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Staying cool in a changing climate: Reaching vulnerable populations during heat events

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Abstract

The frequency and intensity of hot weather events are expected to increase globally, threatening human health, especially among the elderly, poor, and chronically ill. Current literature indicates that emergency preparedness plans, heat health warning systems, and related interventions may not be reaching or supporting behavior change among those most vulnerable in heat events. Using

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a qualitative multiple case study design, we comprehensively examined practices of these populations to stay cool during hot weather ("cooling behaviors") in four U.S. cities with documented racial/ethnic and socio-economic disparities and diverse heat preparedness strategies: Phoenix, Arizona; Detroit, Michigan; New York City, New York; and Philadelphia, Pennsylvania. Based on semi-structured in-depth interviews we conducted with 173 community members and organizational leaders during 2009–2010, we assessed why vulnerable populations do or do not participate in health-promoting behaviors at home or in their community during heat events, inquiring about perceptions of heat-related threats and vulnerability and the role of social support. While vulnerable populations often recognize heat's potential health threats, many overlook or disassociate from risk factors or rely on experiences living in or visiting warmer climates as a protective factor. Many adopt basic cooling behaviors, but unknowingly harmful behaviors such as improper use of fans and heating and cooling systems are also adopted. Decision-making related to commonly promoted behaviors such as air conditioner use and cooling center attendance is complex, and these resources are often inaccessible financially, physically, or culturally. Interviewees expressed how interpersonal, intergenerational relationships are generally but not always protective, where peer relationships are a valuable mechanism for facilitating cooling behaviors among the elderly during heat events. To prevent disparities in heat morbidity and mortality in an increasingly changing climate, we note the implications of local context, and we broadly inform heat preparedness plans, interventions, and messages by sharing the perspectives and words of community members representing vulnerable populations and leaders who work most closely with them.

Keywords

heat; vulnerability; preparedness; health behavior; social support

1. Introduction

Heat-related morbidity and mortality are expected to continue to rise globally, particularly for vulnerable populations: the elderly, those living in poverty, and the chronically ill (Anderson and Bell, 2009; Harlan et al., 2006; Kovats and Hajat, 2008; Medina-Ramón et al., 2006; Vaneckova et al., 2010). Mitigation efforts to reduce greenhouse gas emissions are underway globally (Molina et al., 2009). However, given current observations and future predictions for warming (IPCC, 2007), even if emissions are reduced drastically, behavioral adaptation to the changing climate is vital to protect public health and prevent potential disparities (Frumkin et al., 2008; Patz et al., 2000).

Deadly heat waves have illustrated the potential global burden of warming climates. In 2003, Western Europe experienced an unprecedented heat wave lasting nearly three weeks and resulting in approximately 70,000 heat-related deaths (Robine et al., 2008), including nearly 15,000 deaths in France alone. In the U.S., heat is the leading cause of death among all natural disasters, (NOAA, 2011) with Chicago's 1995 and Philadelphia's 1993 heat waves linked to 600 and 118 deaths (CDC, 1994; Semenza et al., 1996), respectively. While there is consensus that heat events such as these will increase in frequency and intensity globally (Fischer and Schär, 2010), heat-related mortality projections are complex and challenging to generate given that models must account for diverse health impacts; there is likely a ‘harvesting effect’ contributing to displaced mortality in years of life lost (Kinney et al., 2008; Kovats and Hajat, 2008); climate change, as a driving factor, is long-term and uncertain; and there are unforeseen moderating effects of emergent mitigation or adaptation strategies (Huang et al., 2011). Heat-related morbidity has been assessed through indicators such as emergency room visits, hospital admissions, and ambulance call-outs during and following heat events (Knowlton et al., 2009; Lin et al., 2009; Ostro et al., 2010; Semenza et al., 2009).

Researchers have attempted to project ranges of possible future temperature changes and consequent heat-related mortality, identifying vulnerable regions of the world in need of preparedness planning (Huang et al., 2011). Cheung et al. project a doubling of heat-related mortality in several Canadian cities by the 2050s. Baccini and colleagues (2008) predicted that heat in Europe’s near future will have the greatest health impacts in Barcelona, Rome, Valencia, Paris, and Budapest. In the U.S., for instance, a report by the Natural Resources Defense Council estimates that cities such as Detroit, New York City, Phoenix, and Philadelphia will see as many as 18,000, 1,100, 700, and 2,000 deaths, respectively by 2100 (Altman, 2012). Takahasi and colleagues (2007) calculated the “severest estimates in the uncertainty range (p. 339),” predicting global excess deaths to increase anywhere from 100% to 1,000% with greatest impacts in areas of high population density, e.g. China and India, by the century’s end.

Current rates and projections of future heat-related mortality have motivated many adaptive government strategies. For instance, following the European Heat Wave, France established a host of actions as part of a National Heat Wave Plan, including real-time surveillance of health data, improved air conditioning capacity for hospitals and retirement homes, the establishment of a warning system, and city tracking of neighborhoods with large populations vulnerable to heat (Fouillet et al., 2008). The approximately 2,065 deaths during a 2006 French heat wave were much fewer than the expected 6,452 deaths, and Fouillet and colleagues theorize this may be a result of successful preparedness planning implemented after the 2003 heat wave. Cities across the U.S. continue to develop related municipal plans (Bernard and McGeehin, 2004; O’Neill et al., 2010) and heat health warning systems (HHWS) (Ebi et al., 2004; Hajat et al., 2010; Sheridan and Kalkstein, 2004) In 2005, the U.S.’s National Weather Service began creating HHWS’s for all municipalities with populations of 500,000 or more (NOAA, 2005).

Despite the increasing number of plans and interventions, however, some studies report that no more than half of people typically alter their behaviors in response to advisory warnings (Kalkstein and Sheridan, 2007; Sheridan, 2007). Adaptive modifications in health behavior may significantly reduce one’s risk of morbidity or mortality associated with heat (Brucker, 2005; McGeehin and Mirabelli, 2001; Richard et al., 2011). These behaviors may include at-home strategies for staying cool (e.g., air conditioner use, drinking fluids) or activities outside the home (e.g., going to a shaded park or cooling center). Low-income populations may be less likely to participate in help-seeking behaviors during heat events, such as making health-related calls, as seen in a Hong Kong study (2011). Bassil and Cole’s (2010) structured review synthesizes studies that assess the role of municipal heat-related interventions globally, which remain largely unevaluated in practice (Kovats and Ebi, 2006). They conclude that interventions are likely reducing heat-related morbidity and mortality, but the most vulnerable populations, including the elderly, low-income, and homeless, are frequently not perceiving themselves as vulnerable or changing their daily practices during heat events.

Researchers have investigated how and why the public and, more specifically, vulnerable populations, participate in heat preparedness (Abrahamsom et al., 2008; Kosatsky et al., 2009; Richard et al., 2011; Semenza et al., 2008; Sheridan, 2007). Related studies generally measure the frequency or likelihood of behaviors in heat events. Among these, Richard and colleagues (2011) noted that external cues to action (i.e., external events such as health messages or a neighbor’s heat stroke) are more predictive of air conditioner use than one’s perceived severity of heat’s health effects for those with chronic heart and lung diseases. In this population, 25% of those without air conditioners said they would refuse to evacuate to a cooling center under emergency circumstances, and only 22% of all respondents would ask for assistance with cooling and hydration (Kotasky et al., 2009). Sheridan’s (2007) survey in three North American cities corroborated the public’s basic understanding of recommended cooling behaviors noted by others, and also reported that, while air conditioner ownership was high among his study’s participants (90%), over a third explained that economic factors determined usage rates. In a set of interviews with 73 seniors in the United Kingdom (U.K.), Abrahamson and colleagues (2008) reported from their qualitative study that seniors disassociate with being labeled as ‘old’ and may not alter their behaviors in a protective manner in response to targeted messages— a disassociation that is not unique to seniors in the U.K. (Pinquart and Sorenson, 2002). In a study of heat-adaptive behavior over an entire summer among 29 senior residents in Detroit, interviewees did not employ the full range of behaviors known to increase comfort in hot weather, although those living in high-rises or in homes surrounded by paved surfaces more frequently took action (White-Newsome et al., 2011).

Further, additional research may improve understanding of how social support, a construct largely predictive of health-related behaviors (Heaney and Israel, 2008), shapes perceptions of vulnerability and individual behaviors during heat events. Perhaps most notably, Klinenberg’s (2002) research highlighted how social isolation, even in a highly populated urban setting, was predictive of heat-related mortality during the 1995 Chicago Heat Wave. However, recent research investigates this conclusion further, suggesting that high levels of social support may actually reduce people’s sense of their own vulnerability to heat’s health effects (Wolf et al., 2010). Emergency planners, typically in the context of floods and hurricanes, often consider the role of family or friends in affecting one’s behavioral responses to emergency weather events (Kaniasty et al., 1990; Lowe et al., 2010; Lu, 2011). These studies suggest various types of social support may be relevant in the context of heat, including informational (e.g., heat health messaging), emotional (e.g., alleviating psychological anxiety of household evacuation to cooling centers) and instrumental (e.g., assisting with a broken air conditioner) support from one’s social network.

As local and national governments and organizations continue to prepare for heat, the current literature demonstrates that public health preparedness strategies must better acknowledge and reflect the real-world heat-related perceptions and experiences of those most medically, socially, and economically at risk. We conducted a qualitative, four-city case study in the U.S. to gather a broad range of descriptions about perceptions and experiences related to threats, vulnerability, health behaviors, and social support in the context of heat. We selected cities with documented racial/ethnic and socio-economic disparities (Harlan et al., 2006; Hondula et al., 2012; O'Neill et al., 2005; Rosenthal, 2010) whose diverse heat preparedness lessons would likely have relevance to a broader set of communities. We sought to identify key considerations about the role of individual and interpersonal factors for those working to translate uncertain heat projections into practical local-level strategies for protecting the public health of vulnerable populations.

2. Methods

A team of nine researchers conducted 159 semi-structured interviews with 96 community members and 77 government and non-profit leaders in Detroit, Michigan (n= 22 community members and 22 non-profit or government leaders); New York City, New York (n= 25 community members and 21 non-profit or government leaders); Philadelphia, Pennsylvania (n= 27 community members and 9 non-profit or government leaders); and Phoenix, Arizona (n= 22 community members and 25 non-profit or government leaders). Eleven interviews involved multiple participants (between two and four interviewees). The Institutional Review Boards of the University of Michigan, the University of Pennsylvania, and George Washington University reviewed and approved the study protocol for all interviews and participant compensation.

2.1 Case selection

We selected these cities for their diversity in geography, climate, population density, demographic composition, and variety of services implemented during heat events that are described at length elsewhere (citation blinded). Tables 1 and 2 summarize the demographic and climate characteristics of the cities. With populations ranging from approximately 712,000 in Detroit to eight million New York City, all cities have some level of heat-related programming and a HHWS in place. Across all four cities, cooling centers are a predominant strategy during heat events, and other standard programs include fan or air conditioner distribution, floor or block captain systems, and utility assistance. All cities also utilize some form of threshold to trigger advisory warnings, where Phoenix and Philadelphia use a HHWS (Ebi et al., 2004; Kalkstein and Sheridan, 2007) and Detroit and New York City use the heat index (Metzger et al., 2010; White-Newsome et al., 2009). While Phoenix experiences a warmer climate year-round, the threat of heat-related health outcomes is thought to be as or more concerning in typically colder climates such as those in Detroit, Philadelphia, and New York City where residents may be less likely to own an air conditioner or be prepared for heat events (Anderson and Bell, 2009; O'Neill and Ebi, 2009).

2.2 Data collection and analysis

We conducted interviews between March 2009 and February 2010. Prior to each interview, the purpose of the research was explained to potential interviewees and formal written consent was obtained for their participation. All but one interviewee consented also to having their interviews audio taped. We used geographic information systems first to create maps of each city based on U.S. Census data, narrowing our recruitment of community members to areas that would include racial and ethnic diversity and neighborhoods characterized by low-income or a large proportion of senior citizens and homeless individuals. This approach was motivated by epidemiologic literature suggesting disproportionate impacts of heat for older individuals, members of certain racial and ethnic groups, and those of limited socioeconomic means. Interviewees were then identified using purposive snowball sampling, where initial participants identified further contacts. Community members, primarily seniors and homeless individuals, were interviewed at senior centers, churches, transitional housing centers, or their homes and were asked questions pertaining to the risks and impacts of heat events, resources and barriers to heat preparedness, and their experiences during hot weather, both personally and of others in their social networks. In Phoenix, three interviews were conducted in Spanish. All interviews lasted approximately 30 minutes to an hour, and all community members who participated received $20 (U.S.) for their time.

Organization leader interviewees included employees at government agencies and not-for-profit organizations in public health, emergency preparedness, aging, housing, social services, energy management, and other related sectors. Participants were asked questions pertaining to heat-related programming, specifically about program goals, funding, reach, messaging and evaluation. These interviews lasted approximately one hour each. No compensation was offered since these individuals participated as part of their professional duties.

Analysis began after each audio interview file was transcribed. Interviews conducted in Spanish were transcribed and translated. The entire research team then open coded the transcripts, identifying themes *in vivo* or based on a theoretical lens. *In vivo* concepts, for instance, included 'compared to the 1995 Chicago heat wave' and discussion of 'preventing utility shut-off policies'. Researchers found data, as expected, related to program planning, epidemiological case definitions, and health behaviors, confirming preliminary codes such as 'personal reaction to heat', 'definition of heat wave' and 'obstacles to staying cool'. This open coding led to the development of approximately 100 codes. All research team members applied these codes to two transcripts through an iterative, team-based process, checking generally for inter-rater reliability and aggregating the full list of codes to approximately 50 codes. Once a final codebook with standard definitions was established, final codes were entered into NVivo 8.0 qualitative data management software package (QSR International, Australia) and used for focused coding of all 159 transcripts by four members of the research team. The research team conducted day-long workshops in all four cities between December 2010 and July 2011 to share preliminary results, triangulate and assess validity of results, and discuss the implications of study findings with government and non-profit leaders (ICLEI, n.d.).

3. Results

Community members discussed many of their strategies for staying cool in hot weather with particular attention to those commonly promoted in health messaging: air conditioner use and leaving to go to cooler locations, such as cooling centers. From their personal and professional experiences, community members and leaders offered additional insight on barriers and facilitators to these behaviors, noting instances where individuals unintentionally participate in harmful behaviors. Social support appears to influence these behaviors through familial and peer relationships, which are described through the words of diverse study participants. Many findings were consistent across all four cities, although we selected representative quotes from individual cities to reflect general themes. Findings that were city-specific are indicated as such.

3.1 Description of study participants

Researchers collected demographic data from 93 community residents across all four cities: Detroit (n=22), New York City (n=25), Philadelphia (n=27), and Phoenix (n=22). These data were not collected consistently for leaders of government or non-profit organizations. The mean age of community residents from the four case study cities was 68.7 years, ranging 25–88 years, and 76% of the interviewed residents were females. Overall, 49% of the residents identified as African American or black; 40% as white and 10% as multiple or other races. Overall, 64% of residents reported having completed high school or receiving their graduate equivalency degree.

3.2 Perceptions of threat and vulnerability during heat events

Interviewees recognized a host of potential threats associated with heat events, among them: morbidity, mortality, food safety, financial cost, excess waste, psychological distress, infectious disease, and electricity outage. Concerns of community members and leaders were similar. However, community members more frequently stressed concerns related to morbidity such as heat strokes and the outcomes of heat interacting with existing health conditions, while leaders emphasized heat-related mortality. Another notable theme among community members, but not leaders, was heat's effects on an individual's mood or energy levels and their resultant ability to function in activities of daily living, echoed here by Detroit and New York residents:

> When it gets really hot you cannot do anything because you become sick. The heat just make you sick. It is so hot. When you get too hot you just don't feel like doing anything.

> No energy and no appetite is mostly the problem. The low energy, yeah. Well it get you flustered. You feel hot inside. The heat will drain your energy.

Some community members described their own vulnerabilities in heat, but many others did not and organizational leaders noted that many seniors and homeless individuals disassociate themselves with being part of a vulnerable population. When asked to discuss heat vulnerability, community members frequently talked about others rather than themselves. Many interviewees reported stories of someone they knew or heard of getting heat stress, being hospitalized during a heat event, or in a few cases, dying from heat-related illnesses.

As organizational leaders indicated, for many seniors, ‘old’ always applies to someone who is older than them. A senior in Philadelphia illustrated this common way of thinking, “I am a senior too, now, but still to older people who are alone and who don’t drink water or anything especially those who don’t have anybody to come and check on them. I do think about those people.” Similarly, a homeless man in Detroit discussed caring for more senior homeless men in general and during heat events, “So my job is to look after him even though I am up in age and he is way older than me.”

Community members considered their current or past geography when describing why they did not see themselves particularly vulnerable to heat. In Phoenix, interviewees talked about heat as part of their lifestyle. One resident explained, “I don’t know anybody that has been affected by the heat or the coolness of the weather either because everybody that I know of is from here and they enjoy like I do because they were born and raised here.” Similarly, another Phoenix resident explained, “And the people that has been here the longest they can handle it better, or they are more immune to the heat.” In Detroit, New York, and Phoenix, interviewees frequently referenced growing up without air conditioners and “doing just fine then.” Some interviewees in these northern regions discussed growing up or traveling to warmer, southern parts of the U.S., helping them to acclimate. As one New York woman discussed her neighbor’s situation, “And my other neighbor…in the winter she goes to Florida. She’s here in the summer. I think she tolerates the heat better than I do because they say your blood thins out in Florida and I believe it’s true.”

3.3 Cooling behaviors during heat events

As described by community members in all case study cities, strategies for staying cool during heat events included use of air conditioners and fans, going to cooler locations, taking cold showers, drinking water, adjusting schedules to avoid travelling during the hottest parts of the day, opening windows, sitting in the shade, and wearing lighter clothes (see Table 3). In Phoenix, community members also discussed their use of evaporative coolers (colloquially referred to as swamp coolers). More common among low-income households in the Southwest U.S., evaporative coolers are thought to be less effective in late summer when conditions are hottest and most humid (Harlan et al., 2006).

3.3.1 Harmful behaviors—Organization leaders in all cities expressed concern that some vulnerable community members displayed unintentionally harmful behaviors during heat events. In Phoenix, for instance, a government employee explained that many people wait until they are thirsty to hydrate, which might put them at greater risk for heat-related morbidity or mortality. Also, using a fan can easily be done incorrectly with windows closed, leading to increased heat indoors and, potentially, associated heat-related health outcomes; a government employee in Philadelphia explained, “You do want a fan to exhaust all the hot air, pull the cool night breeze all the way through your house, through it and out…And that’s something that a lot of people don’t really understand.” In a few instances, organization leaders discussed how community members misinterpreted their household thermostat reading or made mistakes in using an air conditioner, such as, “The guy who took his wife to the ER because she was not feeling well on the account of the heat waited outside in the car and turned on the heat instead of the air conditioning.”

Many participants, both community members and leaders, also worried that vulnerable populations could accidentally overheat as, “they’re not registering the heat.” This inability to recognize personal heat stress was often attributed to medications, drugs and alcohol, or simply being older. For some, this meant not turning on an air conditioner or wearing heavy clothing, as described by a social service provider in Philadelphia, “Folks at the [senior center] told us that they have residents there on the hottest day of the summer sitting on the porch in a sweater.”

3.3.2 Air conditioner use—In this study, many of those with air conditioners appeared to use them, but financial cost was the barrier cited by the majority of these community members. Participants noted utility bills as an obstacle to staying cool in the summer. If they were unable to pay winter heating costs or associated late fees, their air conditioner use decreased in summer months, a pattern frequently described by interviewees in Detroit, Philadelphia, and New York City. However, one woman living in Phoenix’s warmer climate also explained this, “…yes it is expensive. In the winter times they will stick it to you with the heat and in the summer time with the cool…so we try to conserve as much as possible.”

Some community members also indicated that they disliked colder temperatures, sounds from the air conditioner, or associated physiological reactions they experience when using air conditioners, including aggravated respiratory problems or arthritis. One Detroit senior discussed the lack of air conditioning at the senior center she attends as something many prefer, “It will be roasting in here. I mean roasting. Half the seniors don’t want the air on so we suffocate. We suffocate…I mean because they don’t want it on because they will be cold. But it really should be on.” Another respondent avoided using her air conditioner due to concerns about contributing to a regional blackout. Other cooling measures were often used in place of the air conditioner or to supplement it. Only one respondent indicated that the air conditioner was the *only* behavior she employed to stay cool.

3.3.3 Going to cooler locations—Community members and leaders listed a host of places in their neighborhood where individuals went to stay cool, including public pools, libraries, malls, movie theatres, homeless shelters, parks, senior centers, and churches, and many described barriers related to these places. Usage was inconsistent and residents faced barriers to accessing some cooling areas. Lack of public funding has led to closing of parks, pool facilities, or public restrooms. Other cooler places are difficult to get to, such as malls or movie theatres, which are not always located in immediate city centers or on major public transportation routes. Community members across case cities explained that some places required entrance fees they could not afford. Those who were homeless or worked with homeless individuals explained exclusionary policies in parks and libraries, as in Detroit:

> You sit in a park and sometimes the police chase you away. I sat there because I am exhausted, and I am hot. And I just want to get, you know, the water. They don’t turn on the fountain till all the white folks come down here for the game and stuff…so you sitting there, and you baking. And then the police come and think you are loitering or a panhandler, or you are a vagrant.

In Phoenix, Detroit, and New York, community members discussed the hesitancy or inability of undocumented immigrant community members to access public cool places. Physical and psychological health issues can also hinder the process of actually leaving one's home. According to organization leaders, underlying health problems and frailty make travel to cooler locations outside the home difficult. Changing clothes to go to a relative's house or getting down the front stairs were barriers described when discussing experiences of less ambulatory individuals.

Community members commonly referenced cooling centers as another specific type of place they or others go to stay cool, although less frequently mentioned among Detroit residents. As described by community members and leaders, barriers to using cooling centers included concerns about culturally appropriate food, accommodations or care for pets, safe and affordable transportation to and from the centers, psychosocial elements of the home evacuation experience, distrust in the entities offering services at the centers or transportation to them, and general misconceptions as described below. As highlighted by a diversity of respondents, many unaddressed questions and concerns about cooling centers may deter community members from choosing to attend. For instance, as captured by a Detroit community member, "Well, they do have cooling shelters for homeless people". However, recreation centers in Detroit are actually converted and open to all of the public, not just individuals who are homeless, and, in fact, some homeless shelters in Detroit are not air-conditioned. Those who are homebound or who choose not to attend senior or recreation sites year-round can be uncertain of what happens there, and thus potentially less likely to go to a cooling center. A New York City government employee explained, "Am I going to be sitting in a room with nothing to do?" Similarly, a Philadelphian community member expressed, "I think if it's through the senior center–people who are used to using the senior center can use it. I think people who don't know where it is or don't use it are not going to start using it." Finally, some participants discussed apprehension or distrust of local services. A City of Detroit employee explained that community members told him they did not feel comfortable using a police precinct as a transportation pick-up point for cooling centers, and thus, did not go. A New York City employee posited that some community members might also avoid government facilities given their immigration status, "Yeah, the government is supposed to come and rescue me, and people would say, 'Well the government is the one who is persecuting me'."

Transportation was raised as both a resource and a barrier in all four cities for those trying to go to cooler places during heat events. While many community members positively referenced free or reduced-cost transportation programs for seniors or para-transit for individuals with disabilities (e.g., Access-a-Ride, Dial-a-Ride), an underlying concern across a diversity of participants was that not everyone used these services or that public transportation did not sufficiently get people to specific locations such as cooling centers. Some community centers do provide bus service, which participants described as particularly helpful on hot days if the buses are also air-conditioned. Waiting at a bus stop or on a subway platform in the heat is also a barrier to reaching a cooling site, as is the cost of public transportation.

3.3.4 Safety and cooling behaviors—Neighborhood safety was an underlying concern for community members, particularly seniors, thereby affecting relocation to cool places and at-home cooling behaviors. Seniors expressed this in all four cities, saying things like, "There is nothing to stop these teenagers from mugging us or beating us up," "I won't go out at night. I try not to come home late at night," and "…at this age, there's no reason for us to be out late at night." Risk of crime in the streets and parking structures was cited as a barrier to traveling to a cooling site. Some community members in all cities indicated that they were afraid to open their windows or doors for ventilation because of safety concerns. One Detroit resident was reluctant to open her window because the tree outside her apartment window was used as "the bathroom" by passers-by. Further, some organization leaders in Philadelphia and Detroit explained that in older homes, windows had been painted shut and could no longer be opened as a cooling strategy. Another interviewee in Phoenix explained that many people did not open windows or doors for fear of insects or animals entering their home, "There are many places that don't have a screen door. I said it [screens] costs a lot, and nobody here understands that."

3.4 Role of social support

Organization leaders referenced the role of social support in promoting cooling behaviors and social isolation as a risk factor for heat-related morbidity and mortality, sometimes directly referencing Klinenberg's (2002) research following the 1995 Chicago heat wave. In the context of a 2008 heat event in New York, one participant warned of focusing too heavily on social support as a predictor of health outcomes:

> …I think that the image of people who are affected by heat, it's like, 'Oh, they're socially isolated.' These weren't people that were socially isolated. It's maybe there wasn't awareness that the symptoms of like heat stroke or other illness relating to it, or maybe they had air conditioning, and they weren't using it because they didn't want to pay for it.

Indeed, participants' comments indicated that the role of social support was prominent yet complex. Participants discussed the role of family and friends in relation to informational, emotional, and instrumental support and the relationship between these supports and health behaviors.

3.4.1 Social support from family—Family, as one source of social support, was found to be generally protective during heat events. Many community members discussed their adult children's health messages as informational support through regular check-ins:

> My daughter most of all, she call me and say 'Mom, I heard the news.' I'd say 'Yes.' And she said 'Be alert and see what's going on…' '…Yes.' 'Wear light clothing. Don't walk.' She always say, 'Take your umbrella if you're going out in the sun.' I say, 'I am. I have my umbrella.'

Intergenerational messaging went both ways for some, as seniors also checked on younger generations, "I'll call my daughter and tell her, because I have my daughter, granddaughters and one baby great granddaughter. So they have to keep her cool. You know? Keep a fan. A wet washcloth, wash off all the time." This theme among community members was noted by a social service provider in New York, "…because the common thing that I see among older adults is that they normally care about their loved ones before they care about themselves… That's a constant among all cultural groups."

Social networks, however, could also be ineffective in encouraging cooling behaviors for vulnerable participants who do not want to burden family members for support. A subset of senior participants described how they “try not to bother” their adult children for cooling assistance during heat events. Interviewees in Detroit, New York City, and Phoenix, respectively, stated:

> If it’s 80, I’m not going out. Because my car is down, so I kind of have to walk everywhere I’m going or my daughter will come get me. And I try not to bother her because she has kids that go to school.

> I live alone. I have no one living [nearby]… a daughter with her family. They don’t live close to me. In the city, but they’re not very close. They live their lives. They go to work every day. Get up and go to work. I live by myself.

> Once you get old, they put you on one side like an old shoe. Yeah, once you are doing things for them like cooking, washing and things like that, you’re alright. But once you can’t do that, they don’t want you around. Like an old shoe. I keep up with myself because I know I don’t have too many kids to do that for you.

Some organization leaders stressed the need to recognize diversity in family structure and roles to better understand cooling behaviors. In New York, a social service provider explained, “In some other cultural groups, the role of the grandparents is to raise grandchildren…a grandparent who has to walk fifteen blocks to go pick up their grandchild during the heat is something that we have to learn how to work with.” A utility company employee in Detroit explained changes in housing circumstances due to a threatened economy, “Your seniors…they have their kids in their homes living with them, and they know that they are running up their bills. They feel that their bills are so way out of whack.” In such instances, seniors are responsible for offering this daily instrumental financial support to their family, thereby reducing their available funds for “extras” such as air conditioning.

3.4.2 Social support from peers—In addition to family, peers are generally a significant source of social support. Some participants discussed their tendency to keep to themselves, “I don’t have many friends. I stay home all the time and watch TV.” Emotionally, however, participants indicated how peers enabled people to commiserate and communicate concerns during heat events, “Talking on the phone to friends who are in the same situation…You know, ‘How are you handling it? How am I handling it?’ Because they’re basically my age, and we can compare who’s sweating more profusely than the other.” Instrumental support was common in the form of informal check-ins among friends, as well as block or floor captain programs, which existed in all four case study communities. These programs entail elected or assigned captains responsible for calling or knocking on doors regularly or during particular emergencies. Sometimes these systems form organically by grassroots action among neighbors, and sometimes they are the result of organized tenant associations or government agencies. Also, sharing information about community centers, frequently converted to respite centers during heat events, was a common form of informational support among seniors. Multiple community members talked about how they recruited others to come to the centers, "So I brought, where I live, I brought about nine people already here [to the senior center], and they like it."

4. Discussion

Generally, participants identified and described common cooling behaviors and identified barriers to regularly promoted heat preparedness advice, particularly air conditioner use and relocation to cooler locations. These behaviors (summarized in Table 3) reflect common heat-protection advice from public health agencies and organizations across Australia, Canada, Europe, and the United States, specifically those behaviors that Hajat and colleagues' (2010) deemed evidence-based. Noted by Hajat and colleagues, however, community members made few, if any, mentions of altering or considering the impacts of their own medications, which could have unknown population-level implications for heat-related morbidity. While participants generally recognized heat's threats to health and described protective cooling behaviors, we know this may not be enough to prevent projected heat-related morbidity and mortality. By describing their perceptions, behaviors, and social support's potential role during heat events, participants in this study have offered invaluable, nuanced insights for those designing health interventions and associated messaging to reach vulnerable populations as part of local or national heat preparedness plans.

4.1 Implications for practice

Our findings have important implications for the content of future heat-related health communication. First, typical heat-related health messages must be improved to more explicitly address common misguided behaviors such as ineffective fan use or hydration efforts. Second, pre-season doctor recommendations and additional research regarding thermoregulation for various medications may not be reaching vulnerable populations, where such messages may need enhancement (Hajat et al., 2010). Thirdly, preparedness professionals should acknowledge cultural and economic characteristics of families, targeting messages accordingly, as is frequently promoted for all-hazards natural disaster planning (Seidenberg, 2009). Additionally, those designing and evaluating large-scale health communication may attempt to craft messages that do not single out a particular group, such as older people, as being especially vulnerable to heat's threats, but emphasize that anyone can be affected, and mention symptoms that may precede more serious health problems, such as loss of appetite. Finally, messages should recognize local perceptions of vulnerability. For instance, in the Northeast or Midwest, messages should recognize attitudes about acclimatization.

Further, our findings illustrate new opportunities for delivering heat-related health communication. Intergenerational messaging is a promising approach to promote health behaviors during emergencies (Hutton, 2008), since older generations need assistance even though they may avoid asking for it during heat events (Kosatsky et al., 2009) thinking they are not vulnerable or that they may be a "burden". This need to focus on older populations is reinforced by Wolf and colleagues' (2010) findings that elderly people valued their independence and expressed reluctance to ask for assistance during heat events, even when they had a robust social network. Methods to encourage intergenerational messaging may include school-based outreach to youth as potential messengers, as recommended by some interviewees. Also, the role of peers among seniors appears to be addressed only minimally in related literature and may be a considerable source of emotional or informational social support to protect vulnerable individuals during or prior to heat events. This is apparent in the practice of peers checking on each other, the presence of block and floor captain programs in all four cities, and the recruitment of peers to attend senior centers year-round. Thus, peers should be considered as important deliverers of health messages relevant to protection from heat. All of these approaches may not, however, reach homeless populations, where social service providers remain vital in locating individuals and communicating heat's threats. While our findings may improve reach of health messages to vulnerable populations, limited personal resources to undertake cooling behaviors suggest additional resources must be assessed also.

Like others (Sheridan, 2007), we found the cost of air conditioning to be a major barrier. Air conditioner use can be protective in heat events (O'Neill et al., 2005; Richard et al., 2011) and is often touted in heat-related health messages (Hajat et al., 2010). Even so, it is likely maladaptive in the face of climate change (Barnett and O'Neill, 2010). Use of air conditioners contributes to climate change and can overload large-scale electrical grids during heat events, while "fuel poverty" (Liddell and Morris, 2010) may exclude vulnerable populations from achieving its protective benefits. Programs and messages that promote air conditioner use may be more effective when they also specifically acknowledge and address the needs of those who cannot or do not use air conditioners or those that use them minimally.

Recognizing that air conditioners may be maladaptive, and in the absence of resources to assist families with year-round utility costs, planners may consider disseminating one of an increasing number of resources that promote 'traditional' cooling behaviors. The City of Philadelphia (Simmons Schade, 2008), for instance, has published the *Philadelphia Rowhouse Manual* that includes some tips, besides air conditioner use, for cooling this older style of home. Such materials could be revisited and adapted to share with vulnerable populations in multiple communities, acknowledging regional housing types and offering common suggestions, such as use of awnings, vegetation, strategic ventilation, and weatherization, to enhance health and comfort across the U.S. In this study, we did not ask what types of homes or facilities participants lived in, but local heat preparedness programming would benefit from this type of tracking given that indoor and outdoor housing features can be a factor in one's vulnerability (Salagnac, 2007). These approaches also support climate change mitigation efforts by encouraging strategies that do not rely solely on use of energy derived from the burning of fossil fuels.

To encourage use of cool places, both barriers and resources must be recognized to ensure use by vulnerable populations. This is particularly relevant in addressing the needs of homeless individuals, whereas other vulnerable populations, such as elderly or disabled individuals, may be less likely or able to relocate during a heat event. Misconceptions about cooling centers should be addressed with tailored media outreach during heat events, as different cities employ different types of facilities. Media should answer common questions about cooling centers— who goes to them, who coordinates them, and what do you do while there? Both leaders and community members emphasized that pets were a major consideration when deciding whether or not to evacuate one's home to go to a cooler location. While social service providers may have limited resources to assist vulnerable humans during hot weather events, interventions that do not provide safe spaces or plans for these animals may ultimately fail to protect their owners, as seen in other emergency events (Hall et al., 2004). Those working on heat-related issues should forge partnerships with agencies in charge of cool places that may not be official cooling centers (e.g., parks, libraries) to identify policies that promote safety during hot weather and welcome people of diverse age ranges and backgrounds, especially vulnerable individuals. If cooling centers continue to be a primary heat preparedness strategy, ongoing evaluation of cooling centers is needed with attention to transportation planning and perceived safety. This may include geographic tracking of vulnerable populations, transportation programs, or calls to social service providers during heat events. Heat preparedness could also entail *creating* cool places, by establishing water stations at parks or centers that homeless individuals frequent or common air conditioned spaces in senior housing centers or communities, per the suggestions of our interviewees.

In our four-city study, interviewees highlighted many commonalities in their understanding and experiences of heat, but they also emphasized ways that preparedness plans should consider local risk factors in designing health behavior messages and interventions. Community members and organizational leaders in all four cities identified similar perceptions of threat and vulnerability, cooling behaviors, and economic barriers, but some themes were more common in specific cities. Although varied, the existence of myths and misconceptions about cooling centers were prevalent in all four cities. Issues of safety in the context of travelling to cool places or opening windows were raised in all cities, but more frequently in Detroit and New York. Residents of Detroit also mentioned cooling centers least frequently, as, historically, there have been fewer sites and less outreach. While cultural factors were discussed across all four cities, culture's relevance in the context of social support was expressed largely in New York City, where great cultural diversity may motivate similarly diverse strategies. Geography also appeared to impact one's sense of vulnerability. If someone always or previously lived in a warmer climate, such as that of the Southern U.S., interviewees frequently felt these individuals were less vulnerable. While there may be some scientific basis for acclimatization (Medina-Ramon et al. 2006; Medina-Ramon and Schwartz 2007), interviewees did not generally discuss how age, chronic illness, increasing temperature trends, or other risk factors countered this personal history.

4.3 Study limitations

Our research has some limitations. We spoke with a variety of community members and leaders, but not with many elderly who were fully homebound. This population may have further insights on how heat wave programming could address their specific needs. However, researchers did ask participants to discuss the behaviors of community members who may be vulnerable or isolated with little social support and how to best address their circumstances. Because some interviews were conducted during times when heat was not an immediate concern, participants may have been less likely to recall experiences as vividly as they may have during an actual heat event. Further, it may have been helpful to collect additional background information on government or non-profit leaders to assess their level of relevant training; however, snowball sampling techniques implied their professional involvement in heat-related issues. While results varied among study cities in terms of the reported health behaviors, risk perceptions, and descriptions of the role of social support, for example, the reasons for these differences or similarities could only be speculated upon, not statistically investigated, given our study design. This study was not intended to assess and compare each city's heat preparedness plan's impacts on behavior, but such studies would also be valuable. Although these findings are context-specific, they do describe a range of perceptions about and experiences during heat events for vulnerable populations that are likely applicable and relevant to other cities globally.

4.3 Conclusion

By offering the direct perspectives and words of community members representing vulnerable populations and leaders who work most closely with them in these cities, this paper adds to our current understanding of heat-related health behaviors at a time when heat preparedness plans are growing increasingly strategic, organized, and necessary globally. Specifically, our research adds to a growing area of scholarship focused on protecting vulnerable populations, as current interventions may not be reaching the elderly, low-income, or homeless populations. We offer a deeper understanding of the nuanced perceptions of heat-related vulnerability; misconceptions, myths, and barriers that determine adoption of cooling or maladaptive behaviors; and the complex role of social support that should be recognized in heat-related health messages that may accompany a heat warning or advisory. While promoting basic lists of cooling behaviors is helpful, additional evidence-based messages are needed that recognize personal, interpersonal, and community resources that shape the experience of vulnerable individuals during heat events. Our findings suggest that ongoing health behaviors may more likely be maintained during a heat event than the adoption of new behaviors. Thus, public health must support leaders at social service (e.g., para-transit, senior centers, meal delivery programs) or community programs (e.g., weatherization, block groups) that work with vulnerable populations in efforts to prepare for outreach prior to and during heat events. We hope our findings inform design or refinement of local or national heat preparedness plans. Evaluation, in combination with tracking heat-related health occurrences in a systematic and consistent way, is then necessary to understand how local or national preparedness plans shape behavior changes among vulnerable populations during heat events.

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Study Highlights

- We conduct case studies of heat-related health behaviors in four U.S. cities.
- Interviewees explain barriers to basic cooling strategies such as fan use.
- Intergenerational and peer relationships affect heat-related health among seniors.
- Ongoing planning may best support uptake and maintenance of key health behaviors.
- We inform interventions to protect vulnerable populations in a changing climate.

Table 1

Demographic overview of case study cities[a,b]

	Detroit, Michigan Total (%)	New York City, New York Total (%)	Philadelphia, Pennsylvania Total (%)	Phoenix, Arizona Total (%)
Total Population	711,910	8,184,899	1,528,306	1,449,481
Population Density (per sq. mile)	5,131	27,045	11,397	2,805
Race				
White	77,423 (10.9%)	3,649,022 (44.6%)	634,294 (41.5%)	690,476 (47.6%)
Black or African American	589,659 (82.8%)	2,048,482 (25.0%)	668,961 (43.8%)	100,335 (6.9%)
Other	44,828 (6.3%)	2,487,395 (30.4%)	225,051 (14.8%)	220,537 (15.2%)
Ethnicity				
Hispanic or Latino	666,330 (93.6%)	2,346,826 (28.7%)	188,503 (12.3%)	571,745 (39.4%)
Not Hispanic or Latino	45,580 (6.4%)	5,838,073 (71.3%)	1,339,803 (87.7%)	877,736 (60.6%)
Education (population 25–64 years)				
Less than high school	99,961 (22.6%)	1,131,619 (20.4%)	195,946 (20.0%)	170,522 (19.0%)
High school or equivalency	289,094 (65.4%)	2,563,857 (46.2%)	564,089 (57.5%)	503,536 (56.1%)
Advanced degree	52,949 (12.0%)	1,852,648 (33.4%)	221,378 (22.6%)	223,823 (24.9%)
Poverty status (for whom determined)				
Living in poverty	263,864 (37.6%)	1,621,327 (20.1%)	397,083 (26.7%)	321,560 (22.5%)
At or above poverty	438,146 (62.4%)	6,440,390 (79.9%)	1,090,388 (73.3%)	1,109,292(77.5%)
Age				
Under 18 years	189,540 (26.6%)	1,765,279 (21.6%)	343,370 (22.5%)	403,416 (27.8%)
18 years – 65 years	440,548 (61.9%)	5,422,274 (66.2%)	998,762 (65.4%)	919,649 (63.4%)
Over 65 years	81,822 (11.5%)	997,346 (12.2%)	186,174 (12.2%)	126,416 (8.7%)

[a]Source: U.S. Census Bureau, 2010

[b]Demographics approximated through sampling techniques of the American Community Survey.

Table 2

Normal daily high & low heat index (HI)[a,b] in July & January for case study cities

Case Study City	July daily high HI F(C)	July daily low HI F(C)	January daily high HI F(C)	January daily low HI F(C)
Detroit, Michigan	82.58 (28.10)	65.44 (18.58)	29.28 (−1.51)	22.74 (−5.15)
New York City, New York	84.49 (29.16)	72.11 (22.28)	36.78 (2.65)	30.63 (−0.76)
Philadelphia, Pennsylvania	87.72 (30.96)	70.58 (21.44)	38.45 (3.58)	29.49 (−1.39)
Phoenix, Arizona	104.77 (40.43)	85.65 (29.80)	66.27 (19.04)	47.07 (8.37)

[a]Source: Hourly Heat Index 30-Year (1981–2010) Climate Normals, National Climatic Data Center, 2011

[b]Heat index is a composite measure of air temperature and relative humidity. Data are collected at Detroit Metropolitan Airport, New York La Guardia Airport, Philadelphia International Airport, and Phoenix Sky Harbor International Airport.

Table 3

Personal behaviors to avoid or deal with heat as reported by residents of Detroit, Michigan; New York, New York; Philadelphia, Pennsylvania; and Phoenix, Arizona during interviews taking place in 2009 and 2010.

In-home Behaviors	Out-of-home Behaviors
Stays indoors.	Alters daily schedule to avoid the heat.
Uses air conditioner or swamp cooler.	Goes to cooler indoor locations:
Uses floor or ceiling fans.	Friends' or relatives' homes
Opens windows.	Senior or cooling centers
Closes blinds, drapes or shades.	Libraries
Goes to the basement.	Private businesses.[a]
Dresses in cooler or lighter clothing or wears less clothing.	Goes swimming in a swimming pool or walks through a sprinkler.
Fans self with a hand fan.	Sits in the shade or the yard.
Drinks non-alcoholic beverages to cool off or stay hydrated.	Goes to cooler outdoor locations, e.g., a park, river or location with a mister.
Eats light meals that don't require cooking.	Wears a hat when outside.
Doesn't use other appliances as much.	Carries an umbrella.
Eats ice cream or popsicles.	Avoids direct sunlight.
Stocks supplies or water in case of heat wave.	Carries beverages when going outside.
Takes cold shower or bath.	Uses door-to-door public transportation.
Uses a wet cloth or ice pack on skin.	
Engages in less physical activity.	

[a]Private businesses which respondents traveled to in order to stay cool were stores, malls, restaurants, casinos, movie theaters and concert or recital venues.