n = 1.8, 1.4%) 1 month postevacuation. This was followed by a return to expected mortality levels at 4 months postevacuation. One study[21] found in a nuclear disaster, loss of life expectancy from evacuation immediately after a disaster (11,000 person-days) was much higher than loss of life expectancy because of radiation exposure (between 1100 and 5800 person-days).

Six studies[17,20,22,24,25,27] reported a significant difference in mortality between evacuated residents and a comparison group, whereas 1 study[28] did not. Evacuated residents had a significant increase in mortality at 1 (277 extra deaths; 200%; 1.7%; 2.8%),[17,20,24,27] 2 (300%),[20] and 3 months postevacuation (579 extra deaths; 3.0%; 3.9%)[17,24,27] and were significantly more likely to die (odds ratio 1.85; relative risk 2.68).[22,25]

Causes of death were only reported in 1 study, the most common being pneumonia (n = 734, 40.9%), which authors attributed to suboptimal living conditions postevacuation.[26]

All studies considered mitigation either in terms of residents' vulnerability or recommendations for future evacuations. The most vulnerable residents were found by all studies to be male residents aged over 80 years, who had greater functional and cognitive impairment and a number of comorbidities (Table 2).

Recommendations to reduce the effects of evacuation were proposed by studies,[22,23,26–28] these often focusing on disaster preparedness (Table 2). A lack of available data on evacuation locations, health statistics, and information on the process of evacuation was raised in studies.[20,22,23,25–27]

Discussion

To our knowledge, this study is the first to systematically review mortality in nursing home residents following disaster evacuation. We identified 10 studies, describing mortality to be elevated at 1, 3, and 6 months postevacuation, compared with pre-evacuation and non-evacuated residents.

Disaster Management Cycle

Preparation

Few studies detailed the preparation-phase, which is paramount to reduce deleterious health outcomes and mortality in disasters.[29,30] As seen in 1 study,[23] collaboration between emergency services and nursing homes is critical. It can assist in developing well-defined plans, training, drills, and agreements as to the support provided to nursing homes in disasters.[31] However, the existence of a plan does not guarantee its successful implementation.[30]

Response

Similarly, few studies detailed the responses of nursing homes to the disaster. Effective disaster response for nursing homes is achieved through coordination of multiple agencies, including nursing homes that both evacuate and shelter residents, emergency services, governments, hospitals, and resource suppliers.[31] However, experiences from hurricanes and earthquakes in the United States show that nursing homes receive little support from federal, state, and local response agencies during and after disasters.[15,16,32] Integrating nursing homes in state or national disaster plans could improve outcomes for residents in disasters.

Recovery

Recovery from evacuation was highly variable, with mortality ranging from 0% to 17%, peaking significantly in the first few months then stabilizing to expected mortality levels. This increased mortality postevacuation is comparable to other vulnerable populations such as ethnic minorities[33] and people from low socioeconomic backgrounds.[34,35] However, in these other vulnerable populations, it is not clear whether this is a result of evacuation or other reasons (residential location, building construction and community isolation). Although intrinsic resident factors were significantly associated with elevated mortality, evacuation itself appears to play a role as mortality was higher than in comparison groups when controlling for these variables.[17,22,24,27]

This indicates that factors, such as the physiological stress of evacuation, could contribute to the reported increase in deaths. Stressful life events, such as evacuation, have been associated with declining health, especially in vulnerable populations.[36–38] Such stressful events coupled with inadvertent changes, deficits, or errors in provision of care to residents increase the mortality risk. This may arise from loss of pertinent clinical information, important supplies, and medical equipment not being available and inability to mobilize or access the clinical workforce. Specifically, nurses and/or physicians may not be available or contactable to guide assessment and treatment.

The causes of mortality may be directly or indirectly related to the evacuation or the hazardous event (the disaster itself). Injuries may be a direct result sustained during the evacuation (falls, fractures, lacerations) or may be an indirect result, such as precipitating delirium because of rapid changes in environment and staff or an exacerbation of pre-existing conditions. For example, people with heart disease may develop acute coronary syndrome during the evacuation because of the increased mental and physical demands in relocating. Similarly, the hazard, for example a flood, may cause injuries directly such as drowning, or indirectly because of creating a barrier that interrupts the supply chain of food, water, medication, and trained staff. Disasters pose safety risks to residents whether they are evacuated or not, however, it is notable that in disasters, evacuated residents have been found to have experienced higher mortality than those who sheltered-in-place.[4,17]

Mitigation

Designing effective interventions should entail identifying which residents are more likely to benefit from being evacuated from those who should shelter-in-place.[30] Postevacuation is also a period of mental and emotional stress for staff, who face challenges of inadequate staffing levels, loss of staff and exhaustion while dealing with their own grief and caring for residents.[15,32] Nursing homes should be prepared for staff losses and develop strategies to support staff and residents mental health.[4,15]

Lessons from unsuccessful nursing home evacuations from Hurricane Katrina and Rita highlight the importance of nursing homes being included in community disaster plans, given support from local emergency agencies, and having appropriate transport equipped for residents' needs.[4,15] A possible strategy is to give priority to vehicles carrying nursing home residents in high-traffic slow-travel scenarios. This would lessen the duration of transit and reduce the associated stress. Communication with caregivers of residents should be a high priority for nursing homes during evacuations. Geriatric specific protocols for continuum of care need to be considered in disasters and information on resident's medical care should be readily accessible.[15]

Implications

This research highlights a gap in knowledge on the effects and risks associated with evacuation of nursing home residents. Residents, their families and the community expect that evacuation during a disaster will reduce mortality. However, research suggests that evacuation may not always be the best strategy to prevent the death of older people. A possible explanation could be that standard evacuation procedures are less applicable to nursing home residents. The cognitive impairment and lack of mobility of many residents could

compound the physical stress of evacuation. Rather than being the default option, the decision to evacuate should arise from a judicious, transparent, and evidence-guided process. In certain disasters, it is preferable to evacuate (for example, nuclear disasters) and in others, it is preferable to seek other alternatives like sheltering-in-place (for example, hurricanes). However, the preferred response may not always be available or feasible. Evacuation may be hindered due to immobile residents and a lack of appropriate transportation or having a place to evacuate to safely. Similarly, sheltering-in-place may be impeded from a lack of staff, supplies, or inadequate power generators. As the number of older people rapidly grows, it is imperative that the challenges unique to this vulnerable population are recognized in disaster management frameworks.

This review is limited by the few available studies, of which 4[20,24,26,27] did not compare mortality with nonexposed residents, only comparing to mortality prior evacuation. Importantly, there was a lack of information on the preparedness and response of institutions. Further, studies were often (n = 5) conducted in the USA, which may limit the generalizability of the results.

Conclusions

There is a dearth of research on the effects of evacuation on the mortality of nursing home residents. This is surprising considering the elevated risk of mortality postevacuation compared with preevacuation and to those who sheltered-in-place. Evacuation seems to have a negative impact on the survival of nursing home residents independent of the effect of the disaster. The causes of mortality may be directly or indirectly related to the evacuation or the disaster, and are likely to change depending on the hazard, means of evacuation, and living conditions on arrival. Rather than being the default option, the decision to evacuate should arise from a judicious, transparent, and evidence-guided process. Standard evacuation procedures may be less applicable to this vulnerable population because of extra challenges (such as a greater reliance on support, cognitive impairment and lack of mobility) that are exacerbated in disasters. For example, when there is a lack of available transportation suitable for immobile older persons. Alternatives may need to be found such as in foreseeable disasters (eg, hurricanes), nursing home staff could organize for the family or other caregivers to pick up the resident and evacuate with them.

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Supplementary Data

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