Health Impacts of Extreme Weather Events: Exploring Protective Factors with a Capitals Framework

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Health Impacts of Extreme Weather Events: Exploring Protective Factors with a Capitals Framework

Lisa Reyes Mason, Jennifer Erwin, Aaron Brown, Kelsey N. Ellis, and Jon M. Hathaway

Abstract

Purpose: Extreme weather events are increasing with climate change. The physical and mental health of people served by social workers may be especially at risk from these hazards. This exploratory study examines if specific types of human, financial, physical, and social capital are associated with health impacts from excessive summer heat and extreme winter weather.

Method: Data from resident surveys (N = 424) in low- and moderate-income areas of a Southeastern US city are analyzed with descriptive statistics and logistic regression.

Results: Key findings are that health status and social cohesion are negatively associated with health impacts of summer heat and winter extremes.

Conclusion: Further study is needed of how specific types of capital may help people cope with a changing climate. Social capital may be a particularly relevant area for social work to address within the pressing issue of climate, weather, and the health of vulnerable groups.

Keywords: Weather; climate change; physical health; mental health; social cohesion.

Climate change is associated with increased frequency and severity of extreme weather events, including summer heat waves and severe winters (Cohen et al., 2014; Intergovernmental Panel on Climate Change, 2014). Potential and unfolding health impacts of these extremes include greater prevalence of infectious disease, temperature-related illness and death, and mental distress (McMichael, Woodruff, & Hales, 2006; Nichols, Maynard, Goodman, & Richardson, 2009). The physical and mental health of people served by social workers may be especially at risk, as groups with lower socioeconomic status tend to be more socially vulnerable to the negative impacts of weather and climate (Kemp & Palinkas, 2015; Mearns & Norton, 2010). Certain forms of capital (e.g., financial capital in the form of income, social capital in the form of cohesion with neighbors) may serve as important protective resources during hazardous events. This exploratory study examines associations between specific capitals and health impacts of excessive summer heat and extreme winter weather among a predominantly low-to-moderate-income population. If key associations emerge, social work interventions can be designed to promote more equitable
access to these particular forms of capital, both in advance of and during extreme weather events.

**Weather extremes and health**

The relationship between weather extremes and physical health is often measured by mortality or hospital admission. Temperature-related mortality has been associated with poverty, homelessness, age, less education, being a race other than white, living alone, mental illness, and no air conditioning (Curriero et al., 2002; Maier et al., 2014; O’Neill & Ebi, 2009). An increase in hospitalization due to temperature has been found for asthma, pediatric, and cardiovascular emergencies (Lee, Sheridan, & Lin, 2012; Pantea, Lin, & Sheridan, 2012; Xu et al., 2014).

The impact of extreme weather on health disproportionately affects infants and older adults and can vary geographically (Curriero et al., 2002; Deschenes, 2014; Yardley, Sigal, & Kenny, 2011). Curriero et al. (2002) conducted a retrospective study (1973–1994) on the relationship between temperature and mortality across 11 large metropolitan areas in the Eastern United States. They found that both extreme heat and cold were associated with increased mortality and that the association increased with age. While the relationship between temperature and mortality was found across all study areas, populations in warmer regions tended to be more vulnerable to cold, while those in colder regions tended to be more sensitive to heat (Curriero et al., 2002), a geographic result similar to that found by Deschenes (2014) in a review of 20 studies.

Weather extremes are also linked to mental health concerns, though much less studied than links with physical health ones (Bourque & Willox, 2014; Fountoulakis et al., 2016; Hansen et al., 2008). Extreme temperatures can increase stress and exacerbate preexisting mental health problems, leading to increased psychiatric emergencies, emergency department visits, and hospital admissions (Cervellin et al., 2014; Hansen et al., 2008; Vida, Durocher, Ouarda, & Gosselin, 2012). Fountoulakis et al. (2016), for example, examined the relationship between climate and suicide in Europe and found that climate variables explained about 30% of the variability in suicide rates, controlling for economic variables. Hansen et al. (2008) conducted a retrospective study of 171,614 hospital admissions between 1993 and 1996 in Adelaide, Australia, and found that admissions related to a variety of mental and behavioral disorders including mood and anxiety disorders increased significantly during heat waves. Santiago, McLay, and Hammer (2005) found similar results in their retrospective study of 1909 emergency department psychiatric evaluations between 2002 and 2003 in Southern California. Extreme heat was found to be predictive of increased number of psychiatric evaluations performed (Santiago et al., 2005).

People who are older or have less education may be more prone to emotional effects of temperature. Noelke et al. (2016) examined the relationship between air temperature and emotional well-being from 2008 to 2013 in a large nationally representative sample in the United States. Ambient temperatures above 70°F were found to significantly reduce emotional well-being, with the strongest effects being observed above 90°F. The effect of high temperatures on emotional well-being was found across genders, education levels, and different geographic locations in the United States. Similar to physical health outcomes, older and less educated Americans were found to be the most vulnerable to the effects of temperature on emotional well-being (Noelke et al., 2016).
Prior research in this area has tended to use secondary data such as hospital records and examined severe outcomes such as mortality, hospitalization, or psychiatric emergency, which help capture some of the most severe health impacts that people experience. However, other health impacts that vulnerable groups may experience have been less frequently examined, as many people do not (or may not have resources to) seek medical help, and because research in this area has relied so heavily on secondary data from hospitals. Thus, new research using primary data collection and self-reported health impacts to understand the linkages between weather extremes and health, in ways that relying only on mortality or hospital admission data cannot capture, is one gap that this study aims to fill.

**Protective factors and a capitals framework**

From the broader area of vulnerability and climate change, we know that people with lower socioeconomic status tend to have higher vulnerability to the negative impacts of weather extremes (Mearns & Norton, 2010). As Kemp and Palinkas (2015, p.8) summarize in their foundational paper for social work’s grand challenge to create social responses to a changing environment, “These groups include minorities, women, children, older adults, rural and urban poor, and individuals with a history of mental or behavioral health problems, as well as low-income and geographically vulnerable individual communities and entire nations.”

Yet, to move beyond describing vulnerability and toward addressing it, a capitals (or assets) framework can be useful in identifying protective factors that help people cope with or adapt to extremes (Moser & Satterthwaite, 2010; Prowse & Scott, 2008). Widely discussed in the global development literature, human, financial, physical, social, and natural capitals are resources that people have and can use to prepare for or recover from shocks or other life events (e.g., Galor & Moav, 2004; Moser, 2007; Pretty & Ward, 2001). A common example of each is education as a form of human capital, income as financial capital, a home or property as physical capital, connectedness with neighbors as social capital, and green space as natural capital. During an adverse event—such as job loss, a health crisis, or a natural disaster—stocks of capitals can be used as flows of resources to help an individual or household cope, adapt, and potentially recover from the event.

In the area of vulnerability and climate, however, empirical application of a capitals framework to understanding event impact and recovery is still rare. Also, analysis of capitals has tended to focus on developing countries (e.g., Carter, Little, Mogues, & Negatu, 2007; Verner, 2010), or on topics such as adaptation to hurricanes and flooding (Molua, 2009), environmental degradation (Cruz-Torres, 2001), and water insecurity (Mason, 2014). Thus, this study’s application of a capitals framework to understanding the impacts of two specific weather extremes—summer heat and extreme winter—which are increasing in frequency and severity in many locations is another contribution to the literature. If specific capitals are found to protect people from adverse physical and mental health impacts of weather extremes, then programs and policies can be designed to improve capital access among groups of people with less access or none at all.
**The current study**

This exploratory study’s examination of health, capitals, and weather extremes is carried out with a sample of primarily low- and moderate-income residents in Knoxville, Tennessee. A medium sized city, Knoxville, has a humid subtropical climate and is projected to experience an increasing number of extreme hot days and greater precipitation, the latter of which is associated with severe winter storms, due to climate change (Gill & Fellows, 2017). Prior research in Knoxville suggests that, like many other cities, environmental conditions can disproportionately affect people from lower income or other socially vulnerable groups (Mason, Ellis, & Hathaway, 2017).

This study’s examination of both physical and mental health impacts, with the goal of understanding protective factors, is consonant with social work values and a strength-based perspective. Climate change is a social and environmental justice issue of pressing concern to the social work profession (Dominelli, 2011; Kemp & Palinkas, 2015). New social work research that moves beyond documenting environmental or climate-related disparities and toward how we can address these concerns—in this case by potentially identifying forms of capital that may matter most—is critically needed (Mason, Shires, Arwood, & Borst, 2017).

**Method**

**Sample and data collection**

Data are from a survey mailed to randomly selected residents of 25 census tracts in Knoxville, Tennessee, between August and November 2016. We included census tracts with median household income at or below the city median of $33,494, based on 2010–2014 US Census estimates, with the exception of one tract which we excluded because it primarily houses undergraduate college students. In the census tract with a notably higher percentage of Hispanic residents than other included tracts (an area which is known in Knoxville for its sizeable and growing Hispanic community), we oversampled and mailed the survey in English and Spanish to try and obtain a sufficient subsample from this group for analysis.

We used a four-contact approach to recruitment: postcard, letter with survey, follow-up postcard, and follow-up letter with survey. The survey was mailed to the household with instruction that it be completed by “an adult in the household (age 18 or over) with the most recent birthday.” Participants received a $6 Subway® gift card for returning the survey. We received 442 completed surveys, for a response rate of 24.3%. Participant return of the survey implied informed consent, as explained on recruitment materials and the survey cover. The University of Tennessee Institutional Review Board approved the study procedures.

**Measures**

The survey instrument had 56 items organized into the following sections: summer temperatures, winter weather, heavy rainfall and flooding, climate change, neighborhood relationships, household resources, information about your home, and information about you. The sections on rainfall/flooding and climate change are outside the scope of this study; thus, their measures are not described below.
**Dependent variables**

We measured health impacts with similarly worded items for physical and mental health, across both seasonal events. Participants were asked “To what extent is your {physical/mental} health negatively affected by {very hot temperatures in the summer/extreme winter weather}?”. We did not elaborate on “very hot temperatures in the summer,” while for “extreme winter weather,” we described this as “unusually cold, snowy, or icy conditions in the winter.” Participants chose from the following for each item: not at all, slightly, somewhat, or very much. We collapsed “slightly” and “somewhat” for analysis, yielding three ordered levels (1 = not at all, 2 = slightly or somewhat, 3 = very much).

As discussed earlier, we intentionally sought participant self-report about health, given limitations of studies that look only at mortality or hospital admissions data. Single-item, self-rated, and non-comparative (i.e., asking about respondents’ own health, without comparing to others their same age or to the past) measures of health—which are characteristics of the items used in this study—are recognized in the literature as appropriate ways to assess self-rated health (Eriksson, Undén, & Elofsson, 2001).

We also asked open-ended questions about kinds of impacts experienced via the following items: “Have you experienced {a heat wave/extreme winter weather} in the City of Knoxville?” and then, “If Yes, in what ways were you or your household affected by the {heat wave/extreme winter weather}, if any?”

**Explanatory variables**

Explanatory variables consisted of specific types of human, financial, physical, and social capital. For each type of capital, we hypothesized an inverse relationship between the presence or amount of the capital and the degree of impact reported by participants (Moser & Satterthwaite, 2010; Prowse & Scott, 2008; see “Hypotheses” section).

**Human capital.** We measured education and health status. For education, participants chose from a list ranging from “less than high school” to “college graduate or higher.” We collapsed responses for analysis: 1 = high school degree or less, 2 = some college or a technical/associate’s degree, 3 = college degree or higher. For health status, we asked “How would you rate your general health status?” with five response options which we collapsed for analysis: 1 = very poor or poor, 2 = neither good nor poor, 3 = good or very good.

**Financial capital.** We measured income and emergency savings. For income, participants chose one of eight levels for their annual gross household income ranging from “less than $10,000” to “$95,000 or more.” We treated income level as a continuous variable for analysis. For emergency savings, participants were asked if their household has “savings set aside for an emergency” (1 = yes, 0 = no).

**Physical capital.** We measured homeownership (“do you own or rent your home?”), coded for analysis as 1 = owns, 0 = does not own), and whether the home has central cooling (1 = yes, 0 = no) and/or central heating (1 = yes, 0 = no).

**Social capital.** We measured perceived neighborhood social cohesion (hereafter, social cohesion). We used the Social Cohesion and Trust scale which consists of five items that
assess feelings of trust and support among neighbors (Sampson, Raudenbush, & Earls, 1997). With a 5-point scale (1 = strongly disagree to 5 = strongly agree), participants were asked to what extent they agree with each of the following: “People around here are willing to help their neighbors,” “This is a close knit neighborhood,” “People in this neighborhood can be trusted,” “People in this neighborhood generally don’t get along with each other,” and “People in this neighborhood do not share the same values,” with the last two items reverse coded for analysis. We averaged the five responses to create a social cohesion score for each participant.

Control variables
We measured the following demographic control variables: gender (1 = male, 0 = female), age (years), race or ethnicity (participant could select more than one, responses coded as 1 = White or Caucasian, 2 = Black or African American, 3 = Other, which includes American Indian or Alaska Native, Asian, Hispanic or Latino, other as specified by the participant, biracial, and multiracial), and marital status (coded as 1 = married or living with a long-term partner, 0 = not married or living with a long-term partner).

Hypotheses
Next, we list the study hypotheses for each seasonal event and type of impact.

Summer heat
H1a. Education will be negatively associated with physical health impacts.
H1b. Education will be negatively associated with mental health impacts.
H2a. Health status will be negatively associated with physical health impacts.
H2b. Health status will be negatively associated with mental health impacts.
H3a. Income level will be negatively associated with physical health impacts.
H3b. Income level will be negatively associated with mental health impacts.
H4a. Having emergency savings will be negatively associated with physical health impacts.
H4b. Having emergency savings will be negatively associated with mental health impacts.
H5a. Homeownership will be negatively associated with physical health impacts.
H5b. Homeownership will be negatively associated with mental health impacts.
H6a. Having central cooling will be negatively associated with physical health impacts.
H6b. Having central cooling will be negatively associated with mental health impacts.
H7a. Social cohesion will be negatively associated with physical health impacts.
H7b. Social cohesion will be negatively associated with mental health impacts.

Winter extremes
H8a. Education will be negatively associated with physical health impacts.
H8b. Education will be negatively associated with mental health impacts.
H9a. Health status will be negatively associated with physical health impacts.
H9b. Health status will be negatively associated with mental health impacts.
H10a. Income level will be negatively associated with physical health impacts.
H10b. Income level will be negatively associated with mental health impacts.
H11a. Having emergency savings will be negatively associated with physical health impacts.
H11b. Having emergency savings will be negatively associated with mental health impacts.
H12a. Homeownership will be negatively associated with physical health impacts.
H12b. Homeownership will be negatively associated with mental health impacts.
H13a. Having central heating will be negatively associated with physical health impacts.
H13b. Having central heating will be negatively associated with mental health impacts.
H14a. Social cohesion will be negatively associated with physical health impacts.
H14b. Social cohesion will be negatively associated with mental health impacts.

Analyses

We analyzed the quantitative data with SPSS 24.0. For descriptive statistics, we applied sampling weights to account for oversampling in one census tract. Missing data rates range from 1.8% to 5.4% across all variables. To address missing data, we used multiple imputations with fully conditional specification to create 10 imputed datasets for regression (Lee & Carlin, 2010). To test the study hypotheses, we conducted ordinal logistic regression with each dependent variable, regressing it on the same set of explanatory and control variables for each model. For one of the dependent variables (physical health impacts of extreme winter weather), the proportional odds assumption of ordinal logistic regression was not met, and we used multinomial logistic regression instead.

For qualitative data, open-ended responses were coded and cross-checked by two of the study authors to categorize responses into type of impact.

Results

Sample characteristics

Table 1 presents characteristics for the weighted sample of 424 participants. As these are substantively similar to the unweighted values, we present only one set of descriptives. The typical participant was female (64.3%), on average 50.3 years old, and identified as White or Caucasian (72.7%). About 61.9% of participants had annual household income below $35,000, and about half reported emergency savings (49.7%) and/or owning their home (50.9%). The average neighborhood social cohesion score was 3.4. Compared to the demographics of the sampled census tracts (using 2015 US Census Bureau data), our sample had a higher percentage of female (64.3% vs. 52.3%), White or Caucasian (72.7% vs. 66.0%), and college educated or higher (35.1% vs. 20.1%) participants.

Health impacts

For each kind of impact and for both seasonal events, over half of participants reported being affected to at least some degree (Table 2). Physical health impacts were more common (77.1% responding slightly, somewhat, or very much for summer, and 65.6% for winter) than mental health impacts (56.7% for summer, 52.2% for winter).

From the open-ended responses, 33 participants described summer heat wave impacts that were categorized as health related, and 14 participants described extreme winter weather health impacts. Table 3 provides sample responses for health impacts of each kind of event.
Regression analyses

Summer heat

Health status (human capital) and social cohesion (social capital) were negatively associated with physical and mental health impacts of summer heat (Table 4), providing support for hypotheses H2a, H2b, H7a, and H7b. Participants with good/very good health had lower odds of reporting more physical health (OR = 0.125, \( p < 0.001 \)) and mental health impacts (OR = 0.379, \( p = 0.006 \)), and those with neither good nor poor health had lower odds of reporting more physical health impacts (OR = 0.402, \( p = 0.014 \)) compared to those with very

Table 1. Sample characteristics, weighted (N = 424).

<table>
<thead>
<tr>
<th>Variable</th>
<th>% or Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>64.3</td>
</tr>
<tr>
<td>Male</td>
<td>35.7</td>
</tr>
<tr>
<td>Age (years)</td>
<td>50.3 (17.7)</td>
</tr>
<tr>
<td>Race or ethnicity</td>
<td></td>
</tr>
<tr>
<td>White or Caucasian</td>
<td>72.7</td>
</tr>
<tr>
<td>Black or African-American</td>
<td>20.0</td>
</tr>
<tr>
<td>Other (^a)</td>
<td>7.3</td>
</tr>
<tr>
<td>Married or living with a long-term partner</td>
<td>37.6</td>
</tr>
<tr>
<td>Education level</td>
<td></td>
</tr>
<tr>
<td>High school diploma or less</td>
<td>32.0</td>
</tr>
<tr>
<td>Some college, or technical/associate’s degree</td>
<td>32.9</td>
</tr>
<tr>
<td>College degree or more</td>
<td>35.1</td>
</tr>
<tr>
<td>Health status</td>
<td></td>
</tr>
<tr>
<td>Very poor or poor</td>
<td>11.8</td>
</tr>
<tr>
<td>Neither good nor poor</td>
<td>23.1</td>
</tr>
<tr>
<td>Good or very good</td>
<td>65.1</td>
</tr>
<tr>
<td>Income</td>
<td></td>
</tr>
<tr>
<td>Less than $10,000</td>
<td>20.0</td>
</tr>
<tr>
<td>$10,000 to less than $20,000</td>
<td>18.9</td>
</tr>
<tr>
<td>$20,000 to less than $35,000</td>
<td>23.0</td>
</tr>
<tr>
<td>$35,000 to less than $50,000</td>
<td>15.8</td>
</tr>
<tr>
<td>$50,000 to less than $65,000</td>
<td>7.2</td>
</tr>
<tr>
<td>$65,000 to less than $80,000</td>
<td>5.7</td>
</tr>
<tr>
<td>$80,000 to less than $95,000</td>
<td>3.5</td>
</tr>
<tr>
<td>$95,000 or more</td>
<td>6.1</td>
</tr>
<tr>
<td>Household has emergency savings</td>
<td>49.7</td>
</tr>
<tr>
<td>Homeownership</td>
<td>50.9</td>
</tr>
<tr>
<td>Home has central cooling</td>
<td>80.0</td>
</tr>
<tr>
<td>Home has central heating</td>
<td>74.9</td>
</tr>
<tr>
<td>Social cohesion, score</td>
<td>3.4 (0.91)</td>
</tr>
</tbody>
</table>

\(^a\)Other includes American Indian or Alaska Native, Asian, Hispanic or Latino, other (specified by the participant), biracial, and multiracial.

Table 2. Self-reported health impacts, weighted (N = 424).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Not at All (%)</th>
<th>Slightly or somewhat (%)</th>
<th>Very much (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer heat</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical health</td>
<td>22.9</td>
<td>60.0</td>
<td>17.1</td>
</tr>
<tr>
<td>Mental health</td>
<td>43.3</td>
<td>49.9</td>
<td>6.8</td>
</tr>
<tr>
<td>Winter extremes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical health</td>
<td>34.3</td>
<td>54.1</td>
<td>11.5</td>
</tr>
<tr>
<td>Mental health</td>
<td>47.8</td>
<td>46.4</td>
<td>5.8</td>
</tr>
</tbody>
</table>

Regression analyses

Summer heat

Health status (human capital) and social cohesion (social capital) were negatively associated with physical and mental health impacts of summer heat (Table 4), providing support for hypotheses H2a, H2b, H7a, and H7b. Participants with good/very good health had lower odds of reporting more physical health (OR = 0.125, \( p < 0.001 \)) and mental health impacts (OR = 0.379, \( p = 0.006 \)), and those with neither good nor poor health had lower odds of reporting more physical health impacts (OR = 0.402, \( p = 0.014 \)) compared to those with very
poor/poor health. As social cohesion increases, the odds of reporting more physical health (OR = 0.724, \( p = 0.009 \)) or mental health impacts (OR = 0.710, \( p = 0.004 \)) decrease.

**Winter extremes**

Health status (human capital) and social cohesion (social capital) were negatively associated with physical and mental health impacts of winter extremes, a pattern similar to those found for summer heat (Table 5), providing support for hypotheses H9a, H9b, H14a, and H14b. Participants with good/very good health had lower odds of reporting the highest category of physical health impacts (compared to the lowest; OR = 0.054, \( p < 0.001 \)) and of reporting more mental health impacts (OR = 0.291, \( p < 0.001 \)).
compared to those with very poor/poor health. As social cohesion increases, the odds of reporting the highest category of health impacts (compared to the lowest; OR = 0.571, \(p = 0.013\)) and of reporting more mental health impacts (OR = 0.710, \(p = 0.004\)) decrease.

While the results for summer heat found no association with income level (financial capital), results for winter extremes found a negative association between income and physical health impacts (Table 5), providing support for hypothesis H10a. As income level increases, the odds of reporting the middle category (OR = 0.766, \(p = 0.002\)) or highest category (OR = 0.596, \(p = 0.003\)) of physical health impacts decrease (compared to the lowest category of impacts).

### Limitations

While a strength of this study is its focus on a population likely vulnerable to climate change impacts, results should be considered in light of study limitations. First, we used only one single-item quantitative measure for each physical and mental health impact, although open-ended qualitative items provided nuanced responses for some participants. Second, nonresponse bias suggests that participants are not necessarily representative of the study census tracts. Third, this study explores associations among capitals and health impacts, conceiving capitals as potential protective factors; yet, relationships found are not necessarily causal, and there may also be associations with other forms of each capital that are not studied here. Fourth, the study sample is limited to a single city in the

<table>
<thead>
<tr>
<th>Variable</th>
<th>Physical health impact: slightly or somewhat</th>
<th>Physical health impact: very much</th>
<th>Mental health impact</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Est.</td>
<td>SE</td>
<td>OR</td>
</tr>
<tr>
<td><strong>Human capital</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education, HS or less</td>
<td>0.262</td>
<td>0.322</td>
<td>1.300</td>
</tr>
<tr>
<td>College degree+</td>
<td>-0.188</td>
<td>0.355</td>
<td>0.828</td>
</tr>
<tr>
<td>Health, very poor/poor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neither good/poor</td>
<td>-0.313</td>
<td>0.542</td>
<td>0.731</td>
</tr>
<tr>
<td>Good/Very good</td>
<td>-0.773</td>
<td>0.515</td>
<td>0.462</td>
</tr>
<tr>
<td><strong>Financial capital</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Income level</td>
<td>-0.267**</td>
<td>0.087</td>
<td>0.766</td>
</tr>
<tr>
<td>Emergency savings</td>
<td>0.313</td>
<td>0.268</td>
<td>1.368</td>
</tr>
<tr>
<td><strong>Physical capital</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Homeownership</td>
<td>-0.001</td>
<td>0.259</td>
<td>0.999</td>
</tr>
<tr>
<td>Central heating</td>
<td>-0.171</td>
<td>0.303</td>
<td>0.843</td>
</tr>
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<td><strong>Social capital</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Social cohesion, score</td>
<td>0.088</td>
<td>0.135</td>
<td>1.092</td>
</tr>
<tr>
<td><strong>Control variables</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male gender</td>
<td>-0.294</td>
<td>0.241</td>
<td>0.745</td>
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<tr>
<td>Age (years)</td>
<td>0.009</td>
<td>0.007</td>
<td>1.009</td>
</tr>
<tr>
<td>White or Caucasian</td>
<td>0.720***</td>
<td>0.260</td>
<td>2.054</td>
</tr>
<tr>
<td>Married/Long-term partner</td>
<td>0.566*</td>
<td>0.260</td>
<td>1.761</td>
</tr>
</tbody>
</table>

Note: Physical health is modeled with multinomial logistic regression (reference group = Not at all). Mental health is modeled with ordinal logistic regression (1 = not at all, 2 = slightly or somewhat, 3 = very much). Est.: Parameter estimate; SE: standard error; OR: odds ratio; HS: high school. *\(p < 0.05\); **\(p < 0.01\); ***\(p < 0.001\).
Southeastern United States, and results are not necessarily generalizable to populations in other settings. Future research that collects data during or immediately after an extreme weather event, uses more detailed health impact measurement, conducts experimental studies of how changes in capitals affect outcomes, or represents multicity comparative or national studies could help address these limitations.

**Discussion and implications**

This study examined physical and mental health impacts of two kinds of weather extremes among a predominantly low- and moderate-income sample of residents. The study also tested how certain forms of human, financial, physical, and social capital may be associated with health impacts to explore possible protective factors.

Overall, reported health impacts of summer heat and winter extremes are common in the study setting, with several examples identified of how health is affected beyond prior studies’ typical focus on mortality, hospitalization, or psychiatric emergencies. Before and during these events, social workers who practice directly with clients should be aware of the likelihood of increased physical and mental health impacts and consider the environmental hazard as a contextual factor affecting clients’ lives. Future research could involve partnering with social work practitioners to better understand the ways that physical and mental health are impacted by weather extremes and studies designed to have more nuanced measures of health impacts. With the recent introduction of environmental justice competencies into social work training (Council on Social Work Education, 2015), and environmental social work as an emerging area of practice, there is still much need to conduct new social work research and educate current and future social workers about such human–environment interactions. Development of continuing education classes for licensing requirements may be a strategy for reaching already practicing social workers about these critical issues.

Regression analyses point to specific kinds of human and social capital—health status and social cohesion—as possible protective factors from health impacts of summer heat and winter extremes, and financial capital for winter extremes. Health status had a large effect size for physical health impacts under either event. Compared to participants with the highest health status, those with the lowest health status are 8.0 times more likely to report a higher category of physical health impacts from summer heat (taking the inverse of the odds ratio, 0.125) and 18.5 times more likely to report the highest category of physical health impacts from winter extremes. Analogous effect sizes for mental health impacts are 2.6 for summer and 3.4 for winter.

The finding that people with lower health status may be more likely to experience health impacts of extreme weather is consistent with prior studies in this area (e.g., Maier et al., 2014; Yardley et al., 2011). Extreme weather fluctuations can exacerbate existing health problems or underlying medical conditions, with people having less physical resilience to cope or adapt. Further, physical health impacts may also affect mental health. Social workers should be aware of the increased risks to these particular groups, stay informed of health- and weather-related resources, and provide referrals that clients with lower health status may need during extreme weather events. These may include lists of local heating and cooling centers (and transportation to centers if needed) and energy-related financial assistance or weatherization programs to help ensure homes are
temperature safe. For groups with pulmonary health concerns, lower air quality when temperatures rise (Kinney, 2008) can be a particular concern. Medical social workers, in particular, might focus on educating these groups about their increased vulnerability as climates change and on connecting them to financial resources for breathing devices (e.g., inhalers, nebulizers). To help improve baseline health overall, social work involvement with both the movement toward integrated health care and with policy efforts to ensure access to health-care coverage could help ensure that vulnerable groups have access to quality physical and mental health care, a need exacerbated by the impacts of weather extremes in a changing climate.

Effect sizes for social cohesion are similar for physical and mental health impacts from summer heat and mental health impacts from winter extremes, at approximately a 38–41% increase in odds of higher impacts for every 1 point decrease in social cohesion. For physical health impacts of winter extremes, the effect is larger—a 75% increase in odds of higher impacts for every 1 point decrease in social cohesion. In neighborhoods with more social cohesion, people may be more likely to check on each other during extreme weather events and help neighbors access resources that help protect health (e.g., visiting elderly neighbors, ensuring neighbors without air conditioning have fans; Mason, Ellis, & Hathaway, 2017). Also, feelings of social cohesion may improve baseline mental health and perceived quality of life, which can then serve as health impact buffers during stressful events—weather related or otherwise.

Indeed, building social cohesion and other forms of social capital is an emerging area in the broader climate adaptation and disaster literature. Social capital can enhance community resilience, and it has been suggested that community-based disaster prevention and response teams seek new and effective ways of building such capital, particularly among vulnerable groups (Messias, Barrington, & Lacy, 2012; Pfefferbaum, Van Horn, & Pfefferbaum, 2017). With skills in community organizing, assessment, group facilitation, and relationship building, social work practitioners can seek ways to proactively build social capital in neighborhoods with high concentrations of people most vulnerable to the impacts of weather extremes and climate change and partner with social work scholars in studying the effectiveness of those efforts. Specific social work strategies to pursue, for example, may include working proactively with neighborhood groups to create tailored weather preparedness plans and strategies for checking on isolated or elderly neighbors (e.g., phone trees, personal visits). Program and policy development that partner with city government and emergency managers to build social capital, and research evaluations of such partnerships, are also ripe for social work practitioners in this area to explore.

It is interesting that income, a form of financial capital, was only associated with physical health impacts of winter extremes. For people with less income, choosing to use space heaters or central heating may have too high of an impact on utility bills, or they may be less likely to seek medical care if they pay out of pocket or have high deductibles. Also, while this study found no support for savings as a form of financial capital that protects from health impacts, it may be that a scaled savings measure (how much a household has in savings) would yield different results and should be explored in future research.

Finally, that effect sizes for winter extremes are generally higher than for summer heat is of note. Few studies have examined impacts of winter extremes, even though they are expected to increase in some regions with climate change. Thus, studying inequities in climate impacts and access to resources needed to cope with these extremes is an area for future research.
Conclusion

Results suggest that physical and mental health impacts of summer heat and winter extremes are common in the study setting. Social workers should be aware of the likelihood of these impacts and consider ways to proactively plan for adaptation to weather extremes with vulnerable groups. Within predominantly low- and moderate-income communities, further study is needed of how investing in specific forms of capital may help people cope with and adapt to a changing climate. Social capital may be a particularly relevant and emerging area for social work to address within the pressing issue of climate, weather, and the health of vulnerable groups.

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