

Factors Associated with the Climate Change Vulnerability and the Adaptive Capacity of People with Disability: A Systematic Review

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(Manuscript received 20 November 2016, in final form 18 May 2017)

ABSTRACT

People with disability experience multidimensional inequalities, which heighten their vulnerability to climate change. An understanding of the vulnerability and adaptive capacity of people with disability can be gained through considering how they have fared during the types of events associated with climate change, such as droughts, floods, heat waves, hurricanes, and wildfires. A systematic review was conducted to identify factors associated with climate change vulnerability and adaptive capacity of people with disability. Papers were sourced from 12 electronic databases, the Google search engine, the websites of 21 organizations, and the reference lists of included papers; 34 papers (relating to 28 studies) met the selection criteria. Most studies were located in the United States, and almost half were focused on hurricane events. Factors contributing to vulnerability included personal factors (e.g., female gender, uncoupled or living alone, nonwhite ethnicity, and low income), environmental factors (commonly, limited practical support from government agencies and disability organizations), bodily impairments (cognitive impairments, hearing impairments, progression of impairments, relapse/exacerbation of symptoms, and thermoregulation difficulties), and activity limitations and participation restrictions (limited preparedness, difficulties with evacuation, and difficulties reassembling individual accommodations and repairing or replacing adaptive equipment). Factors relating to their adaptive capacity included personal factors (e.g., formal education), environmental factors (practical support from mainstream organizations, disability organizations, family, and friends), and activities and participation (emergency planning, keeping an emergency pack, and seeking information). People with disability are vulnerable to climate change largely due to inequalities and their exclusion from adaptation and mitigation efforts.

1. Introduction

Climate change presents an immense risk to the health and well-being of the global human population (Costello et al. 2009). People who experience cultural, economic, institutional, political, social, or other types of marginalization are particularly vulnerable to climate change (IPCC 2014). The non-climate-related challenges these people face reduces their resilience to climate change and can also impair their adaption and mitigation responses, with scarce resources being deployed among competing needs. Disability is one of the factors that increases vulnerability and exposure to

climate change (Cardona et al. 2012). With disability disproportionately affecting already vulnerable populations [people from lower income countries, older adults, poorly educated persons, low income earners, unemployed persons, and children from poorer households and those in ethnic minority groups; World Health Organization (WHO) 2011], people with disability are especially at risk of the direct and indirect effects of climate change.

Many of the changes to the climate system in the latter half of the twentieth century are unprecedented (IPCC 2013). Observed trends include the warming atmosphere and oceans; shrinking glaciers and ice sheets; reducing spring snow cover in the Northern Hemisphere; rising sea levels; increasing frequency, duration,

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DOI: 10.1175/WCAS-D-16-0126.1

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and intensity of extreme weather and climate events; rising atmospheric concentrations of carbon dioxide, methane, and nitrous oxide; and increasing ocean acidification through absorption of emitted anthropogenic carbon dioxide. With continued emissions of greenhouse gases, these trends are projected to continue during the twenty-first century.

Climate change also poses increased risks for human health (Smith et al. 2014). In the near term (about midcentury), adverse impacts on health are anticipated from more frequent and intense heatwaves and wildfires (increasing risks of disease, injury, and mortality), higher temperatures (increasing mortality and having health consequences for vulnerable populations due to compromised work capacity and lower labor productivity), decreased food production in poorer regions (increasing the risk of undernutrition), and greater spread of food-, water-, and vectorborne diseases (increasing infections). Climate change mainly affects human health through the exacerbation of existing health conditions, which means the most vulnerable are those with the weakest health protection systems and least adaptive capacity.

Over 1 billion people are estimated to live with disability, of whom almost 200 million experience substantial challenges in daily functioning (WHO 2011). Their heightened vulnerability to climate change, and the consequential impacts of climate-related extremes, is partially demonstrable through higher mortality rates of people with disability during natural disasters and extreme weather events (Bouchama et al. 2007; Cabinet Office 2013; Chou et al. 2004). During heatwaves, for example, people with preexisting psychiatric conditions and those who are unable to adequately care for themselves have substantially increased risk of mortality (Bouchama et al. 2007). Some people with psychiatric conditions have compromised thermoregulation, which may be due to a combination of their underlying disorders, the effects of medications, impaired judgement, and social factors (Bouchama et al. 2007; Cheshire 2016; Chong and Castle 2004).

Understanding the factors that may change the vulnerability and adaptive capacity of people with disability to climate change requires the consideration of disability from a biopsychosocial perspective [e.g., International Classification of Functioning, Disability and Health (ICF); WHO 2002]. Within the ICF, functioning and disability are conceptualized as the outcome of interactions between health conditions and contextual factors (both personal and environmental). Applied to climate change, such an approach encourages the exploration of the health conditions (diseases, disorders, and injuries), personal factors (e.g., gender, age, social

background, education, and past experiences), and environmental factors (e.g., social attitudes and the characteristics of built and natural environments) that may contribute to vulnerability and adaptive capacity. The focus on contextual factors is particularly pertinent because, like other marginalized populations, many people with disability experience social factors that lead to multidimensional inequalities and exposure (IPCC 2014). For people with disability, such inequalities are evident, for example, in income, employment, education, health, housing, nutrition, age, ethnicity, and community participation [Organisation for Economic Co-operation and Development (OECD) 2010; WHO 2011].

Despite composing about 15% of the world's population (WHO 2011), representations of the interests of people with disabilities are comparatively absent from climate change discourses (see, e.g., Boon et al. 2011; Polack 2008; Wolbring 2009, 2011). Nevertheless, the disproportional effects of changes within the natural environment on people with disability form compelling reasons why their perspectives and interests need more prominent places in climate change debates. To this end, we conducted a systematic review of factors associated with climate change vulnerability and adaptive capacity of people with disability. Specifically, we considered the vulnerability and adaptive capacity of this population to the types of events associated with climate change, such as droughts, floods, heat waves, hurricanes, and wildfires (IPCC 2014). Secondary objectives were to determine (i) how these factors mapped onto the components of the ICF and (ii) the extent to which people with disability were involved in the studies included in this review.

2. Method

a. Search strategy

We identified studies by searching the following 12 electronic databases: Academic Search Complete, Applied Science and Technology Source, Business Source Complete, Cumulative Index to Nursing and Allied Health Literature (CINAHL) Complete, Embase, GreenFILE, MEDLINE Complete, ProQuest, PsycINFO, ScienceDirect, Scopus, and Web of Science. The terms used in the search were: climate change, global warming, extreme weather, natural disaster*, heatwave*, flood, storm*, bushfire*, cyclone*, sea level*, drought*, hurricane*, wildfire*, natural hazard*, disab*, and impairment*. The search strategy is detailed in appendix A. The search was limited to English language publications. No limit was applied for publication date. The search was current as of 23 April 2016. The reference lists of papers meeting the inclusion criteria were also scanned for additional

papers that were candidates for possible inclusion in the review.

We also searched for gray literature using the Google search engine and the websites of 21 organizations (see [appendix B](#)). This search was current as of 20 April 2016. With research showing that there is a bias toward publishing studies with stronger, statistically significant effects ([Franco et al. 2014](#); [McAuley et al. 2000](#)), the incorporation of gray literature into systematic reviews represents an attempt to assess the whole evidence base.

b. Selection criteria

Studies were included in this review if they met the following inclusion criteria: (i) people with disability were participants or data were provided on this population, (ii) the exposures (or likely exposures) were events of the types likely to be associated with climate change (bushfires, droughts, floods, heatwaves, hurricanes, sea level rises, storms, and wildfires; [IPCC 2014](#)), and (iii) factors contributing to the vulnerability or adaptive capacity of people with disability were identified. Studies using quantitative, qualitative, or mixed methods were eligible for inclusion. Studies were excluded for which (i) data on the vulnerability and adaptive capacity of people with disability were presented without reporting findings on factors contributing to their vulnerability and adaptive capacity or (ii) data or separate analyses for people with disability were not presented.

c. Study selection

Two reviewers (CJG and DT) performed the eligibility assessment independently in an unblinded standardized manner. Papers were screened based on title, then abstract, and then full text. Disagreements between reviewers were resolved through consensus and, when necessary, in consultation with a third reviewer (SK).

d. Data extraction

The following information was extracted from each study that met the selection criteria: (i) study design, (ii) study methods, (iii) participants, (iv) whether or not people with disability were participants, (v) types of impairments, (vi) geographic locations, (vii) events (e.g., hurricanes), and (viii) factors contributing to adaptive capacity and vulnerability. Data were also extracted to enable an assessment of study quality using the mixed methods appraisal tool ([Pluye et al. 2011](#)). The first author (CJG) performed the initial data extraction, which the second author (DT) independently verified.

e. Data analysis

The factors associated with climate change vulnerability and the adaptive capacity of people with disability

identified from the included studies were analyzed using thematic synthesis. This process involved (i) coding text from included papers, (ii) developing descriptive themes from these codes, and (iii) generating analytical themes ([Thomas and Harden 2008](#)). NVivo qualitative data analysis software (version 11, QSR International Pty Ltd.) facilitated this synthesis. As part of the last stage of the analysis, the factors contributing to climate change vulnerability and adaptive capacity were grouped according to event phase (preparedness, evacuation, during the event, and recovery) and mapped onto the [WHO's \(2002\) ICF](#). The ICF has three levels of human functioning: (i) body functions and structures, (ii) activities (execution of tasks or actions), and (iii) participation (involvement in life situations). Activities and participation are commonly combined as one domain because of the degree of potential overlap between these levels. In the ICF, these levels of human functioning interact with personal and environmental factors to determine the extent of functioning and disability.

3. Results

Potentially relevant papers were identified through electronic database searches ($n = 6776$) and from other sources (citations in papers meeting the eligibility criteria, $n = 21$; gray literature, $n = 4$; see [Fig. 1](#)). Following removal of duplicates, screening, and eligibility assessment, 34 papers (relating to 28 studies) met the selection criteria. Most of the papers ($n = 26$ papers on 24 studies) were published in the peer-reviewed literature ([Al-Rousan et al. 2014](#); [Bethel et al. 2011](#); [Blendon et al. 2009](#); [Boon et al. 2012](#); [Christensen and Castañeda 2014](#); [Engelman et al. 2013](#); [Fox et al. 2007](#); [Fox et al. 2010](#); [Galea et al. 2013](#); [Gignac et al. 2003](#); [Hogaboom et al. 2013](#); [Lazrus et al. 2012](#); [Lutgendorf et al. 1995](#); [McAdams Ducey and Stough 2011](#); [McClure et al. 2011](#); [McCormick et al. 2013](#); [Nick et al. 2009](#); [Smith and Notaro 2015](#); [Spence et al. 2007](#); [Stough et al. 2010](#); [Stough et al. 2016](#); [Tomio et al. 2012](#); [Van Willigen et al. 2002](#); [Vink et al. 2014](#); [White et al. 2007c](#); [Zeinomar et al. 2007](#)). The remaining eight papers were unpublished. Half of these papers ($n = 4$) were sourced from the reference lists of published papers already included in the review and were reports ([Stough and Sharp 2008](#); [White et al. 2007a](#); [White et al. 2007b](#)) and a thesis ([Christensen 2012](#)). All four of these unpublished papers had accompanying peer-reviewed publications that were included in this review. The other four unpublished papers (on four studies) were two theses sourced through the electronic database searches ([Brittingham 2014](#); [Steiner 2009](#)), one report sourced from the website of an organization included in the search strategy

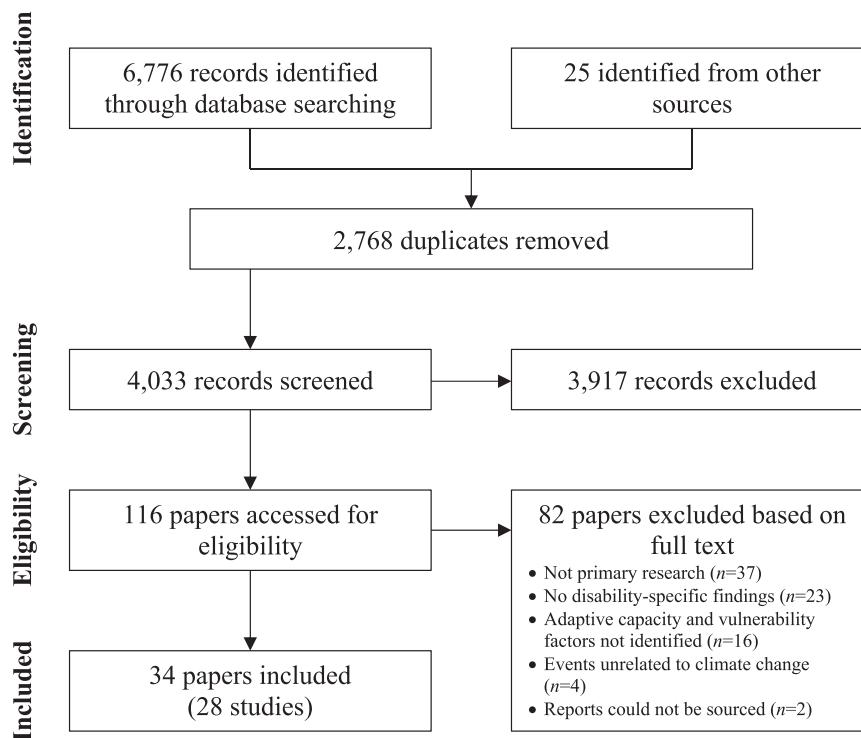


FIG. 1. Identification and selection of studies for the systematic review.

(United Nations Office for Disaster Risk Reduction 2014), and one report sourced via the Google search engine (National Organization on Disability 2005).

a. Description of the studies

Of the 28 studies, most had quantitative descriptive designs ($n = 17$), with surveys ($n = 17$), interviews ($n = 10$), and focus groups, ($n = 5$) being the main methods of data collection (see Table 1). For many of these studies, people with disability were intentionally recruited ($n = 11$) or coincidentally recruited ($n = 6$); coincidental recruitment may have also occurred in a further eight studies (no information was provided on the presence or absence of disability among participants), and human participants were not involved in three studies. In the 11 studies for which people with disability were intentionally recruited, physical impairment ($n = 6$) was the most common type of impairment. Almost all studies were located in the United States ($n = 23$), with half the studies using data from states on the East Coast of the United States ($n = 14$). Almost half of the studies focused on hurricanes ($n = 13$). Hurricane Katrina (August 2005) was the single event generating the most studies ($n = 4$).

In terms of study quality, all studies had clear research questions and appropriate data collection methods. For those studies with quantitative descriptive approaches

($n = 22$), the majority had sampling strategies relevant to answering the research questions ($n = 14$), under half had samples that could be considered representative of the populations under study ($n = 11$), most had appropriate measures ($n = 18$), and few had response rates over 60% ($n = 2$). For those studies with qualitative approaches ($n = 11$), all had sources of data relevant to addressing the stated research questions ($n = 11$) and most had processes of analyzing data appropriate to addressing the research questions ($n = 7$; processes were not reported in a further four studies). Consideration was given to how findings related to the contexts in all qualitative studies ($n = 11$), and the potential influence of researchers on the findings was only reported in one study. In the only study with a quantitative randomized design, participants were recruited in a way that minimized selection bias, appropriate measures were used, and the participants were comparable in the conditions being compared; whether or not there were complete outcome data or an acceptable response rate was not reported. For the mixed methods studies ($n = 5$), this choice of research design was appropriate in all instances ($n = 5$), the integration of qualitative and quantitative data was relevant to addressing the research questions in most studies ($n = 3$), and consideration to the limitations associated with this integration was rarely given ($n = 1$).

b. Findings of the studies

Factors contributing to the vulnerability of people with disability ($n = 57$) were identified in 26 studies (Table 2), with some factors ($n = 6$) present across multiple event phases. Personal factors increasing vulnerability included female gender, uncoupled or living alone, nonwhite ethnicity, and low income. Common environmental factors included limited practical support from government agencies and disability organizations. Factors pertaining to impairments of body functions and structures included cognitive impairments, hearing impairments, thermoregulation difficulties (for people with quadriplegia and heat exposure), and the relapse, exacerbation, or progression of impairments (e.g., with chronic fatigue syndrome). Factors relating to activity limitations and participation restrictions commonly included limited preparedness, difficulties (either anticipated or experienced) with evacuation, and difficulties reassembling individual accommodations and repairing or replacing adaptive equipment (sometimes in new locations).

Factors relating to the adaptive capacity of people with disability were identified from 13 studies (Table 3). Of the factors identified ($n = 14$), half were environmental factors ($n = 7$). Environmental factors were associated with adaptive capacity throughout the phases of events (preparedness, evacuation, during the event, and recovery) and included practical support from both mainstream and disability organizations as well as from family and friends. Personal factors (e.g., formal education) and the extent to which they engaged in activities and participated in their communities (emergency planning, keeping an emergency pack, and seeking information) also contributed positively to the adaptive capacity of people with disability during the preparation for an event.

4. Discussion

People with disability experience multidimensional inequalities (WHO 2011) and are particularly vulnerable to climate change (Cardona et al. 2012). The findings of this review are that a broad range of personal and environmental factors contribute to the vulnerability and adaptive capacity of people with disability.

With most of the included studies conducted in the United States, providing some background on people with disability in this country would be informative. People with disability made up 18.7% of the U.S. population in 2010, with 12.6% having severe disability and 4.4% requiring assistance with daily living (Brault 2012). The prevalence of disability increased with age; 8.4% of people under 15 years of age had disabilities (4.2% with severe disability and 0.5% needing assistance) compared

with 70.5% of those aged 80 and older (55.8% with severe disability and 30.2% needing assistance). After adjusting for age, the prevalence of disability was marginally higher for females (18.3%) than males (17.6%) and was most prevalent in the non-Hispanic Black population (22.3%) and least prevalent in the non-Hispanic Asian population (14.4%). Differences between people with severe disability, non-severe disability, and no disability were evident for attaining college education (49.4%, 62.1%, and 68.3%, respectively, for those aged 15 to 64), employment (27.5%, 71.2%, and 79.1%, respectively, for those aged 21 to 64), median monthly income (\$1,577, \$2,402, and \$2,724, respectively, for those aged 21 to 64), and poverty status (28.6%, 17.9%, and 14.3%, respectively, for those aged 15 to 64).

Female gender, uncoupled or living alone, low incomes, nonwhite ethnicity, and nondominant cultural background are personal factors contributing to vulnerability that point to the inequalities that people with disability experience. This finding reinforces the IPCC's (2014) conclusion that people who experience marginalization in society are likely to be highly vulnerable to climate change. People with disability may be particularly vulnerable because disability is more prevalent in vulnerable populations, such as those on low incomes and ethnic minorities (WHO 2011).

The environmental factors associated with vulnerability predominantly clustered on two types of organizations from which many people with disability readily receive support: disability organizations and government agencies. The studies included in this review revealed that many disability organizations had not prepared their staff or clients for emergency situations and, as a consequence, did not have the capacity to contribute to the evacuation or sheltering of people with disability or to help them recover (Engelman et al. 2013; White et al. 2007a). On the part of government agencies, there was limited (or no) application of universal design principles (i.e., designing environments, products, and communications that are accessible to everyone; Boon et al. 2012; Fox et al. 2007; Lazrus et al. 2012; National Organization on Disability 2005; Nick et al. 2009; Steiner 2009; Stough et al. 2010; Vink et al. 2014; White et al. 2007a). Limited interorganizational coordination (lack of coordination, regular consultation, information sharing, and integration of information into citywide emergency planning) seemed to exacerbate these factors. In contrast, the adaptive capacity of people with disability seems to be promoted through the availability of information and practical support from many sources (disability and mainstream organizations, family and friends, television, and teachers) and the accessibility of shelters.

Physical, cognitive, and sensory impairments were identified as contributing to vulnerability. This finding

TABLE 1. Summary of included studies.

Study	Study design	Study method	Participants	Geographic location	Event
Al-Rousan et al. (2014)	Quantitative descriptive	Survey	1304 older adults (37.6% with activities of daily living impairments)	United States	Natural disasters (emergency preparedness)
Bethel et al. (2011)	Quantitative descriptive	Telephone survey	37 303 respondents (19.2% with activity limitations)	Six U.S. states (Delaware, Georgia, Louisiana, Montana, Nevada, and Tennessee)	Natural disasters (emergency preparedness)
Blendon et al. (2009)	Quantitative descriptive	Telephone survey	5013 residents (701 from households in which someone had a chronic illness or disability)	Coastal counties of eight U.S. states (Texas, Louisiana, Mississippi, Alabama, Florida, Georgia, South Carolina, and North Carolina)	Hurricanes (emergency preparedness, experiences, and expectations)
Boon et al. (2012)	Qualitative descriptive	Document analysis	133 documents underpinning emergency management in schools	Australia	Weather-related disasters (emergency management)
Brittingham (2014)	Quantitative descriptive	Telephone survey	424 residents (129 with sensory, mobility, or learning impairments)	North Carolina, United States	Hurricanes (emergency public shelter access)
Christensen (2012) and Christensen and Castañeda (2014)	Mixed methods (sequential explanatory design)	Intervention, interviews, participant observation, survey, disaster literacy testing, and focus group	Administrators and eight staff of organization supporting people with Alzheimer's disease or a related dementia (ADRD), caregivers of community-dwelling persons with ADRD (20 participants interviewed and involved in the disaster literacy measurement, 253 surveyed), chart and disaster plans (290 at baseline, 259 at follow-up)	South Florida, United States	Hurricanes (emergency preparedness and responses)
Engelman et al. (2013)	Quantitative descriptive	Interviews	50 key informants from emergency management and public health agencies, 14 key informants from community-based organizations serving the deaf community	San Francisco Bay area, United States	Weather-related and other disasters (emergency preparedness)

TABLE 1. (Continued)

Study	Study design	Study method	Participants	Geographic location	Event
Fox et al. (2007) and White et al. (2007b)	Quantitative descriptive	Survey	30 emergency managers	30 counties or equivalent units affected by disasters between 1998 and 2003, United States	Weather-related and other disasters (emergency preparedness)
Galea et al. (2013)	Qualitative descriptive	Interviews	70 veterans with disability (66 with spinal cord injury, 4 with multiple sclerosis)	New York, United States	Hurricane Sandy
Gignac et al. (2003)	Quantitative non-randomized (case control study)	Survey	59 ice storm-affected respondents with osteoarthritis and/or osteoporosis, 55 respondents with osteoarthritis and/or osteoporosis living outside the affected area	Kingston and Toronto, Canada	1998 Canadian ice storm
Hogaboom et al. (2013)	Quantitative descriptive	Interviews	21 people with spinal cord injury attending an outpatient center	Pittsburgh, Pennsylvania, United States	Natural disasters (emergency preparedness)
Lazrus et al. (2012)	Qualitative descriptive	Focus groups	46 participants (12 with disability) from a center for independent living	Miami, Florida, United States	Hurricanes (emergency preparedness)
Lutgendorf et al. (1995)	Quantitative descriptive	Survey, interviews, physical examinations	49 people with chronic fatigue syndrome who lived in high-impact and less affected areas	South Florida, United States	Hurricane Andrew
McAdams Ducey and Stough (2011)	Qualitative (grounded theory)	Interviews	4 special education teachers	Texas, United States	Hurricane Ike
McClure et al. (2011)	Quantitative descriptive	Survey	487 people with spinal cord injuries	United States	Weather-related and other disasters (emergency preparedness)
McCormick et al. (2013)	Quantitative descriptive	Survey	1603 respondents, 26.2% with activity limitations	Jefferson County, Alabama, United States	Weather-related disasters (emergency preparedness)
National Organization on Disability (2005)	Mixed methods (triangulation design)	Interviews, observations	26 lead officials from 18 shelters, 4 community-based organizations, and 8 emergency operation centers	Louisiana, Mississippi, Alabama, and Texas, United States	Hurricane Katrina
Nick et al. (2009)	Qualitative descriptive	Facilitated discussions, interviews	110 people representing 66 organizations	Boston, Massachusetts, United States	Symposium on populations with special healthcare needs due to disability
Smith and Notaro (2015)	Quantitative descriptive	Telephone survey	23 172 people with activity limitations, 61 890 people without activity limitations	United States	Natural disasters (emergency preparedness)

TABLE 1. (Continued)

Study	Study design	Study method	Participants	Geographic location	Event
Spence et al. (2007)	Quantitative descriptive	Survey	517 evacuees (232 with physical disability) in relief centers and evacuation aid distribution centers	Massachusetts, Michigan, and Texas, United States	Hurricane Katrina
Steiner (2009)	Mixed methods (triangulation design)	Observation	5 storm shelters at the University of Central Oklahoma	Edmond, Oklahoma, United States	Tornadoes (emergency preparedness)
Stough and Sharp (2008) and Stough et al. (2010, 2016)	Qualitative (grounded theory)	Interviews, focus groups	42 case managers, 12 case management supervisors, and 31 people with disability	Louisiana, Mississippi, Alabama, Texas, and Georgia, United States	Hurricane Katrina
Tomio et al. (2012)	Quantitative descriptive	Survey	553 people with rheumatoid arthritis	Municipalities affected by 16 natural disasters between 2004 and 2006, Japan	Weather-related disasters (emergency preparedness)
United Nations Office for Disaster Risk Reduction (2014)	Quantitative descriptive	Survey	5717 people with disability and their caregivers	137 countries and 9 non-self-governing territories	Weather-related disasters (emergency preparedness)
Van Willigen et al. (2002)	Quantitative descriptive	Telephone surveys and focus group	935 respondents from coastal counties in North Carolina (14% living with at least one person with physical disability), 383 respondents from Pitt County (9% living with at least one person with physical disability)	Eastern North Carolina, United States	Hurricanes Bonnie, Dennis, and Floyd
Vink et al. (2014)	Quantitative descriptive	Law and policy review	36 laws and policies	Japan, Netherlands, and United States	Flooding (emergency preparedness)
White et al. (2007a,c) and Fox et al. (2010)	Mixed methods (triangulation design)	Surveys, focus groups, interviews	6 Center for Independent Living (CIL) directors and key staff, 22 CIL personnel, 18 CIL consumers, 19 additional people with disability, contacts within 40 statewide independent living councils	Alabama, Mississippi, and Louisiana, United States	Hurricane Katrina
Zeinomar et al. (2007)	Quantitative descriptive	Telephone survey	4898 respondents (21% with activity limitations or were users of special equipment)	Florida, United States	2004 hurricane season

TABLE 2. Mapping the factors associated with vulnerability onto the International Classification of Functioning, Disability, and Health framework.

Event phase	Body functions and structures	Activities and participation	Environmental factors	Personal factors
Preparedness for event	Cognitive impairments (Alzheimer's disease)	Limited overall preparedness	Limited provision of information and emergency preparedness services from disability organizations	Female gender
	Hearing impairments	Not signed up for support initiatives No emergency evacuation plan Planning not to evacuate if asked to do so Limited involvement in community disaster management and risk reduction processes Reliance on elderly caregivers Transportation issues Few preparedness items	Limited staff training on emergency preparedness within disability organizations Limited preparedness within government agencies to accommodate the needs of people with disability Limited interorganization coordination	Uncoupled or living alone Low income Nondominant cultural background Avoidance of information to prevent fear and anxiety Limited knowledge of what to do in an event Nonwhite ethnicity Denial of the seriousness of threats
Evacuation	Evacuation experiences	Evacuation experiences	Perceived ability to evacuate	Evacuation experiences
	Cognitive impairments (Alzheimer's disease)	Not evacuating (due to underestimation of storm severity or to perceived lack of accessible alternative shelters) Transportation issues	Variable access to social support systems Other factors Laws preventing the sharing of information about clients Inaccessible evacuation routes Disruption to basic support services Limited evacuation services from disability organizations	High stress levels contributing to death Resistance to evacuation Perceived ability to evacuate
During the event	Evacuation experiences	Perceived ability to evacuate Could not evacuate Would have difficulty evacuating Less likely to evacuate and to evacuate early Transportation issues Lack of accessible alternative shelter	Shelters not accessible Impaired coordination between shelters and disability organizations Limited practical support available from family and friends	Female gender Uncoupled Nonwhite ethnicity
	Evacuation experiences	Other factors People with disability becoming lost Reliance on assistance from others Reliance on mobile phones for communication		

TABLE 2. (Continued)

Event phase	Body functions and structures	Activities and participation	Environmental factors	Personal factors
Recovery from the event	Cognitive impairments (Alzheimer's disease) Thermoregulation difficulties (quadriplegia with heat exposure) Relapse and exacerbation of symptoms (chronic fatigue syndrome and other chronic conditions) Progression of impairments	Difficulties repairing or replacing adaptive equipment Damaged vehicles Navigating new cities (following forced relocation) Property (housing) damage Reassembling individual accommodations in new environments Living farther away from natural supports Finding new employment Less able to assist in recovery efforts	Reduced public transport and compromised infrastructure Inaccessible government programs Repeated referrals between government departments Complex processes for obtaining government support Limited capacity of disability organizations to provide support Reduced social support	Low income

regarding physical impairments is consistent with the broader literature, in which evidence is presented of the significant challenges to thermoregulation with impairments such as multiple sclerosis (Baker 2002), schizophrenia (Chong; Castle 2004), and spinal cord injury (Dawson et al. 1994; Totel 1974). Certain medications, such as antipsychotics, can also contribute to thermoregulatory dysfunction (Kreuzer et al. 2012). People with other types of impairments, such as cerebral palsy, can also experience greater thermal strain in hot conditions than those without impairments (Maltais et al. 2004). With respect to cognitive impairments, the literature reviewed showed that people with Alzheimer's disease face additional challenges during hurricanes (e.g., not comprehending what is happening around them and hampering preparation, evacuation, and recovery efforts; Christensen 2012; Christensen and Castañeda 2014). Despite such issues potentially also affecting people with intellectual disability, minimal information was found relative to their vulnerability and adaptive capacity. Although people with intellectual disability participated in some studies (e.g., Lazrus et al. 2012), their data were typically pooled with that of people with other types of impairments. Similarly, there was limited evidence of the vulnerability and adaptive capacity of people with sensory impairments.

The limited preparedness of people with disability for weather-related emergencies was a theme emerging from several studies and was coded as a factor increasing vulnerability to the types of events associated with climate change. Some of these studies showed that people with disability were less prepared (had fewer items than recommended in their emergency supply kits and were less likely to have evacuation plans) than people without disability (Al-Rousan et al. 2014; Bethel et al. 2011; Smith and Notaro 2015; Spence et al. 2007), whereas others showed similar levels of preparedness (McCormick et al. 2013; Tomio et al. 2012). These findings do not lend themselves to simple interpretation. First, with regard to emergency supply kits, there is no consensus about what these kits should contain and a lack of evidence for their effectiveness in times of disaster (Heagele 2016). Although having an emergency supply kit is recommended, the extent to which someone might be disadvantaged through not having one is unknown. Second, there seems to be an implicit assumption that it is satisfactory for people with disability to have similar levels of preparedness as those without disability. People without disability who are underprepared may be more able to assemble required items and do other preparedness tasks at short notice than those with

TABLE 3. Mapping the factors associated with adaptive capacity onto the International Classification of Functioning, Disability, and Health framework. No factors relating to body functions and structures were identified, so this level of human functioning has been omitted from the table.

Event phase	Activities and participation	Environmental factors	Personal factors
Preparedness for event	Emergency planning Keeping an emergency pack Seeking information from family, caregivers, and friends	Emergency planning support from disability organizations Information from television and teachers	Older age Formal education Living close to key services Faith
Evacuation		Support to evacuate from family and friends	
During the event		Shelters accommodative of everyone	
Recovery from the event		Practical support from mainstream organizations Practical support from disability organizations Practical support from family and friends	

disability. Therefore, people with disability may need to be more prepared for emergencies than those without disability.

There are several limitations inherent in the literature we reviewed. First, people with disability were intentionally recruited for less than half of the studies. Significant scope exists for researchers to include people with disability in disability-focused and mainstream projects, both as participants and as partners. Second, the scope of the literature is fairly narrow, with most studies focused on natural disasters (or emergency preparedness for such events) in the United States. There is substantial need to understand the vulnerability and adaptive capacity of people with disability experiencing other events potentially related to climate change and to do so in countries other than the United States. In addition to many of the factors identified in this review, a report from an international e-discussion on climate change and people with disability highlighted issues such as the abandonment of people with disability at the onset of disasters, emergencies, and conflict situations; their heightened vulnerability to abuse during violent conflicts (e.g., over limited water); their exclusion from refugee camps by other refugees following disasters; the discrimination they face during the distribution of scarce resources (such as food and water) as well as the inaccessibility of the sources of these resources; and the practical difficulties of forced migration [Global Partnership for Disability & Development (GPDD) and World Bank 2009]. Third, insufficient attention has been paid to factors contributing to the adaptive capacity of people with disability, with twice as many studies highlighting their vulnerability. Focusing on vulnerability continues to perpetuate a deficits-based model of disability and ignores the strengths of people with disability and their adaptive potential, especially when adequate

supports are available in their communities. Fourth, in most of the studies, researchers either (i) identified differences between people with and without disability (with no examination of the causes, importance, and implications of these differences) or (ii) identified issues within samples of people with disability (meaning that it was sometimes difficult to assess whether the issues mentioned were unique to people with disability). Mixed method approaches would allow a closer investigation of the differences in the experiences of people with and without disability and the ramifications of such differences for their vulnerability and adaptive capacity.

5. Conclusions

The United Nations (2011) Convention on the Rights of Persons with Disabilities affords people with disability the right to protection and safety in situations of risk, such as during natural disasters. The findings of this systematic review, however, suggest that in many instances people with disability may not have been able to enjoy this right. Systems designed to assist people in times of emergency, in particular, are often inaccessible to people with disability. The evidence presented in this review shows that both environmental and personal factors contribute to the vulnerability and adaptive capacity of people with disability. The environmental factors demonstrate the need for responses that are inclusive of everyone. The personal factors illustrate the need to address the problem of multidimensional inequalities. The scope of the available evidence is quite narrow, however, in terms of geography and types of events associated with climate change. There is an urgent need to identify and address factors associated with climate change vulnerability and people with disability in developing, as well as developed, countries. Equally,

and perhaps more importantly, concerted efforts are needed to improve the adaptive capacity and resilience of people with disability.

APPENDIX A

Electronic Databases and Search Strategy

a. Databases

We identified studies through searching the following 12 electronic databases: Academic Search Complete (via EBSCOhost), Applied Science and Technology Source (via EBSCOhost), Business Source Complete (via EBSCOhost), CINAHL Complete (via EBSCOhost), Embase, GreenFILE (via EBSCOhost), MEDLINE Complete (via EBSCOhost), ProQuest, PsycINFO (via EBSCOhost), ScienceDirect, Scopus, and web of Science.

b. Search strategy:

The search strategy terms were as follows:

- 1) climate change
- 2) global warming
- 3) extreme weather
- 4) natural disaster*
- 5) heatwave*
- 6) flood*
- 7) storm*
- 8) bushfire*
- 9) cyclone*
- 10) sea level*
- 11) drought*
- 12) hurricane*
- 13) wildfire*
- 14) natural hazard*
- 15) disab*
- 16) impairment
- 17) 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14
- 18) 15 or 16
- 19) 17 or 18

APPENDIX B

Websites Included in the Gray Literature Search

a. Search engine

The search engine used was Google (www.google.com).

b. Organizations

We searched the websites of the following organizations: Asian Development Bank (www.adb.org), CBM

International (www.cbm.org), Chatham House (www.chathamhouse.org), Christian Aid (www.christianaid.org.uk), Eldis (www.eldis.org), Environment and Security Initiative (www.envsec.org), Global Development and Environment Institute (www.ase.tufts.edu), Governance and Social Development Resource Centre (www.gsdrc.org), Gray Literature Report (www.greylit.org), Institute for Development Studies (www.ids.ac.uk), Intergovernmental Panel on Climate Change (www.ipcc.ch), International Institute for Sustainable Development (www.iisd.org), National Technical Information Service (www.ntis.gov), Open Gray (www.opengrey.eu), Oxfam (www.oxfam.org), Source (www.asksource.info), Stockholm Environment Institute (www.sei-international.org), Tyndall Centre for Climate Change Research (www.tyndall.ac.uk), United Nations Office for Disaster Risk Reduction (www.unisdr.org), Woodrow Wilson International Center for Scholars (www.wilsoncenter.org), and World Health Organization (www.who.int).

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