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Evacuation from Natural Disasters: A Systematic Review of the Literature

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Research on evacuation from natural disasters has been published across the peer-reviewed literature among several disparate disciplinary outlets and has suggested a wide variety of predictors of evacuation behavior. We conducted a systematic review to summarize and evaluate the current literature on demographic, storm-related, and psychosocial correlates of natural disaster evacuation behavior. Eighty-three eligible papers utilizing 83 independent samples were identified. Risk perception was a consistent positive predictor of evacuation, as were several demographic indicators, prior evacuation behavior, and having an evacuation plan. The influence of prior experiences, self-efficacy, personality, and links between expected and actual behavior were examined less frequently. Prospective, longitudinal designs are relatively uncommon. Although difficult to conduct in postdisaster settings, more prospective, methodologically rigorous studies would bolster inferences. Results synthesize the current body of literature on evacuation behavior and can help inform the design of more effective predisaster evacuation warnings and procedures.

KEY WORDS: Evacuation; natural disaster; systematic review

1. INTRODUCTION

In October 1999, the rural, impoverished state of Odisha, India was rocked by Tropical Cyclone 05B. This storm had wind speeds of 155 mph—the equivalent of a Category 5 hurricane—and resulted in 10,000 deaths. In contrast, 14 years later, in October 2013, Tropical Cyclone Phailin made landfall in the same area with 140 mph winds at landfall, yet only 14 people died. Although both cyclones caused millions of dollars of damage, the immense difference in human casualties was due primarily to the Indian government's "zero casualty" policy, which involved the evacuation of over 1 million people prior to landfall.(1) Evacuations in the United States have had a similarly striking impact on the scope of casualties. For example, the successful evacuation of over 1 million people in southern California during the firestorms of 2007 contributed to a very low death toll (14 lives lost) in the face of hundreds of thousands of acres of destruction.(2)

These are a few of many examples of the life-saving capabilities of effective evacuations. While most commonly undertaken prior to the landfall of a hurricane or tropical storm, evacuations can also greatly reduce the human impact of natural disasters such as floods, firestorms, tsunamis, and volcano eruptions. Taken together, these disasters affect over 26 million people in the United States, and 255 million globally, each year.(3) In addition, forecasts predict increases in natural disaster events in the coming years.(4) However, many disasters are predictable to the extent that sufficient warning can be provided to many who need to get out of harm's way, and effective evacuations are critical to reducing disaster-related casualties. It is imperative that we understand predictors of evacuation in order to

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consistently replicate the striking successes of the Cyclone Phailin and San Diego wildfire evacuations during future events, both international and domestic.

Disaster research comes with a unique set of logistical and methodological challenges. The unpredictable nature of natural disasters often precludes the collection of predisaster data on prior experiences, risk assessments, plans, and intentions for evacuation, which may be useful predictors of evacuation behavior. As a result, predisaster evacuation is often only studied *after* the disaster in question has occurred. However, obtaining acute measurements of disaster decision-making processes during or in the immediate aftermath of a disaster is also difficult due to the necessity of obtaining requisite ethics board approval, sufficient funding, and access to disrupted communities within a very short time span. Time constraints often impede collecting data from representative samples, negatively impacting the generalizability of findings.[5]

Despite inherent methodological challenges, understanding predictors of evacuation behavior has been of interest to researchers across a number of disparate disciplines (e.g., sociology, psychology, engineering, natural hazards, risk assessment and management, communication, public health). Studies from the social sciences literature have examined factors such as social ties, storm context, and perceived risk. In contrast, transportation engineering and disaster management studies tend to focus more on objective characteristics of the storm and logistical issues for evacuees, such as time to evacuation and anticipated destination. These studies often differ in terms of message, methodology, and application, resulting in an array of evacuation behavior indicators. Unfortunately, there has been little cross-discipline synthesis and integration.

This systematic review organizes and synthesizes the diverse literature on natural disaster evacuation behavior. More specifically, we seek to identify common predictors of evacuation and highlight those that may require more empirical attention. We also seek to characterize the methods used in the evacuation behavior literature and suggest areas for improvement.

2. METHODS

2.1. Search Strategy

In order to enhance the likelihood of capturing the literature conducted on this topic across a variety of disciplines facilitating a systematic literature review, papers were selected for inclusion via a three-stage search process. The search process was developed based on recommendations from prior literature.[6,7] First, in March 2016, a literature search was conducted in the Web of Science, PsycINFO, and Published International Literature on Traumatic Stress (PILOTS) databases using the search terms "evacuation," "disaster," "hurricane," "flood," "volcano," and "tsunami." This search returned 1,326 journal articles from Web of Science, 211 from PsycINFO, and 39 from PILOTS. Fifty-seven articles from this search met inclusion criteria (described below). Second, we conducted a backwards citation search through articles cited by these 57 papers, which returned an additional 14 papers. Third, we conducted a forward citation search of papers that cited these 71 articles using Google Scholar, which added 12 more papers to the sample.

2.2. Inclusion Criteria

We included peer-reviewed journal articles examining predictors of evacuation behavior, which includes studies of individuals' choices or intentions to leave their homes for a safer location in the event of a natural disaster. This definition does not take into account whether or not these decisions resulted in a successful evacuation, as we only examined predictors of the decision to evacuate. All articles were written in English. To ensure that we were only including literature that had undergone peer review, technical reports, dissertations, and book chapters were excluded. Eligible articles must have described quantitative research conducted at the individual level of analysis (i.e., reports of one's own behavior/predicted behavior); community-level assessments were not included. Because we sought to characterize independent and dependent variables and examine associations among them, research that only reported qualitative findings was not included. Also, we only assessed studies of evacuations that took place *prior to* a natural disaster (e.g., hurricane, flood, or firestorm). In addition, studies of actual evacuation behavior from past disasters as well as studies assessing individuals' predictions of their evacuation behavior from a future disaster were included. Finally, studies with only postdisaster assessments and those with prospective data were included. Studies reporting data of postevent evacuations following a disaster were excluded.

2.3. Article Review Strategy

Information from articles' methodology sections was sorted along several *a priori* determined methodological dimensions (type of data collection, sample characteristics, and assessment timing), as determined among the researchers. Data collection methodology included information on the type of survey medium that was used by the researchers (i.e., in-person interview, telephone interview, paper-and-pencil questionnaire, mail survey, or online survey) and the population from which the sample was drawn (e.g., Florida residents who evacuated for Hurricane Frances, residents of Icelandic communities at risk for volcanic eruption). Sample characteristics included information about the sample size, response rate, and sampling methodology as described by the researchers (e.g., population assessment, random digit dialing, convenience sample). Information on the timing of assessments came from whether the study was prospective and/or longitudinal in nature, and, for studies of actual disasters, the amount of time between the disaster itself and the assessment of evacuation behavior. This information is presented in Table I.

We identified two types of studies: those based upon past behavior and those based upon participants' expected evacuation behavior in the event of a future disaster. The major findings from each study were synthesized into two tables (see Tables II and III). Common thematic constructs were then evaluated across studies.

3. RESULTS

Eighty-three peer-reviewed articles that were published between 1961 and 2016 met inclusion criteria and were included in the review. Several articles presented separate analyses conducted on the same sample ($n = 9$), others published analyses of multiple independent samples in the same article ($n = 7$), yielding a total of 83 independent samples included in this review. Fifty-nine studies examined evacuation behavior prior to hurricanes and cyclones, 14 before floods and/or mudslides, 5 before tsunamis, 3 before firestorms, and 2 before volcano eruptions. Of these, 53 studies (59 independent samples) examined communities that evacuated from a specific disaster, and 30 studies (22 independent samples) examined predicted evacuation behavior from a future natural disaster. Seventy-one studies were conducted in the United States and its territories, while 12 were conducted with international samples in Mexico,[8,9] Norway,[10] Japan,[11,12] Thailand,[13] Philippines,[14] Iceland,[15] India,[16,17] Bangladesh,[18] and New Zealand.[19]

3.1. Methodology in the Literature

First, studies were characterized based on several *a priori* determined methodological dimensions. Table I describes the methods utilized by each study in greater detail. Specifically, we report each study's sample size, the population from which that sample was drawn, the response rate, how much time had elapsed between the disaster in question and the study's assessment, whether the study was prospective, whether the study was longitudinal, and a description of the survey methodology that was used.

3.1.1. Study Methodology

Study methodologies varied: 29 administered in-person interviews/surveys, 18 conducted telephone interviews, 13 used mail-in surveys, and 6 utilized online surveys. Four studies employed multiple survey methods to collect their data—McClure *et al.*[20] provided participants the option of completing surveys face-to-face, over the phone, or through the mail, Drabek[21] and Van Willigen *et al.*[22] conducted in-person interviews with part of the sample and telephone interviews with the rest, and Aguirre[9] conducted both field observations and in-person interviews. Thirteen studies did not report their data collection method.

3.1.2. Sampling Methods

Most studies ($n = 62$, 74.7%) reported their sampling methodology. The majority of those studies ($n = 44$, 71%) used probability sampling—often random ($n = 22$) or stratified random ($n = 16$) sampling. Three studies obtained their samples from the entire population of interest.[10,15,23] One study utilized systematic sampling,[24,25] and another did not indicate the specific type of probability sampling used.[26] The remaining studies utilized forms of nonprobability sampling ($n = 17$, 27.4%). Fourteen studies used convenience sampling (22.6%), two used purposive sampling (3.2%),[17,21] and one used quota sampling (1.6%[27]). Twenty-four studies (28.9%) did not report sampling methodology.

Table I. Methodological Qualities of Studies of Past and Expected Future Evacuation Behavior from Natural Disasters

Citation	*N*	Sampling Strategy	Population Drawn	Response Rate	Time Since Disaster	Prospective?	Longitudinal?	Survey Methodology
Adeola, 2008	598	Not reported	Hurricane Katrina victims in the New Orleans Metropolitan Area	85.4%	6-7 months	No	No	Paper-and-pencil surveys
Aguirre, 1991	431	Stratified random sampling of city blocks, household members selected to meet census benchmarks for age and gender	Residents of Cancun at the time of Hurricane Gilbert	Not reported	Field observations at 1 week; interviews conducted at 1 year	No	Yes	Interviews and field observations
Arlikatti *et al.*, 2006	501	Stratified random sample of households from each evacuation zone within each of 5 study areas in coastal Texas	Households in coastal Texas	22.1%	N/A	N/A	No	Mail surveys
Baker, 1979	1500	Not reported	Households in the area of greatest hurricane impact	Not reported	Few weeks (nonspecific)	No	No	Interviews (nonspecific)
	400	Not reported	Households in Harrison County, MS	Not reported	4-6 weeks	No	No	Interviews (nonspecific)
	375	Not reported	Households in Fort Walton Beach and Panama City Beach, FL	Not reported	1 week	No	No	Interviews (nonspecific)
	200	Not reported	Residents of Panama City and Panama City Beach, FL	Not reported	3 months	No	No	Interviews (nonspecific)
Baker, 1995	400	Random selection within 7 clusters stratified by hurricane risk and age	Residents of selected coastal communities in Pinellas County, FL	Not reported	N/A	N/A	No	In-person interviews
Bateman & Edwards, 2002	1029	Random digit dialing	Households in NC's coastal counties: Brunswick, Carteret, Currituck, Dare, Hyde, New Hanover, Onslow, and Pender	76%	5 months	No	No	Telephone interviews
Bird, Gísladóttir, & Dominey-Howe, 2011	66	All households approached for participation	Residents of Icelandic communities at risk for volcanic eruption	77%	N/A	N/A	No	In-person interviews
Brackenridge *et al.*, 2012	120	Random sample from list of pet owners obtained from a survey marketing firm	Pet-owning residents of Harris County who resided in zip codes that were under mandatory evacuation order	20%	10 months	No	No	Mail surveys

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Table I. Continued

Citation	*N*	Sampling Strategy	Population Drawn	Response Rate	Time Since Disaster	Prospective?	Longitudinal?	Survey Methodology
Brown *et al.*, 2016	420	US census blocks randomly selected from inundation areas; tax lots randomly selected from census blocks	Adult residents in South Brooklyn, the Rockaways, and Staten Island	45%	6 weeks	No	No	In-person surveys
Burnside, 2006[a]	400	Random digit dialing	Residents of Orleans Parish, LA	Not reported	N/A	N/A	No	Telephone interviews
Burnside, Miller, & Rivera, 2007[a]	1207	Random digit dialing	Residents of Orleans, Jefferson, & Bernard Parishes, LA	Not reported	N/A	N/A	No	Telephone interviews
Cahyanto *et al.*, 2014[b]	533	Random selection of every third tourist	Tourists who were visiting FL at 2 sites in Orlando and Ft. Lauderdale Beach	86%	N/A	N/A	No	In-person interviews
Cahyanto & Pennington-Grey, 2014[b]	533	Random selection of every third tourist	Tourists who were visiting FL at 2 sites in Orlando and Ft. Lauderdale Beach	86%	N/A	N/A	No	In-person interviews
Charnkol & Tanaboriboon, 2006a	274	Not reported	Residents of Baan Namkhem, Phang Nga Province, Thailand	85.6%	3 months	No	No	Not reported
Charnkol & Tanaboriboon, 2006b	907	Convenience sample	Residents of Phuket and Phang Nga, Thailand	79%	3-4 months	No	No	Paper-and-pencil surveys
Christensen, Richey, & Castañeda, 2013	186	Convenience sample (Alzheimer's Community Care)	Community-dwelling individuals with a diagnosis of Alzheimer's Disease or a related disorder and their caregivers	Not reported	N/A	N/A	No	Telephone interviews
Dixit *et al.*, 2008	454	Not reported	FL residents who evacuated for Hurricane Frances	Not reported	9-10 months	No	No	Telephone interviews
Dixit, Wilmot, & Wolshon, 2012	429	Not reported	Households living in an affected parish when Hurricane Andrew struck	Not reported	Not reported	No	No	Not reported
Dow & Cutter, 1998	323	Participants approached for participation at entrances to major grocery stores in each area	Individuals in Hilton Head and Charleston, SC and Wilmington, NC	75%	2-4 weeks	No	No	In-person interviews

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Table I. Continued

Citation	*N*	Sampling Strategy	Population Drawn	Response Rate	Time Since Disaster	Prospective?	Longitudinal?	Survey Methodology
Dow & Cutter, 2000[c]	536	Random selection of phone numbers from all zip codes under mandatory evacuation order	Coastal SC residents	63.5%	N/A	N/A	No	Telephone interviews
	123	Convenience sample	Convenience sample of previously sampled (N = 166) Horry County residents	74%	6 weeks post-Hurricane Floyd	No	No	In-person interviews
	427	Convenience sample	Local elected officials in SC	81%	N/A	N/A	No	Not reported
Dow & Cutter, 2002[c]	536	Random selection of phone numbers from zip codes that were under evacuation orders for Hurricane Floyd	Households in coastal SC given mandatory evacuation orders before Hurricane Floyd	64%	6 weeks	No	No	Telephone interviews
Drabek, 1969[d]	278	Random sample drawn from pool of all affected households	Families evacuated from the Denver, CO Metropolitan Area	77.2%	6 months - 1 year	No	No	In-person interviews
Drabek, 2001	406	Purposive sampling	Employees at 118 affected businesses	66%	Variable, not reported	No	No	In-person and telephone interviews
Drabek & Boggs, 1968[d]	278	Random sample drawn from pool of all affected households	Families evacuated from the Denver, CO Metropolitan Area	77.2%	6 months - 1 year	No	No	In-person interviews
Drabek & Stephenson, 1971[d]	278	Random sample drawn from pool of all affected households	Families evacuated from the Denver, CO Metropolitan Area	77.2%	6 months - 1 year	No	No	In-person interviews
Elliott & Pais, 2006	1510	Random sample	Katrina survivors who sought assistance from the Red Cross	90%	One month	No	No	Telephone interviews
Fischer *et al.*, 1995	83	All households in the study area approached	Households in 2 affected neighborhoods	53%	3 months	No	No	In-person interviews
Fu *et al.*, 2007	1887	Not reported	SC residents	Not reported	Not reported	No	No	Telephone interviews
	135	Not reported	Households in 6 parishes who provided information regarding evacuation notices	Not reported	Not reported	No	No	Not reported
Gray-Graves, Turner, & Swan, 2011	765	Not reported	Older adults (age 60+) at 30 senior centers within 7 counties in OK	Not reported	N/A	N/A	No	Paper-and-pencil surveys
Hasan *et al.*, 2011[e]	3200	Random sample	Households in several counties and parishes in LA, MS, AL, & FL that were in the path of Hurricane Ivan	Not reported	Not reported	No	No	Telephone interviews

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Table I. Continued

Citation	*N*	Sampling Strategy	Population Drawn	Response Rate	Time Since Disaster	Prospective?	Longitudinal?	Survey Methodology
Hasan *et al.*, 2012[e]	954	Not reported	Miami-Dade County residents who lived in or adjacent to evacuation zones	Not reported	Not reported	No	No	Not reported
	3200	Random sample	Households in several counties and parishes in LA, MS, AL, & FL that were in the path of Hurricane Ivan	Not reported	Not reported	No	No	Not reported
	811	Not reported	FL, AL, MS, and LA households who had previously participated in a survey on Hurricane Ivan	Not reported	Not reported	No	No	Not reported
He, Tiefenbacher, & Samson, 2007	376	Convenience sample	University students in the Houston metropolitan area	Not reported	N/A	N/A	No	Online surveys
Heath *et al.*, 2001	397	Random digit dialing	Households in Yuba County, CA who were under evacuation notice for flooding	46%	6 months	No	No	Telephone interviews
Horney *et al.*, 2010a[f]	570	Two-stage cluster sampling: census blocks stratified by flood zone, then census blocks within strata were randomly selected	NC residents residing in the same location as they lived during Hurricane Isabel	86.8%	5 years	No	No	In-person interviews
Horney *et al.*, 2010b[f]	570	Two-stage cluster sampling: census blocks stratified by flood zone, then census blocks within strata were randomly selected	NC residents residing in the same location as they lived during Hurricane Isabel	86.8%	5 years	No	No	In-person interviews
Huang *et al.*, 2012	562	Disproportionate stratified random sample, 200 households in each of three risk areas in Galveston and 200 in Lake Sabine	Households in the Galveston and Lake Sabine areas	39%	5 months	No	No	Mail surveys
Kang, Lindell, & Prater, 2007[g]	51	Stratified random sample of 100 drawn from each of 5 risk areas within each of 5 hurricane risk areas	Households in Vermilion and Cameron Parishes (LA) and Orange, Jefferson, and Chambers Counties (TX)	Initial surveys 24.6%; second survey 65.4%	6 months	Yes	Yes	Mail surveys

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Table I. Continued

Citation	*N*	Sampling Strategy	Population Drawn	Response Rate	Time Since Disaster	Prospective?	Longitudinal?	Survey Methodology
Kim & Oh, 2014	893	Random sample of adults from the Roper Center for Public Opinion Research	National sample	Not reported	One year post-Hurricane Katrina	No	No	Telephone interviews
Lachman, Tatsuoka, & Bonk, 1961	327	Quasi-random sample	Adult population of affected areas of Hilo, HI	Not reported	Not reported	No	No	In-person interviews
Lamb *et al.*, 2013	186	Random selection of meshblocks within and around the evacuation area	Residents of a flood-prone area of Lower Hutt, New Zealand	72%	N/A	N/A	No	Computer surveys
Lazo *et al.*, 2010	80	Not reported	Households in Miami, FL	Not reported	N/A	N/A	No	In-person interviews
Lazo *et al.*, 2015	804	Participants randomly sampled from probability-based web panel	Adult residents of Broward, Miami-Dade, and Palm Beach Counties in FL and Brazoria, Galveston, Harris, and Matagorda Counties in TX	61.6%	N/A	N/A	No	Online surveys
Lindell, Kang, & Prater, 2011[g]	507	Randomly sampled households (200 in each county)	Households in Vermilion and Cameron Parishes (LA) and Orange, Jefferson, and Chambers Counties (TX)	50.7%	6 months	No	No	Mail surveys
Lindell, Lu, & Prater, 2005[g]	507	Randomly sampled households (200 in each county)	Households in Vermilion and Cameron Parishes (LA) and Orange, Jefferson, and Chambers Counties (TX)	50.7%	6 months	No	No	Mail surveys
Lindell *et al.*, 2015	262	Systematic random sample of households within geographical areas	Households in five villages from the Western District of Tutuila, Samoa	78%	10 months	No	No	In-person interviews
Matyas *et al.*, 2011	448	Convenience sample	Tourists visiting central FL (Orlando and Pinellas Counties)	Not reported	N/A	N/A	No	Paper-and-pencil surveys
McCaffrey, Velez, & Briefel, 2013	432	Random selection within each perimeter, with oversampling within the Schultz fire evacuation zone	Individuals living within a 5-mile area around the perimeter of the Schultz (AZ) and Fourmile Canyon (CO) fires	18% (Schultz), 26% (Schultz oversample), and 16% (Fourmile Canyon)	Few months (nonspecific)	No	No	Mail surveys

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Citation	*N*	Sampling Strategy	Population Drawn	Response Rate	Time Since Disaster	Prospective?	Longitudinal?	Survey Methodology
McClure *et al.*, 2011	487	Convenience sample	Members of the National Spinal Cord Injury Database who were at least 16 and had been injured for at least 1 year and completed follow-up between October 2007 and August 2009	Not reported	N/A	N/A	No	In-person, telephone (database participants), or mail surveys
Medina & Moraca, 2016	150	Not reported	Victims of the 12/27/11 flood in Barangay Batangan, Philippines	Not reported	3 years	No	No	In-person interviews
Meyer *et al.*, 2013	356	Not reported	Residents of southern and central Florida who were members of a survey panel maintained by Knowledge Networks	Not reported	N/A	N/A	No	Online simulation
Mileti & Beck, 1975	188	Random sample of all affected households	Adult heads of households and their spouses, living in the June 9th flood plain, within the city limits of Rapid City, IA	83.3%	Not reported	No	No	Interviews (nonspecific)
Morss *et al.*, 2016	255	Random sample of addresses from census blocks containing relevant evacuation zones	Coastal Miami-Dade County, FL residents	1.5%	N/A	N/A	No	Online surveys
Mozumder *et al.*, 2008	1018	Not reported	East Mountain, NM residents	25%	N/A	N/A	No	Mail surveys
Murray-Tuite *et al.*, 2012[e]	811	Not reported	FL, AL, MS, and LA households who had previously participated in a survey on Hurricane Ivan	Not reported	Not reported	Yes	Yes	Telephone interviews
Nozawa *et al.*, 2008	481	Not reported	Residents who were issued an evacuation advisory alert at the time of the 2004 season's 23rd typhoon	17.7%	1 month	No	No	Mail surveys
Paul, 2012	277	Stratified random sampling of households from each district based on size	Cyclone Sidr victims from Bagerhat, Barguna, Patuakhali, and Pirojpur districts	Not reported	3 months	No	No	In-person interviews
Perry & Lindell, 1991	182	Probability sample	Residents of Abilene, TX who received a pre-flood warning	92.3%	Not reported	No	No	In-person interviews

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Table I. Continued

Citation	*N*	Sampling Strategy	Population Drawn	Response Rate	Time Since Disaster	Prospective?	Longitudinal?	Survey Methodology
Perry, Lindell, & Greene, 1982	110	Random sample of all eligible households	Residents of Fillmore who received warning prior to the flood	90%	Not reported	No	No	Not reported
Petrolia & Bhattacharjee, 2010[h]	531	Random selection, with greater sampling weights in coastal counties	Residents across AL, Northwest FL, Southeast LA, and MS	30%	N/A	N/A	No	Mail surveys
Petrolia, Bhattacharjee, & Hanson, 2011[h]	531	Random selection, with greater sampling weights in coastal counties	Residents across AL, Northwest FL, Southeast LA, and MS	30%	N/A	N/A	No	Mail surveys
Reininger *et al.*, 2013	3088	2-stage cluster sampling - 100 census tracts identified, 30 individuals randomly sampled from each tract	Residents of 3 hurricane-prone counties in TX	Not reported	N/A	N/A	No	In-person interviews
Riad, Norris, & Rubak, 1999	777	Quota sampling in Charleston and Savannah; not reported for Miami sample	Residents of Charleston, Savannah, & Miami for whom evacuation was required or suggested	Not reported	1 year post-Hurricane Hugo, 6 months post-Hurricane Andrew	No	No	In-person interviews
Richetti-Masterson & Horney, 2012	205	Stratified two-stage cluster sample	Residents of Beaufort County, NC	90.7%	6 weeks	No	No	In-person interviews
Rincon, Linares, & Greenberg, 2001	325	Random selection from among those present in the triage area of the ED of Miami Children's Hospital	Randomly selected caregivers of patients at Miami Children's Hospital	95.6%	7 years post-Hurricane Andrew	No	No	Mail surveys
Rosenkoetter *et al.*, 2007a	280	Convenience sample - all older adults attending noon meals at each site were invited to participate	Older residents at 5 congregate meal sites in Georgia and North Carolina	Not reported	N/A	N/A	No	Paper-and-pencil surveys
Rosenkoetter *et al.*, 2007b	139	Convenience sample - all older adults attending noon meals at each site were invited to participate	Older residents at 6 congregate meal sites in Richmond and Columbia Counties in Georgia	Not reported	N/A	No	No	Paper-and-pencil surveys

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Table I. Continued

Citation	*N*	Sampling Strategy	Population Drawn	Response Rate	Time Since Disaster	Prospective?	Longitudinal?	Survey Methodology
Rød, Botan, & Holen, 2012	382	All residents age 18 and older received questionnaires	Residents of 4 Norwegian communities under threat of rockslide and tsunami	43.6%	N/A	N/A	No	Mail surveys
Samaddar *et al.*, 2012	40	Not reported	Heads of households who experienced the 2005 Mumbai flood	Not reported	Not reported	No	No	In-person interviews
Sharma & Patt, 2011	212	Purposive convenience sampling	Residents of districts that were under evacuation order for Cyclones Fanoos and Ogni	Not reported	1 year since first cyclone, 2–3 months since second	No	No	In-person interviews
Smith & McCarty, 2013	9048	List-assisted random digit dialing	Permanent residents of Florida in August 2004; oversampling in most affected regions of the state	24.5% overall; 33.3% in most affected areas	4-10 months	No	No	Telephone interviews
Solis, Thomas, & Letson, 2010	1335	Not reported	Panel of FL households, which was part of a larger nationwide household database maintained by Survey Sampling International Inc.	13.1%	2-3 years	No	No	Online surveys
Spence *et al.*, 2007	554	Not reported	Katrina evacuees in relief centers in Cape Cod, MA; Lansing, MI; and at federal emergency aid distribution centers in TX	Not reported	A few weeks (nonspecific)	No	No	Surveys (nonspecific)
Stein *et al.*, 2010[i]	651	Random digit dialing	Residents of the Houston Metropolitan Area	24%	4-8 days	No	No	Telephone interviews
Stein *et al.*, 2013[i]	410	Random digit dialing	Residents of the Houston Metropolitan Area	35%	4-8 days	No	No	Telephone interviews
	1503	Random digit dialing	Residents of the Houston Metropolitan Area	24%	Not reported	No	No	Telephone interviews
Thiede & Brown, 2013	1019	Not reported	English-speaking adults whose pre-Katrina residences were located in FEMA-defined "affected areas"	Not reported	1 year	No	No	Not reported
Tinsley, Dillon, & Cronin, 2012[g]	507	Randomly sampled households (200 in each county)	Households in Vermilion and Cameron Parishes (LA) and Orange, Jefferson, and Chambers Counties (TX)	50.7%	6 months	No	No	Mail surveys

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Table I. Continued

Citation	*N*	Sampling Strategy	Population Drawn	Response Rate	Time Since Disaster	Prospective?	Longitudinal?	Survey Methodology
	770	Recruitment through university solicitation and Natural Hazards Center email lists	Students from a large, private, eastern university, Tulane University, and emergency managers	Not reported	N/A	N/A	No	Not reported
	236	Convenience sample	Undergraduate and graduate business students	Not reported	N/A	N/A	No	Not reported
Tobin *et al.*, 2011	61	Random sample	Households in San Pedro Benito Juárez	79% across both samples	N/A	No	No	Not reported
	139	Convenience sample	Participants from a 2000–2002 study by one of the researchers		Not reported	No	No	Not reported
Van Willigen *et al.*, 2005	852	Students from randomly selected undergraduate and graduate level courses	Students at East Carolina University	Not reported	1 month	No	No	Paper-and-pencil surveys
	309	Random digit dialing	Pitt County, NC households - college students removed	70%	1 year	No	No	Telephone interviews
Villegas *et al.*, 2012	235	Convenience sample	American tourists visiting Orange and Pinellas Counties in FL	Not reported	N/A	N/A	No	Paper-and-pencil surveys
West & Orr, 2007	785	Random digit dialing	Registered voters in RI	60%	N/A	N/A	No	Telephone interviews
Whitehead *et al.*, 2000	895	Random digit dialing	Residents of Brunswick, Carteret, Currituck, Dare, Hyde, New Hanover, Onslow, and Pender Counties (NC)	76%	5 months	No	No	Telephone interviews
Zhai & Ikeda, 2006	1259	Random selection of all affected households	Households from 3 affected communities in Japan	42%	5-8 months	No	No	Mail surveys
Zhang, Prater, & Lindell, 2004	312	Randomly selected households from each county, stratified to reflect population density differences	Residents of Cameron, Willacy, Kennedy, Kleberg, and Nueces Counties (TX)	25.7%	1 year	No	No	Mail surveys

Note: Citations that share the same superscript denote analyses conducted on the same dataset

3.1.3. Sample Size

Range of sample sizes varied greatly, from $N = 40$ in a study of flood evacuation intentions in Mumbai, India[16] to $N = 9{,}048$ in a study of Florida residents' evacuation behavior during the 2004 hurricane season.[28] Mean sample size was $N = 697.7$ ($SD = 1077.9$), or $N = 647.5$ ($SD = 611.4$) when adjusted for outliers (scores greater than two standard deviations above the mean were removed). The median sample size was $N = 428$.

3.1.4. Response Rates

Sixty percent ($N = 50$) of studies reported response rates. The mean response rate was approximately 57% and ranged from 1.5%[29] to 95.6%.[30] Over 62% ($n = 52$) reported a response rate of less than 50% or did not report a response rate at all. One study tested for potential nonresponse response bias by following up with a subsample of nonrespondents[31] and found important differences between respondents and nonrespondents in demographic makeup and in responses to questions regarding key study variables. This provides preliminary support for the notion that nonresponse bias is likely to be present in this literature when response rates are low.

3.1.5. Timing of Assessment

Four studies were longitudinal. Of these, two were prospective,[32,33] and two assessed participants at multiple times after the disaster occurred.[9,34] All others were cross-sectional. For studies of disasters that had actually occurred, time between disaster occurrence and data collection ranged from four to eight days[35,36] to seven years.[30] Eighteen studies completed assessments of evacuation behavior within three months of the disaster, 22 studies completed assessments within one year, and four studies completed assessments more than one year postdisaster.[14,30,37–39] Fourteen studies did not report information on the timings of their assessments.

3.2. Predicting Evacuation Behavior

In addition to the assessment of methodological characteristics, major findings from each paper were collected. A synthesis of these findings is presented below; summaries of the findings from each paper appear in Tables II (studies of evacuation from disasters) and III (studies of expected evacuation from future disasters).

3.2.1. Demographic Indicators

A number of demographic factors emerged as common predictors of evacuation behavior. Female gender consistently correlated with both evacuation expectations[25,29,40–43] and evacuation behavior during an actual disaster.[27,28,44,45] Older age was generally associated with decreased likelihood of evacuation,[22,40,42,46,47] although not uniformly.[24,29] White/Caucasian individuals[20,27,40,48] were most likely to actually evacuate; black individuals reported greater intent to evacuate from a future disaster,[49,50] but were less likely to evacuate in an actual disaster.[45,51] Hispanic individuals were less likely than white/Caucasians,[52] but more likely than individuals of other ethnicities,[27] to evacuate after an actual disaster.

A number of studies have reported inconsistent findings regarding the various indicators of socioeconomic status. For example, some studies found higher education to be related to evacuation behavior,[14,48,51,53] while others reported a negative correlation.[18,40] Similarly, across studies, the correlation between income and evacuation was positive,[24,42,45,48,53] negative,[9,14,22,47,54] or null.[26,33,40,55] Homeownership was often associated with failure to evacuate,[27,37,56] though not uniformly.[42]

Household size emerged as an important predictor of evacuation behavior (both evacuation decision and time to evacuation). Households with more children were most likely to evacuate[14,23,28,37,53,56,57] and to plan to evacuate from a future disaster.[24,58] However, larger households often took longer to do so than did smaller households.[13,54,56] Households with disabled members were less likely to evacuate than others.[34] Households with pets were consistently less likely than those without pets to intend to evacuate[41,50] and to report having actually evacuated.[37,57,59,60] Lack of pet carriers and owning multiple outdoor animals were reported as impediments to evacuation for pet owners; this effect was strongest for pet-owning households without children.[57]

3.2.2. Expectation for Evacuation

Only one study prospectively assessed whether expectation to evacuate was correlated with actual

Table II. Findings from Studies of Evacuation from Natural Disasters

Citation	Disaster Studied	Key Findings
Adeola, 2008	Hurricane Katrina	The persuasion of close others and duration of residency in New Orleans were positively associated with voluntary evacuation, while previous experience with hurricanes was negatively associated with evacuation.
Aguirre, 1991	Hurricane Gilbert	One-quarter of the respondents evacuated. The most cited reason for not evacuating was concern for the safety of one's belongings. Socioeconomic status and frequency of kinship visits were negatively associated with evacuation behavior.
Baker, 1979	Hurricanes Carla, Camille, & Eloise	Source of evacuation information, storm monitoring, recall of forecast information, presence or absence of prior exposure to hurricanes, knowledge about hurricanes, sex, marital status, and occupation were not significant predictors of evacuation. Expectation of damage, confidence in weather forecasting, previous evacuation behavior, shorter length of coastal residence, younger age, site characteristics (more storm exposure), and extent of neighborhood evacuation were associated with a greater likelihood of evacuation.
Bateman & Edwards, 2002	Hurricane Bonnie	Women perceived their homes to be at greater risk and were more likely to have an evacuation plan. However, men who perceived that risk were more likely to evacuate.
Brackenridge *et al.*, 2012	Hurricane Ike	78.3% evacuated. People who reported higher commitment but not high attachment to their pets had lower odds of evacuating.
Brown *et al.*, 2016	Hurricane Sandy	49% of those surveyed reported evacuation. Evacuation was higher among those who witnessed trauma related to 9/11, those who reported extensive household damage after Sandy, and those who lived on a lower floor of their building.
Charnkol & Tanaboriboon, 2006a	December 26, 2004 Indian Ocean tsunami	People with larger families, increased distance from the shore, less disaster knowledge, less education, non-homeowners, and tourists/transients were more likely to exhibit slower response patterns.
Dixit *et al.*, 2008	Hurricane Frances	Homeowners, households with more people, households in higher income brackets, and households at higher surge risk took the longest to evacuate. Having pets or children was not associated with longer response times.
Dixit, Wilmot, & Wolshon, 2012	Hurricane Andrew	The issuance of a mandatory evacuation and the time period between 6:00 a.m. and 6:00 p.m. were positively associated with risk aversion, which was positively associated with evacuation. Longer time living in LA and the time between midnight and 6:00 a.m. were negatively associated with risk aversion, which reduced the likelihood of evacuation.
Dow & Cutter, 1998	Hurricanes Bertha & Fran	There was consistency in people's decisions to evacuate for both storms. Respondents relied more on media and less on authorities' recommendations when making evacuation decisions. Individual evaluation of risk was very important in evacuation decision-making. The "Cry Wolf" hypothesis did not predict changes in warning source reliability or reasons for evacuation.
Dow & Cutter, 2000	Hurricane Floyd	64% in the evacuation zone complied with the evacuation order, but 80% agreed that calling a mandatory evacuation was the correct decision. Most had multiple past experiences with hurricanes. This population depended more heavily on personal risk perceptions than official evacuation orders.
Dow & Cutter, 2002	Hurricane Floyd	The evacuation rate was 65%. Respondents cited concerns about traffic issues as a major reason for not evacuating. These traffic problems mainly stemmed from evacuees' tendency to take multiple vehicles and all leave in one concentrated time period. The majority of respondents also traveled farther than necessary to reach shelter.
Drabek, 1969	1965 flood in Denver, CO	Families showed high degrees of skepticism across warning sources, but the least skepticism arose from warnings straight from law enforcement. Men were more likely to be skeptical of peer warnings than women. Families warned by authorities were most likely to evacuate immediately or confirm the severity of the flood. Most warnings were met with skepticism.

(Continued)

Table II. Continued

Citation	Disaster Studied	Key Findings
Drabek, 2001	2 hurricanes (Felix & Fran) and 5 1997 floods (NV, CA, & CO)	The best predictors of evacuation were risk perceptions, time leaving work and home, multiple evacuations, and conflict between work and family. Denial was the most common first reaction by employees, but risk perceptions increased over time, especially in communities that had engaged in disaster planning.
Drabek & Boggs, 1968	1965 flood in Denver, CO	The initial response of most families was one of disbelief, regardless of warning source. Families tended to evacuate as units, rather than separately. They also were likely to evacuate to the homes of other family members. Mexican-American families were more dependent on kinship ties than Anglo-American families for warning information.
Drabek & Stephenson, 1971	1965 flood in Denver, CO	Most responded as family members, not independent individuals. Warnings from officials were less descriptive and prompted more immediate evacuation behavior. Initial reactions were generally of disbelief, regardless of warning source. There were little behavioral differences between separated and intact families.
Elliott & Pais, 2006	Hurricane Katrina	70.4% of New Orleans residents and 65.8% of residents from other areas evacuated before landfall. For New Orleans residents, black ethnicity, male gender, and lower income were associated with a decreased likelihood of evacuating prior to the storm. Black ethnicity and male gender were associated with decreased likelihood of evacuating for non-New Orleans residents as well.
Fischer *et al.*, 1995	1990 fire in Ephrata, PA	Evacuation orders from community officials preceded most evacuation behavior. Orders, rather than suggestions, and multiple evacuation notices led to the most evacuation compliance. Households with children in the home evacuated more than homes without children. Households with members who considered past evacuation notices to be accurate also evacuated more.
Fu *et al.*, 2007	Hurricanes Floyd & Andrew	The model predicting evacuation was estimated on Hurricane Floyd data and tested on Hurricane Andrew data. Mandatory notices had greater effects than both voluntary notices alone and voluntary notices followed by mandatory notices. Quicker responses followed notices that were issued earlier in the day. Greater wind speeds predicted faster evacuations. Hurricanes that took closer tracks also produced faster evacuations.
Hasan *et al.*, 2011	Hurricane Ivan	Previous experience with a major hurricane resulted in a decreased likelihood of evacuation. Findings regarding children in the home were inconsistent - most households were more likely to evacuate with each additional child, but others were not. Higher income brackets and education levels increased evacuation. Mandatory evacuation orders explicitly increased evacuation, while voluntary orders did not always increase the likelihood of evacuation. Families who received orders from relatives/friends were more likely to evacuate than any other source.
Hasan *et al.*, 2012	Hurricanes Andrew, Ivan, & Katrina	Parameters estimated across hurricanes were similar. Factors predicting increased evacuation were: living in a mobile home, having more children, and receiving an evacuation notice. Factors predicting decreased evacuation were: larger household size, home ownership, living in a house with window protection, and previous hurricane experience.

(Continued)

Table II. Continued

Citation	Disaster Studied	Key Findings
Heath *et al.*, 2001	1997 flood in Yuba County, CA	Households with children were more likely to evacuate than households without. Households with pets were less likely to evacuate than households without pets, largely due to impediments to pet evacuation. Households with both pets and children were more likely to evacuate than those with only pets and no children. Age of any household member was not associated with evacuation failure.
Horney *et al.*, 2010a	Hurricane Isabel	High levels of neighborhood social cohesion, markers of territoriality, membership in church or civic organizations, volunteerism, neighbors' evacuation, and longer length of residence were associated with increased likelihood of evacuation failure.
Horney *et al.*, 2010b	Hurricane Isabel	One-half of the participants could not correctly identify the risk zone of their home. Long-term residents of stick-built homes often underestimated their flood risk. Intended evacuation from a future storm of Category 3 or higher was associated with reduced risk of evacuation failure from Hurricane Isabel.
Huang *et al.*, 2012	Hurricane Ike	Female gender, official warning messages, hurricane experience, coastal location, and environmental and social cues predicted perceived storm characteristics, which predicted expected personal impacts. Expected personal impacts and perceived evacuation impediments together predicted evacuation decisions and departure timing, consistent with the Protective Action Decision Model.
Kang, Lindell, & Prater, 2007	Hurricane Lili	68% of the respondents behaved in their expected way when faced with a hurricane evacuation situation. Expectations and behavior were only moderately correlated. Evacuees took significantly less time to evacuate than they expected. Expected and actual evacuation modes were strongly correlated. Most did not evacuate to the destination they originally expected, however, people generally stayed in the type of accommodations they expected.
Lachman, Tatsuoka, & Bonk, 1961	1960 Hawaiian tsunami	The 291 individuals who heard the siren attributed many different meanings to the sound (warning, alert, evacuation signal, etc.). The most common information source was radio/TV.
Lindell, Kang, & Prater, 2011	Hurricane Lili	Most evacuees left on the day or day after the warning was issued. Most households took their own vehicles, and rode in more than one car. Most stayed with family or friends. Evacuees depend more on previous experience and familiarity with the evacuation route than on recommendations by officials.
Lindell, Lu, & Prater, 2005	Hurricane Lili	53.6% of respondents evacuated. Local news media was most often relied upon. Environmental cues and previous hurricane experience were the most considered among evacuation issues. Evacuation decisions were strongly correlated with geographic characteristics and time of day. Personal experience and evacuation impediments were not significantly correlated with evacuation decisions.

(Continued)

Table II. Continued

Citation	Disaster Studied	Key Findings
Lindell *et al.*, 2015	2009 Samoan earthquake and tsunami	66.1% of respondents evacuated prior to the tsunami. Evacuation was negatively correlated with community tenure, but recommended elements of the warning messages were not.
McCaffrey, Velez, & Briefel, 2013	Schultz (AZ) & Fourmile Canyon (CO) fires	Evacuees accessed more information sources, and had a higher desire for information on evacuation, road closures, protecting homes, and wildfire recovery than nonevacuees.
Medina & Moraca, 2016	2011 flood in Barangay Batangan, Philippines	66% of the sample evacuated. College education, presence of children in the home, poverty, and extent of flood experienced were significant predictors of evacuation decisions.
Mileti & Beck, 1975	1972 flood in Rapid City, SD	Warnings received over the media, rather than in person, increased the likelihood that a person would evacuate. Warning confirmation was a strong predictor of warning belief. Warning content was only an important predictor of evacuation during the first warning, not during subsequent warnings. In the fourth warning, person-specific warnings had significant predictive value.
Murray-Tuite *et al.*, 2012	Hurricanes Katrina and Ivan	Citizens were likely to make the same evacuation decision for Hurricane Katrina that they did for Hurricane Ivan. Increased incomes did not change a person's evacuation decision from one storm to the next. Most evacuees also chose the same accommodations and made the same within-outside county/parish decisions as in the first storm, and took the same number of vehicles.
Nozawa *et al.*, 2008	2004 season's 23rd typhoon	Evacuees left because they perceived their situation as dangerous, while nonevacuees stayed because they did not perceive danger.
Paul, 2012	Cyclone Sidr	Trust in warnings positively predicted evacuation behavior, and distance to the nearest shelter and level of education negatively predicted evacuation behavior.
Perry & Lindell, 1991	Flood in Abilene, TX	Ethnicity and income were not significantly associated with evacuation compliance. Perceived risk was most highly predictive of evacuation, followed by warning confirmation, source credibility, and adaptive planning. Whites placed the most confidence in mass media, blacks in local authority figures, and Mexican-Americans in social contacts.
Perry, Lindell, & Greene, 1982	Flood in Fillmore, CA	Mexican-Americans were more skeptical of warning messages than whites, and reported those same messages as indicating a lesser degree of risk than did whites. Mexican-Americans were also less likely to evacuate than whites.
Riad, Norris, & Rubak, 1999	Hurricanes Hugo & Andrew	Prior evacuation behavior, Latino and white ethnicity, female gender, social support, risk of damage, not being a homeowner, being the only adult in the home, and being a short-term resident were all associated with evacuation behavior. Non-perception of threat, belief in the safety of one's home, inadequate resources for evacuation, and desire to protect one's home were the most common reasons given for nonevacuation. 58% of respondents did not evacuate.
Richetti-Masterson & Horney, 2012	Hurricane Irene	Effect measure modification was present for households with high social capital or social cohesion among special needs residents, those over age 65, males, and non-whites.
Sharma & Patt, 2011	Cyclones Fanoos & Ogni	Past community deaths, past experience with cyclone occurrence, and the quality of the stay at a shelter were positively associated with evacuation compliance. The number of times one had evacuated for previous cyclones was not significant in the full model.
Smith & McCarty, 2013	2004 US hurricane season	25% of those surveyed evacuated prior to at least one hurricane in 2004. The southeast region, which was affected by multiple hurricanes, had evacuation rates of 53% evacuating once and 31% evacuating twice. Of those who failed to evacuate, the modal reason was a belief that they could "ride out the storm." Hurricane strength, living in a mobile home, having children in the home, and female gender were associated with an increased likelihood of evacuation.

(Continued)

Table II. Continued

Citation	Disaster Studied	Key Findings
Solis, Thomas, & Letson, 2010	2005 US hurricane season	Households living in risky environments (mobile home and flooding areas), households with children, and those who had experienced the threat of a hurricane were more likely to evacuate. Homeowners and households with pets were less likely to evacuate.
Spence *et al.*, 2007	Hurricane Katrina	Older evacuees, those in higher income brackets, African-Americans, and the disabled were less likely to have an emergency supply kit or an evacuation plan. The disabled were less likely to place importance on information concerning the amount of damage, government response, rescue operations, the larger impact of the storm, who else was affected, and friends and family. Television was the primary source of information.
Stein *et al.*, 2010	Hurricane Rita	59% evacuated, including 75% of those residing in an evacuation zone. Perceived risk from wind, influence of media and neighbors, and awareness of evacuation zone all predicted evacuation decisions. Sociodemographic variables did not predict evacuation behaviors.
Stein *et al.*, 2013	Hurricanes Ike & Rita	Perceived risk for hurricanes can be summarized by a composite index of general perception of risk severity. This composite measure can predict evacuation compliance better than neighbor evacuation, reliance on media, and knowledge of the evacuation status of one's area.
Thiede & Brown, 2013	Hurricane Katrina	Black and low-education respondents were least likely to evacuate prior to the storm, and among non-evacuees, most likely to have been unable to evacuate.
Tinsley, Dillon, & Cronin, 2012	Hurricane Lili	Geographic proximity, social cues, and sight of storm conditions (but not prior hurricane experience) positively predicted evacuation. Prior near-miss evacuations negatively predicted evacuation.
Tobin *et al.*, 2011	Popocatépetl eruptions & 1999 flood/mudslide event in Teziutlán	In Teziutlán, higher posttraumatic stress and physical health symptoms predicted evacuation plans, while in San Pedro Benito Juárez, negative affect predicted evacuation plans. The main predictors of evacuation in San Pedro Benito Juárez were prior evacuation and risk perception. This relationship existed at the chronic hazard site, but was not significant at the acute hazard site. Both sites showed an increased likelihood of evacuation when family members encouraged it.
Van Willigen *et al.*, 2002	Hurricanes Bonnie, Dennis, & Floyd	Households with physically disabled members were less likely to evacuate than those without, often due to a perceived lack of services and assistance outside of the home.
Van Willigen *et al.*, 2005	Hurricane Floyd	Students were more likely to evacuate than were members of the community. This mirrored the pattern of evacuation among young members of the community, who were more likely to evacuate than were older community members. Predictors of increased likelihood of evacuation included black ethnicity, having children, lower income, and younger age.
Whitehead *et al.*, 2000	Hurricane Bonnie & hypothetical future hurricane	The single most important predictor for evacuation was storm intensity. Households were more likely to evacuate when given evacuation orders, when they perceived a flood risk, and when they lived in mobile homes. Households with pets were less likely to evacuate.
Zhai & Ikeda, 2006	Niigat-Fukushima flood, Fukui flood, & Typhoon No. 23	56% of those who evacuated reported inconvenience. The greatest inconveniences were the shortages of information and food. The willingness to pay for avoiding current inconvenience was approximately half of the estimated economic value of evacuation.
Zhang, Prater, & Lindell, 2004	Hurricane Bret	Actual risk area and reported risk area were correlated. Accuracy was correlated with income and length of coastal residence. Overestimation was negatively correlated with income, education level, and risk education. White ethnicity, homeownership, and risk area accuracy significantly predicted evacuation.

Table III. Findings from Studies of Expected Evacuation from Future Disasters

Citation	Disaster Studied	Key Findings
Arlikatti *et al.*, 2006	Future hurricane	Only 36% of participants correctly identified their risk area; however, risk area accuracy was not significantly related to evacuation expectations. Rather, storm context and previous storm experience predicted evacuation expectancy.
Baker, 1995	Future hurricane	Evacuation notices from local officials were the most likely of all threat variables to influence evacuation. This effect was not moderated by the inclusion of hurricane probabilities.
Bird, Gísladóttir, & Dominey-Howe, 2011	Future volcano eruption	All rural and most urban residents had accurate knowledge of the volcano and of the warning systems and response plan to be put in place. Urban residents were more trusting of the evacuation plan than rural residents, who were more inclined to personally assess their risk before making evacuation decisions.
Burnside, 2006	Future hurricane	Race and income were not significant predictors of evacuation. Greater evacuation likelihood was associated with getting one's information from public officials, specifics of the storm, greater risk perceptions, and previous evacuation behavior.
Burnside, Miller, & Rivera, 2007	Future hurricane	The following variables positively predicted evacuation expectancy: warnings received from officials and family, seeing images of storm damages, having evacuated from a previous storm, having an evacuation plan, and perceived storm risk.
Cahyanto *et al.*, 2014	Future hurricane	Those with low connectedness and knowledge about hurricanes, no past hurricane experience, who were traveling with a larger party including children, first time travelers, traveling by plane and personal vehicle, older in age, female, and with an income more than $125,000 were more likely to evacuate.
Cahyanto & Pennington-Gray, 2014	Future hurricane	Gender, residence, and past experience with hurricanes significantly influenced tourists' perceptions of the credibility of information sources and information search behaviors, which was associated with a voluntary evacuation decision.
Charnkol & Tanaboriboon, 2006b	Future tsunami	Transient residents were more likely to evacuate faster than permanent residents. Those who lived closer to the shore, had personal tsunami experience, had smaller families, and had tsunami knowledge were also likely to evacuate faster.
Christensen, Richey, & Castañeda, 2013	Future hurricane	Predictors of dyad evacuation for a Category 1–3 hurricane included (1) a younger age of the person with an Alzheimer's Disease or related disorder (ADRD) diagnosis, (2) the caregiver living in a different residence than the person with ADRD, (3) lack of hurricane shutters, and (4) lower income. A dyad was more likely to evacuate in a Category 4 or 5 hurricane if there was (1) a younger age person with an ADRD diagnosis, (2) a more recent ADRD diagnosis, (3) a residence in an evacuation zone, and if (4) they needed a shelter.
Gray-Graves, Turner, & Swan, 2011	N/A	Older adults were most likely to comply with evacuation orders from (1) fire department, (2) military/National Guard, and (3) law enforcement officials. Overall compliance was around 80% for most official sources. Projected compliance was higher for mandatory than for voluntary evacuations.

(Continued)

Table III. Continued

Citation	Disaster Studied	Key Findings
He, Tiefenbacher,& Samson, 2007	Future hurricane	The likelihood of evacuation under voluntary order correlated positively with international and domestic students' evacuation intentions and environmental familiarity. Past disaster and evacuation experiences contributed only to international students' evacuation certainty. Experiences with false alarms determined domestic students' certainty more than international students' certainty. Evacuation experiences associated with Hurricane Rita increased all students' certainty of future hurricane evacuation.
Lamb *et al.*, 2013	Simulated flood event	Nearly 75% of shadow evacuation resulted from the incorrect identification of evacuation area. The authoritativeness of the message and message content did not predict evacuation. Respondents indicated the highest trust in evacuation information coming from the highest role within Civil Defense and Emergency Management, the second highest coming from local police.
Lazo *et al.*, 2010	Future hurricane	The only significant barrier to evacuation was reluctance to leave property unprotected. Prior experience with hurricanes was not associated with evacuation intention. Hurricane intention was an important predictor of evacuation intention.
Lazo *et al.*, 2015	Future hurricane	Having an evacuation plan, wanting to keep one's family safe, and viewing one's home as vulnerable to wind damage predicted increased evacuation intentions when under an evacuation order and when a hurricane was forecasted. Evacuation intentions decreased with age in the evacuation order condition but increased in the forecast condition.
Matyas *et al.*, 2011	Future hurricane	Participants with no previous hurricane experience, a trip length of fewer than 6 days, and who had considered hurricane forecasts before traveling were most likely to intend to evacuate. The most risky and evacuation-inducing scenario involved a Category 4 Hurricane making landfall along the Gulf Coast with the centerline passing over the sampling site. Tourists were likely to misinterpret the forecast scenarios, which was associated with a decreased likelihood of evacuation.
McClure *et al.*, 2011	Future hurricane	There was a large discrepancy between feelings of being able to evacuate and actually having a plan for evacuation. Younger white males were more likely to feel able to evacuate and to have an evacuation plan.
Meyer *et al.*, 2013	Simulated hurricane	Intentions to evacuate did not generally emerge until actual warnings were issued. Objective threat, prior experience, and demographics all impacted preparatory action both directly and through risk perceptions. Predictors of evacuation were concern over the storm, younger age, female gender, home ownership, and having a larger home.
Morss *et al.*, 2016	Future hurricane	Evacuation intentions were higher among females, older people, Hispanics, individuals who knew their evacuation zone, individuals with prior evacuation experience, and those who received information about potential storm impacts. Evacuation intentions were lower among those with greater individualistic worldviews, which was also associated with reduced risk perceptions.
Mozumder *et al.*, 2008	Future wildfire	The predicted probability of intended evacuation ranged from 46%-48% under a voluntary evacuation order and from 75%-77% under a mandatory evacuation order. Concern about damage to one's home, the experience of past property damage, female gender, Democratic party affiliation, and the expectation of staying with friends or in a hotel were all associated with increased probability of evacuation. Pet/livestock ownership was associated with decreased probability of evacuation. Respondents who highly rated the risk of fire were more likely to be concerned over fire damage, which also increased their likelihood of evacuation.

(Continued)

Table III. Continued

Citation	Disaster Studied	Key Findings
Petrolia & Bhattacharjee, 2010	Future hurricane	Mandatory evacuation notice and higher wind speeds had the greatest effect on probability of evacuation. Additionally, blacks, those who evacuated for Hurricane Katrina, the disabled, mobile home residents, and those who already had an evacuation destination in mind were more likely to intend to evacuate. Those with pets were less likely to intend to evacuate.
Petrolia, Bhattacharjee, & Hanson, 2011	Future hurricane	Wind speed and landfall time were the only two significant storm forecast attributes that predicted evacuation when accounting for heterogeneity in response to storm attributes.
Reininger *et al.*, 2013	Future hurricane	92.6% of those sampled intended to comply with evacuation procedures in a mandatory evacuation. Income was not an important predictor of intent to evacuate. Younger age, female gender, white ethnicity, having a high school education, and proximity to the shoreline were all associated with increased likelihood of evacuation. Having more education was associated with a decreased likelihood of evacuation.
Rincon, Linares, & Greenberg, 2001	Future hurricane	Both those with prior hurricane experience and those without showed high willingness to evacuate in the case of a future hurricane with a mandatory evacuation order.
Rosenkoetter *et al.*, 2007a	Future hurricane	Gender was not a significant predictor of evacuation expectations; however, influence from Hurricane Katrina and intention to follow the advice of county officials significantly predicted evacuation expectations.
Rosenkoetter *et al.*, 2007b	Future hurricane	80% reported that stories of Hurricane Katrina had led them to be more likely than they previously were to evacuate from a future storm. 70% reported they would "definitely" evacuate from a future storm if they were told to leave. Female gender and black ethnicity were associated with willingness to evacuate. Trust and confidence in county officials and the media were the strongest predictors of willingness to evacuate.
Rød, Botan, & Holen, 2012	Imminent rockslide & tsunami	Trust in experts, finding risk information useful, a university degree, and living in an area with disaster history were associated with reporting a willingness to evacuate prior to a natural disaster. Trust in experts was the strongest predictor.
Samaddar *et al.*, 2012	Future flood	Individuals who were high in "outcome efficacy" and self-efficacy were more likely to intend to evacuate. No other factors were statistically significant.
Tinsley, Dillon, & Cronin, 2012	Future hurricane	People were less likely to evacuate when provided with near miss information. People with vulnerable near miss information that highlighted how a disaster almost happened were more likely to evacuate. Resilient near miss events were associated with lessened perceptions of risk, which in turn led to decreased evacuation.
Villegas *et al.*, 2012	Future hurricane	Risk was strongly influenced by the projected category of the hurricane at landfall, while fear was not. Risk and fear both positively influenced evacuation likelihood.
West & Orr, 2007	Future hurricane	Having children at home, living near the coast, and evacuation orders from the media and government (not from US Weather Service or friends/relatives) were associated with an increased likelihood of expected evacuation. When vulnerability was included in the model, these relationships did not change; however, age also became a significant predictor of evacuation expectations. Vulnerability did not predict evacuation expectancy.

behavior. Kang *et al.*[32] assessed whether evacuation expectations prior to Hurricane Lili were predictive of actual storm evacuation; 68% of participants reported congruence between their intent to evacuate (expected behavior) and actual evacuation behavior (65% of evacuees and 80% of nonevacuees).

3.2.3. Having a Plan

Several studies assessed the link between plan making and postdisaster evacuation behaviors retrospectively. Female gender,[61] younger age, lower income, nonblack race,[49] higher posttraumatic stress, physical health symptoms, and negative affect[8] were all significantly associated with reports of having had an evacuation plan prior to a disaster. Having an evacuation plan was also associated with expectations for future evacuation;[62] however, this variable was more often used to predict actual evacuation behavior. It has not yet been assessed whether having a plan prospectively predicts evacuation behavior.

3.2.4. Type of Government Evacuation Order

The type of evacuation order issued by the government often emerged as a statistically significant predictor of evacuation behavior and expectation to evacuate. People consistently reported greater evacuation behavior and expectation to evacuate given a mandatory evacuation order compared to a voluntary evacuation notice. This relationship was robust in both studies of hypothetical[30,40,41,50,61] and actual evacuation behavior.[53,63,64] This relationship appeared to be stronger for women than for men.[59,65]

3.2.5. Length of Residence in At-Risk Area

Length of residence in an at-risk area was inconsistently related to the likelihood of evacuating. In general, a longer duration of residence in an at-risk area was associated with reduced likelihood of evacuation,[27,29,38,39,46,54,66] and decreases in perceptions of risk.[39,63] However, increased duration of residence in an at-risk area was also associated with an increased ability to identify risk zones (i.e., the predefined geographic risk area for each category of a hurricane) on a map,[48] which was associated with an *increased* likelihood of evacuation.[36,48] This suggests a more complicated relationship between length of residence and evacuation behavior than has been previously hypothesized.

3.2.6. Previous Disaster Experiences

Many studies assessed whether a person had previously experienced a similar disaster as a predictor of future evacuation intentions and behavior, but these results were inconsistent. Various studies found previous experience with disasters to be negatively,[24,53,56,67,68] positively,[17,37,44,69–71] and not at all[30,72–74] associated with evacuation. Several moderators emerged that may qualify these findings. Mozumder *et al.*[41] found that property damage in a past wildfire increased intentions to evacuate before a future wildfire. In a related vein, Tinsley *et al.*[73] found that experiencing a near-miss event (i.e., expecting that an event would occur when it did not) was associated with decreased perceptions of risk and a decreased likelihood of both expected and reported evacuation.

Prior evacuation behavior was a robust predictor of future evacuation behavior. Murray-Tuite *et al.*[33] assessed this prospectively and found that 70% of respondents reported congruent evacuation behaviors during Hurricanes Ivan in 2004 and Katrina in 2005. Moreover, respondents who evacuated from Ivan were nearly six times as likely to evacuate during Katrina as those who did not evacuate previously.[33] Studies using retrospective reports reported similar behavioral consistency. Evacuating before a prior storm was associated with intention to evacuate a future storm,[29,50,55,62,75] and with actual evacuation behavior,[8,27,46] although, conversely, one study found the number of previous evacuations did not significantly predict subsequent evacuation.[17]

3.2.7. Warning Sources

Source of evacuation warning also emerged as a common predictor of evacuation behavior, though this was moderated by the perceived trustworthiness of the source and the recipient's ethnicity. Information received directly from community officials such as law enforcement officers was most often likely to result in evacuation[23,44,76,77] or evacuation expectancy.[19,55,58,61,62,78,79] Peers, friends or family members,[53,67] and the media[49,72,80–82] were also reported as potential disaster warning information sources that resulted in evacuation behavior. Community officials were often seen as the most trustworthy source of information, and this trustworthiness was associated with increased compliance with evacuation orders.[10,18,25] Ethnic differences emerged as moderating factors: Hispanic individuals

were most trusting of information received from family,[26,83] while white/Caucasian individuals were most trusting of media, and black individuals were most trusting of local authority figures.[26]

3.2.8. Psychological Predictors

Very few studies have included psychological constructs as possible predictors of evacuation behavior. One study examined self-efficacy and found it was one of the most important predictors of intentions to evacuate from a future flood.[16] Another study included neuroticism among its predictors, but did not find a significant relationship with evacuation behavior.[10] Beyond these two studies, however, psychological constructs have been unrepresented in the published literature.

3.2.9. Risk

Subjective and objective assessments of risk were frequently examined as potential predictors of evacuation behavior ($n = 22$ studies). Individuals reported greater intention to evacuate under threat of a larger or more intense disaster, such as a higher category hurricane.[47,68,84] Individuals more objectively vulnerable to a disaster were also more likely to evacuate. For example, during a hurricane warning, individuals who reported living closer to the shoreline evacuated more quickly than those farther away,[69] as did individuals who reported living on a lower floor of their buildings.[85] Individuals who reported sustaining a great deal of damage to their homes also were more likely to report having evacuated prior to a hurricane.[85] Similarly, residents of mobile homes, which are at greater risk for destruction than are other types of residences, were also more likely to evacuate from hurricane threat.[28,37,56,59] Conversely, individuals living in homes with hurricane-resistant window coverings were less likely to evacuate.[56] Subjective perceptions of risk were very consistently correlated with evacuation behavior,[8,26,35,36,42,52,59,86] sometimes over and above the impact of official evacuation orders.[87] However, predictors of these risk perceptions were infrequently examined. Two studies found that both the category of a hurricane at landfall[84] and female gender[88] were important predictors of risk perceptions that related to evacuation. However, no other investigations included in this review examined perceptions of risk as a potential mediator of evacuation decision making.

4. DISCUSSION

Over the past five decades, researchers have sought to explore factors that help explain evacuation behavior prior to a natural disaster. Researchers have studied a wide array of predictors, and this literature has been published in a variety of academic outlets. The present review is among the first in recent years[3] to synthesize these findings and present them in a systematic way. A substantial sum of knowledge regarding factors that facilitate and impede evacuation behavior has been accumulated, yet methodological limitations may preclude strong inferences.

Several factors consistently emerged as predictors of evacuation behavior within this literature. Female gender, younger age, and white ethnicity were demographic factors most commonly associated with evacuation. The presence of children in the home was also associated with increased evacuation, while the presence of pets was associated with decreased evacuation behavior. Risk assessments emerged as one of the most robust predictors of evacuation behavior, with strong and positive relationships appearing consistently across studies. Moreover, factors that are often associated with increased risk assessments (e.g., stronger storms, the possibility of putting one's children in danger, or a more credible warning source) also increased evacuation, while factors that are associated with reduced risk assessments (e.g., faith in the strength of one's home, or near-miss experiences) resulted in failure to evacuate. These risk factors for evacuation failure can provide vital information on potential points of intervention for evacuation messaging. For example, findings about the ways in which specific age or ethnic groups react to different sources of evacuation information can be used to target those groups using types of messaging that are more likely to influence their behavior.[26,83]

This review also highlights areas of evacuation behavior research that are not well understood. Importantly, it is unclear whether self-reported expectations or plans for evacuation in a hypothetical future storm is a valid or reliable predictor of actual evacuation behavior. Only one study assessed this prospectively, and found that a majority of participants had congruent intentions and actions.[32] However, this study was conducted in a small sample ($n = 51$) with a poor initial response rate (24.6% participation

[3] See Ref. 102 for a recent review and meta-analysis of the literature specific to hurricane evacuations. See Refs. 103,104 for prior reviews of the evacuation literature.

at the initial survey; 65.4% retention at follow-up). Thus, it would be premature to conclude that evacuation expectations accurately predict evacuation behavior without further investigation. Also, studies of international populations (n=12, 14.5%) are far less common than those conducted in the United States. Given that findings from industrialized samples often do not reliably predict behavior in other nations,[89] more research is needed in these other populations to better understand the differences in their evacuation behavior.

Several key methodological limitations in the current literature emerged. Specific sample and methodological characteristics were frequently absent from methods sections, inhibiting a comprehensive understanding of study designs and limiting opportunities for replication. Of course, such information could easily be incorporated into future manuscripts. Although postdisaster evaluations present inherent challenges (e.g., difficulty predicting when and where a disaster will occur, obtaining rapid funding and university ethics board approval, accessing distressed and mobile populations), future studies should attempt more stringent designs. Sampling strategy, data collection methodology, and response rates have important implications for sample composition and, ultimately, the generalizability of findings. For example, nonprobability sampling methods can often lead to biased samples, certain survey methodologies (e.g., mail[90] and telephone surveys[91]) often produce lower initial response rates and more costly follow-ups, and low response rates can indicate important differences between respondents and nonrespondents. Retrospective reports can be problematic, as human memory can be biased by situational factors (e.g., information presented during retrieval[92]) and can be impaired over time.[93] Interdisciplinary collaborations between risk experts and survey researchers might help address some of these limitations, enabling assessments of predisaster responses. Finally, designing studies in advance that incorporate concrete strategies for obtaining acute assessments would allow for an examination of how initial behavior and responses predict outcomes over time.

4.1. Limitations of Review

The present review has several limitations. Although we intended to conduct a comprehensive review, it is possible that some studies were inadvertently omitted, particularly due to the multidisciplinary nature of publication outlets for this literature. However, the three-step search process makes it unlikely that many studies were missed. We made the decision to exclude both qualitative research and theoretical modeling research from the present review, so there is some work on the topic of evacuation that is not represented in this article. Qualitative research was excluded due to the lack of explicit independent and dependent variables for tests of presence and relative strength of association; theoretical modeling work was excluded due to the absence of human subjects. However, although relatively smaller than the body of work we reviewed here, some of this work can also contribute to our understanding of evacuation behavior, and might be of interest to future researchers.[94–96]

Our review included studies from a variety of countries exploring disparate disasters, but our decision only to include reports published in English may have underrepresented cultural differences that may influence evacuation behavior. Given that such factors as conformity,[97] self-reliance,[98] and adherence to instructions from authority figures[99] vary across cultures, perhaps compliance with both mandatory and voluntary evacuation orders differs between cultures as well. Moreover, collapsing across disaster type may mask existing differences. For example, varying predisaster time intervals among different types of events (e.g., hurricanes have more warning time than flash floods) may influence evacuation behavior. If events that provide greater or less warning time were perceived as differentially risky, this would result in varying evacuation behavior across these events, which may have impacted our findings. This question warrants future study.

4.2. Implications for Future Research

This review highlights a number of areas that should be targeted by future research on evacuation behavior. First, researchers should link individuals' predictions of their behavior with their actual behavior using prospective designs. While these designs are expensive and can be time consuming to conduct, obtaining predisaster data from at-risk communities lessens the degree to which participants' responses regarding evacuation intentions and decisions will be impacted by their subsequent evacuation experience. For example, individuals who successfully evacuate prior to a disaster may remember their original intentions differently from those who experience some barrier to evacuation and are unable to leave. Prospective designs are the only sure way to protect

against this memory bias. Prospective designs would also provide a much needed link between studies that examine evacuation intentions and those that examine more explicit behavior. Future research is required to explicate this link longitudinally.

The role of prior exposure to natural disasters in predicting future evacuation is also unclear. Prior studies on this topic have produced inconsistent evidence. As noted in Section 3.2.6, some suggest that prior disaster experiences predict greater likelihood of evacuation, while others suggest the opposite. Divergent appraisals of prior experiences (e.g., appraisal of prior evacuation as helpful or unnecessary) may lead to different future responses, yet these appraisals typically have not been assessed. More nuanced features of one's prior natural disaster experiences may better predict evacuation outcomes. For example, experiencing storm-related property damage is related to increased evacuation expectations,[41] but most studies do not take this into account when addressing the impact of prior storm experiences. More information on past storm experiences should be collected in future studies.

Psychological variables have also been largely unexplored as predictors of evacuation behavior. Self-efficacy has been consistently associated with disaster preparation behaviors,[100] and may likely predict evacuation behavior, especially given that it has been correlated with intent to evacuate.[16] Other constructs, such as personality, social support,[101] and hazard-related anxiety,[100] have been linked to disaster preparatory behavior, and likely also predict evacuation. These constructs should be included in future studies and provide an important opportunity for increased involvement from psychologists in this literature. Moreover, given the vast amount of psychological research on persuasion and behavior change that can be applied to this topic (e.g., choice architecture), there are ample opportunities for psychologists to apply constructs from the behavioral sciences to evacuation research in the future.

More nuanced statistical approaches could provide additional information useful in designing more effective interventions. Many studies examined unidirectional effects with a limited inclusion of predictors, rather than considering the more complex interrelations among the predictors of evacuation. Future studies should further explore possible mediating mechanisms, such as the possible role of risk perceptions as a path between evacuation behavior and other factors, such as storm strength and message content. Clarification of factors that reliably influence evacuation behavior by affecting risk perceptions can inform targeted warning messages that will have a greater impact on evacuation behavior in times of disaster.[29] Increased knowledge of the moderating effects of various social and demographic variables (e.g., previous experience, racial/ethnic background, socioeconomic status) will elucidate more effective points of intervention for groups that are currently less likely to evacuate. This can help shape policies set in place by emergency planning and management officials. Natural disasters will continue to pose considerable risk for those in their path. Knowledge gained from the continued study of evacuation from these events can increase our capacity to more effectively communicate risks and encourage life-saving evacuation policies and behaviors.

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