Heat Mitigation in the Southeastern United States

Author(s): MICHAEL J. ALLEN, JENNIFER L. WHYTLAW, NICOLE HUTTON and JEREMY S. HOFFMAN

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Heat Mitigation in the Southeastern United States: Are Cooling Centers Equitable and Strategic?

MICHAEL J. ALLEN
Towson University

JENNIFER L. WHYTLAW
Old Dominion University

NICOLE HUTTON
Old Dominion University

JEREMY S. HOFFMAN
Science Museum of Virginia and Virginia Commonwealth University

HIGHLIGHTS

- The southeastern US faces unique challenges related to climate change, heatwave vulnerability, and social adaptive capacity.
- Cooling centers are not strategically co-located for heat-vulnerable populations.
- Tennessee is the only state with an existing comprehensive state cooling center database.
- More coordination across scales of government agencies is needed to reduce adverse heat-health outcomes.

ABSTRACT: *In the face of anthropogenic climate change, the ability of communities to reduce the heat-health burden remains a significant public health issue. This research is the first to identify cooling centers across the southeastern United States, providing a resource for stakeholders. The study evaluates the spatial relationship of these venues for heat-vulnerable populations. Using a survey and publicly available data, researchers identified 1,433 cooling centers, though significant variability exists across states and local jurisdictions. Of the nine states examined, Tennessee was the only location with a health system–supported cooling center network. Only 36 percent of the Southeast's population lives within a fifteen-minute drive of a cooling center. In most states, less than 10 percent of vulnerable populations (elderly, non-white, below poverty) are within this driveshed. Most cooling centers were found in urban environments, although heat vulnerability is not exclusively a city issue. Further research is needed to strengthen cross-agency collaboration and evaluate the effectiveness of cooling centers in areas of both high and low population density. Some states have integrated heat as part of hazard mitigation plans, but additional research is needed to explore how these plans go beyond hazard identification and strengthen vulnerable communities' ability to mitigate heat risk.*

KEYWORDS: Heat, Vulnerability, Hazards, Climate, Emergency management

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INTRODUCTION

Morbidity and mortality both increase during heatwaves (Cheng et al. 2019, Nori-Sarma et al. 2022), yet many of the adverse heat-health outcomes are preventable (Sarofim et al. 2016). Often called the *silent killer*, excessive heat is a leading cause of weather-related deaths (National Weather Service 2022). In the United States, studies estimate at least 5,000 excess deaths per year (Weinberger et al. 2020), although numbers may be underreported due to underlying and contributing causes (U.S. Environmental Protection Agency 2022).

Over the last thirty years, the number of heat-related health issues has declined due to the implementation of diverse mitigation strategies including the development of heat watch-warning systems, increased air conditioning prevalence, improved communication, and awareness (Toloo et al. 2013, Barreca et al. 2016). However, despite these successes, many locations in the southern US have experienced an increase in mortality in recent years, drawing attention to the disproportionate impact heat has on specific populations (Sheridan et al. 2021).

With projected increases in heatwave frequency, duration, and intensity likely to continue due to anthropogenic climate change (Hayhoe et al. 2014), the collective human vulnerability will likely also grow (Huber et al. 2017, Broadbent et al. 2020). Globally, overnight minimum temperatures are warming more rapidly than daytime temperatures, providing little relief during a heatwave (Murgae et al. 2017). Additionally, pavement and other surfaces in the urban environment absorb and retain heat, elevating temperatures within cities and exacerbating adverse health outcomes (Vose et al. 2017). While direct thermal exposure is important, social factors also modify vulnerability by lowering adaptive capacity (or the ability of individuals to apply some intervention to lower their exposure or sensitivity to a stressor like heat). Various populations show elevated risk associated with heat. The elderly and those with underlying medical conditions are well-documented populations known to be at higher heat risk (Sheridan and Allen 2018). Thermal sensitivity is reduced with age, and prescription drugs may affect the body's ability to thermoregulate. Heatwaves exacerbate pre-existing conditions such as cardiovascular disease, diabetes, and asthma (Gronlund et al. 2014, Barreca and Schaller 2020). In the US, non-white communities experience thermal conditions differently than predominantly white neighborhoods. Historic urban planning policies such as redlining help explain these differences in the built environment, which elevate heat exposure and vulnerability (Hoffman et al. 2020, Li et al. 2022, Schinasi et al. 2022). The poor are also a population shown to be at risk for heat-related health issues (Uejio et al. 2011). While air conditioning has shown to be an effective heat-mitigation strategy, the complex relationship of economic and institutional factors that lag in low-income communities heightens risk. Recent estimates suggest that, like exposure to heat extremes, the prevalence of air conditioning tends to separate along racial and economic boundaries within neighborhoods in the US, including southeastern cities (Ahn and Uejio 2022, Romitti et al. 2022). The ability to pay for such interventions or travel to a cooling center is an inhibiting factor for these communities (Thomas et al. 2008, Nayak et al. 2019, Alizadeh et al. 2022). In-home adaptive capacity for frontline communities is at present insufficient to protect themselves from the risk of extreme heat.

While many other heat management strategies exist, cooling centers are a mitigation tool employed to reduce thermal sensitivity (Sampson et al. 2013, Meerow and Keith 2022). A cooling center is a publicly accessible location where residents of a community can shelter in a climate-controlled environment. This strategy becomes increasingly important for communities that do not have access to home air conditioning or the financial capital to maintain such energy-intensive cooling systems for extended periods. Cooling centers vary, with some municipalities using government buildings such as either a library or school while other locations may leverage community centers or public parks (Widerynski et al. 2017, Allen et al. 2022).

Previous research has evaluated the placement and distribution of cooling centers across a variety of administrative boundaries such as municipalities or counties as well as areas that cut across one another (Bradford et al. 2015, Berisha et al. 2017, Ahn and Chae 2018, Nayak et al. 2019, Kim et al. 2021, Mallen 2022, Adams et al. 2023). The present study expands upon the methodology and results from Allen et al. (2022), who focused on Virginia, to include the entire southeastern United States, identifying cooling shelters and comparing the placement of these refuges for vulnerable populations. This study is the first to comprehensively evaluate the placement of cooling centers in the southeastern United States outside of metropolitan area–focused contexts (Adams et al. 2023).

Although there is regional variability, the southeastern US presents unique challenges as it relates to climate change, heatwave vulnerability, and social adaptive capacity. First, the social history of the region echoes in the present day as inequitably distributed heat exposure risk (Benz and Burney 2021), even reflecting *de facto* segregation policies such as neighborhood redlining in patterns of intra-urban surface temperature disparity (Hoffman et al. 2020), heat vulnerability (Yardley et al. 2011, Manware et al. 2022), and health outcomes (Swope et al. 2022). These patterns are also seen in the distribution of air conditioning prevalence, even though it is widely used across the region and regarded as one of the principal home-based heat-adaptive strategies (Ahn and Uejio 2022, Romitti et al. 2022). Second, land cover change in the Southeast has been dominated by expanding imperviousness and developed land cover at the expense of forested areas, more than any other US region (Pengra et al. 2020), exacerbating heat and other climate threats as well as exposure to them (Ferguson and Ashley 2017, Freeman and Ashley 2017, Hansan et al. 2022) even as population in the region continues to increase in metropolitan and coastal areas (U.S. Census Bureau 2021). Southeastern US states also drastically underestimate the risks associated with extreme heat, as evidenced by the low quality of hazard mitigation plan approaches to either prioritize or evaluate extreme heat risks and impacts on individual communities within these areas (Constible 2022, Errett et al. 2023). Extreme heat risk often gets conflated with other hazards such as drought within hazard mitigation plans. Constible (2022) evaluated hazard mitigation plans for eleven southeastern states and found that only Alabama included language outlining mitigation strategies to reduce heat risk and even then, ranked the risk as a low priority compared to other hazard events such as flooding.

This research aims to not only evaluate the placement of cooling centers in the Southeast, but also draw attention to the need for local and state agencies (e.g., health departments, emergency management organizations) to collaborate to address the burden of heat, particularly in the face of anthropogenic climate change.

DATA AND METHODS

The research evaluated the location of cooling centers in nine states: Alabama, Kentucky, Florida, Georgia, Mississippi, North Carolina, South Carolina, Tennessee, and West Virginia (Figure 1, Table 1). This study contextualizes the location of cooling centers across the southeastern United States, building on the methodology employed by Allen et al. (2022), which evaluated Virginia cooling centers.

Using government websites, media communications, and the National Center for Healthy Housing Cooling Centers portal (2022), researchers gathered the names and locations of cooling shelters for each state. Only locations identified as operational cooling centers were included. Tennessee was the only state with an existing state-level network, developed through its state Department of Health. While Tennessee identified private retail stores as public cooling centers, researchers removed these locations from the analysis, allowing for a more direct comparison with other communities that do not consider these public spaces.

Using emergency management directories for each state (Appendix A), an online survey was distributed to local and state stakeholders via email to help uncover the additional locations of cooling centers. The survey aimed to 1) help identify the location of cooling centers, and 2) assess stakeholder experience concerning heat-related issues in their community. Specifically, researchers asked:

- Does your city or county have designated cooling centers that specifically operate during heat events? Please provide the names and addresses of the cooling centers.
- Do you coordinate with the local National Weather Service to develop guidance related to heat?
- Does your office share heat-related information across more than one language? If so, what language(s)?
- What services are available at each cooling center?
- Is there any additional information you would like to share on the topic of heat-related mitigation efforts? For example, does your agency have a social media account?

Cooling center addresses were geocoded using web-based geocoding services (i.e., Bing, Google, U.S. Census Bureau). Esri's ArcGIS Pro software version 2.9.5 was used to visualize the cooling center facilities. The facilities' data were projected into the North America Lambert Conformal Conic projection with units in meters. Using the network analysis service area tool, researchers calculated distance(s) that may be reached from

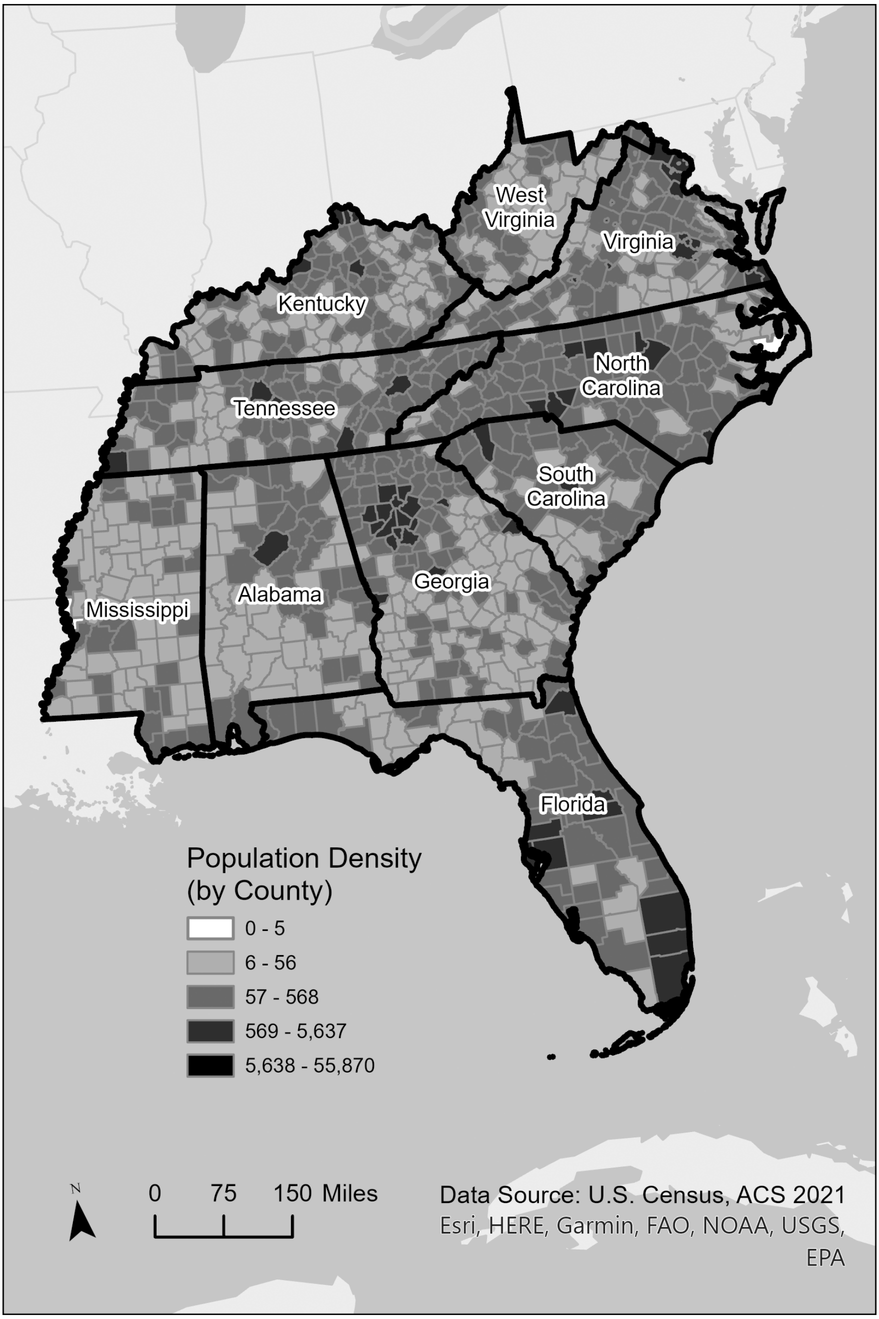

Figure 1. Study area and county-level population density in persons per square mile. Source: U.S. Census Bureau (2021).

Table 1. State population and demographics.

State	Population	Percent below Poverty	Percent Elderly	Percent Non-White
Alabama	4,893,186	25.2	16.9	34.8
Florida	21,216,924	22.4	20.5	46.6
Georgia	10,516,579	22.9	13.9	47.9
Kentucky	4,461,952	25.4	16.4	15.9
Mississippi	2,981,835	29.8	15.9	43.6
North Carolina	10,386,227	22.9	16.3	37.4
South Carolina	5,091,517	23.6	17.7	36.6
Tennessee	6,772,268	23.5	16.4	26.6
Virginia*	8,631,393	10.2	16.3	39.7
West Virginia	1,807,426	26.6	19.9	8.5

Population data from CDC/ATSDR's Social Vulnerability Index 2020 database for the United States.
* Virginia provided for context (Allen et al. 2022).

each cooling center based on existing street networks. The analysis was used to identify walk-time and drive-time service areas within fifteen minutes from each of the cooling center locations. Urban planners use fifteen-minute walk- and drivesheds to understand mobility in urban systems (Duany and Steuteville 2021, Abdelfattah et al. 2022, Khavarian-Garmsi et al. 2023). Using census tract–level data obtained from the Social Vulnerability Index (2020) provided by the Centers for Disease Control and Prevention (CDC) and the Agency for Toxic Substances and Disease Registry (ATSDR), population statistics were calculated based on what proportion of the total value of each of the census tracts overlapped with each of the network analysis service area divisions (i.e., 0–5, 5–10, 10–15 mins). The pairwise intersect tool was used to overlay each of the service area divisions for the states along with the census tracts of the entire United States. Demographic data were not filtered by state to allow for the estimate of populations served to include service areas that crossed beyond administrative boundaries such as state boundaries.

The CDC/ATSDR social vulnerability data are based on earlier developed methods (Cutter et al. 2003) that use United States Census Bureau demographic and socioeconomic indicators to examine potential vulnerability to environmental hazards, such as extreme heat. The original analysis by Cutter et al. (2003), used 42 indicators to develop a measure of total risk within a census enumeration unit (e.g., counties, census tracts). The CDC/ATSDR data use approximately twenty-eight indicators which are categorized into four main categories: socioeconomic status, household characteristics, racial and ethnic minority status, and housing type and transportation. This research specifically examined equity around which populations cooling centers served by using the characteristics of the population below the poverty threshold, elderly (65+ years of age) population, non-white population, and total population values. These indicators were chosen

Table 2. State survey responses.

State	Total Contacts	Responses	Response Rate Percent*
Alabama	68	8	12.1
Florida	96	16	17.6
Georgia	146	17	13.0
Kentucky	78	3	4.4
Mississippi	89	4	4.5
North Carolina	173	23	14.1
South Carolina	51	6	12.2
Tennessee	81	11	13.5
West Virginia	8	1	12.5

*Response rate eliminated discontinued emails and retirements.

to reflect those accepted as environmental justice criteria indicators and to match variables used in previous heat-health research (Allen et al. 2022).

RESULTS

Survey Results

The survey was sent to all individuals identified on the emergency management directory for each state (Appendix A). Forty-four recipients replied, acknowledged retirements, or resulted in a bounced email for an erroneous contact. Adding new contacts provided by some of these individuals brought the total number of surveyed individuals to 790. In total, eighty-eight individuals (11.5 percent) responded; most only identified whether their community had cooling shelters available (Table 2). Of these eighty-eight, forty-eight answered the open-ended question: “Is there any additional information you would like to share?” Thirty-six responded with a social media account but did not provide any additional insight on the topic of heat.

Due to the low response rate and fewer detailed responses, limited insight was gained from the survey beyond identifying cooling centers. Some survey responses raised questions about responsibility, suggesting cooling centers fall within the purview of the local municipalities, not the state or county government. While this may be true, it remains unclear who is responsible for the development of heat mitigation efforts (Keith et al. 2021).

This study identified 1,433 cooling centers (1,689 including Virginia) across the southeastern United States (Figure 2, Table 3, https://arcg.is/S090e). The fewest cooling centers were in Mississippi and South Carolina, while the most were in Tennessee, Florida, and North Carolina. Through previous efforts of the Tennessee Department of Health (2022), Tennessee was the only location with an existing state-level network of cooling centers. Such state-level efforts may serve as a model for other states and municipalities in the region. However, it is noteworthy that some of the locations identified

Figure 2. Cooling center locations across the Southeast.

Table 3. Cooling centers per state.

State	Total Cooling Centers
Alabama	117
Florida	239
Georgia	105
Kentucky	89
Mississippi	12
North Carolina	118
South Carolina	30
Tennessee	668
Virginia*	256
West Virginia	55

*Virginia provided for context (Allen et al. 2022).

in Tennessee are government-owned buildings, and it is unclear if/how their status is communicated to the public as open and available to community members during heat emergencies.

Generally, cooling centers are identified more often in urban areas with the types of cooling centers varying by location (Figure 2). Some jurisdictions used libraries, public health departments, and community centers while others identified parks and schools. Further, some resources simply identified "all city libraries" as cooling centers; such venues hold daily hours open regardless of the weather and raise questions as to the effectiveness of the location as a heat mitigation strategy.

Geospatial Analysis

In total, only 36 percent (3.1 percent) of the Southeast's population lives within a fifteen-minute drive (walk) of a cooling center. For context, Allen et al. (2022) found higher values in Virginia: 65 and 8 percent, respectively. Variability exists, with states such as Mississippi and Florida having only 15 percent of state populations within a fifteen-minute drive of a cooling center (Figure 3, Table 4). Across all locations, smaller populations are served by cooling centers within a fifteen-minute walk, though this is not surprising. Whether a personal vehicle or public transit, access to transit options — including active and micro-mobility options — expands a person's range to visit a cooling center. With an existing state-level network, Tennessee's results are significantly higher than the other locations, with 80 percent (6.3 percent) of the total population within a fifteen-minute drive (walk) of a cooling center.

Beyond the total population, significant differences exist when comparing cooling center proximity to vulnerable populations (Figure 3, Table 4). The majority of vulnerable populations (elderly, non-white, below poverty) live beyond the fifteen-minute drive of a cooling center, potentially reducing the likelihood of these services being used. Cooling centers in all states except Florida and Tennessee served less than 5 percent of

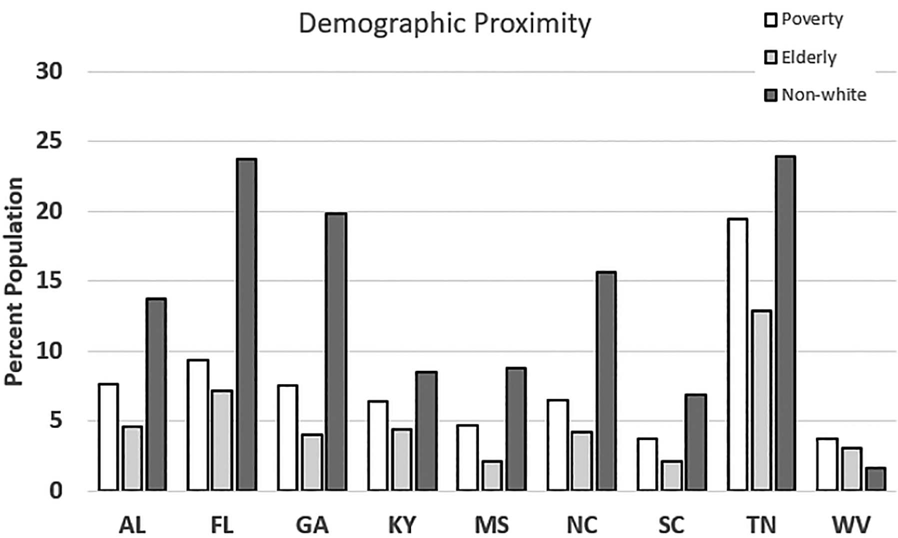

Figure 3. Vulnerable populations within a fifteen-minute drive of cooling centers.

elderly residents. While Florida boasts the largest percentage, only 23.7 percent of non-white residents are within a fifteen-minute drive of a cooling center. Cooling centers in Kentucky, South Carolina, and Mississippi serve less than 10 percent of non-white population. In West Virginia, only 1.6 percent of non-white populations are within a fifteen-minute drive of a cooling center. While the results from Tennessee indicate a more robust network, cooling centers serve no more than 24 percent of any vulnerable population category. Other studies show similar results concerning the placement of cooling centers and their proximity to vulnerable populations (Nayak et al. 2019). In Virginia, Allen et al. (2022) found only 9 percent, 7 percent, and 29 percent of elderly, below-poverty, and non-white populations, respectively, lived within a fifteen-minute driveshed of a cooling center. Across the southeastern United States, those among the most vulnerable to the impacts of heat — the elderly, the poor, and the non-white — are not within the service area of a cooling center.

DISCUSSION

This research offers the first review of cooling centers across the southeastern United States. More work is needed to evaluate the operational plans of such locations and the effectiveness of cooling centers as a heat mitigation strategy across local jurisdictions, particularly as it relates to vulnerable populations. Those least equipped to drive or walk to a cooling shelter are often the most vulnerable to heat impacts (Nayak et al. 2019, Samuelson et al. 2020, Allen et al. 2022, Schwarz et al. 2022). Furthermore, states and

Table 4. Total and vulnerable population (percent) within a fifteen-minute walk and fifteen-minute drive of a cooling center.

Total Population	Alabama	Florida	Georgia	Kentucky	Mississippi	North Carolina	South Carolina	Tennessee	West Virginia
Walk	99,736	881,130	215,771	174,251	13,455	208,227	47,469	423,299	23,757
	(2.0)	(4.2)	(2.1)	(3.9)	(0.5)	(2.0)	(0.9)	(6.3)	(1.3)
Drive	1,464,556	8,350,337	3,387,483	1,268,988	450,433	3,469,934	702,534	5,473,893	273,373
	(29.9)	(39.4)	(32.2)	(28.4)	(15.1)	(33.4)	(13.8)	(80.8)	(15.1)
Below Poverty (Percent)									
Walk	38,057	266,949	68,405	62,423	5,537	50,647	17,725	127,888	7,766
	(0.8)	(1.3)	(0.7)	(1.4)	(0.2)	(0.5)	(0.3)	(1.9)	(0.4)
Drive	371,911	1,970,473	789,707	285,677	139,813	677,609	187,828	1,316,287	67,140
	(7.6)	(9.3)	(7.5)	(6.4)	(4.7)	(6.5)	(3.7)	(19.4)	(3.7)
Elderly (Percent)									
Walk	15,106	157,211	27,205	24,240	1,936	23,632	6,744	58,499	4,489
	(0.3)	(0.7)	(0.3)	(0.5)	(0.1)	(0.2)	(0.1)	(0.9)	(0.2)
Drive	226,596	1,512,658	425,510	194,893	63,043	435,980	105,294	872,792	56,458
	(4.6)	(7.1)	(4.0)	(4.4)	(2.1)	(4.2)	(2.1)	(12.9)	(3.1)
Non-white (percent)									
Walk	62,505	617,266	139,902	77,008	9,580	106,632	26,818	167,441	4,548
	(1.3)	(2.9)	(1.3)	(1.7)	(0.3)	(1.0)	(0.5)	(2.5)	(0.3)
Drive	671,529	5,020,707	2,084,305	378,035	262,898	1,625,350	348,977	1,616,071	28,385
	(13.7)	(23.7)	(19.8)	(8.5)	(8.8)	(15.6)	(6.9)	(23.9)	(1.6)

*Population data taken from CDC/ATSDR's Social Vulnerability Index 2020 database for the United States.

cities in the Southeast tend to top lists of most dangerous pedestrian environments, with six of the top ten deadliest states and twelve of the top twenty deadliest cities for pedestrians being in the study area (U.S. Department of Transportation 2020, Streetlight 2022). This highlights the need for infrastructure investments that prioritize "Vision Zero" to also overlap with climate resilience planning in the Southeast.

While cooling centers are a single strategy designed to reduce heat vulnerability, results show more work is needed to address heat hazards in the southeastern US. Future research should study whether there are areas where residents have few or no options for cooling centers (i.e., "cooling center deserts") and if there is a correlation to those areas being in rural areas versus urban locations. Additional work should also examine how cooling centers address vulnerability within factors of heat vulnerability such as populations with disabilities or the homeless (Cusack et al. 2009) and how internal barriers to using cooling centers manifest across populations accommodated within existing operational plans (Kosatsky et al. 2009, Lane et al. 2014). The mere presence of a cooling center is not sufficient to reduce risk. In examining cooling shelters in Australia, Cusack et al. (2013) found operational hours to be a barrier to visiting a cooling shelter. Despite the evidence that heat kills, research demonstrates vulnerable communities do not view heat as a major hazard (Kosatsky et al. 2009, Lane et al. 2014). Perception of heat as a hazard, operational hours, personal safety, and other factors are potential barriers to accessing and using a cooling center (Widerynski et al. 2017, Mallen et al. 2022).

This research identified most cooling centers located in urban locations, but heat vulnerability is not merely an urban phenomenon (Henderson et al. 2013, Kovach et al. 2015, Odame et al. 2018). Heat is a health, economic, and equity issue. Demographic factors such as age or income modify vulnerability and contribute to adverse heat-health impacts, in both urban and rural communities. Occupations — especially those with individuals working outside in industries such as construction or in agriculture — also elevate risk (Gronlund et al. 2014, Sheridan and Allen 2018, Vanos et al. 2019, Borg et al. 2021). While the role of informal cooling centers (e.g., churches, fire stations) or community networks designed to check on neighbors may be an option in more rural locations, limited information conveying the location or operational hours of such strategies was found. The local networks in rural locations may indeed present opportunities for heat-reducing strategies, but these networks also draw questions as to how such information is disseminated. Non-locals may not be familiar with these informal centers, a function of word-of-mouth communication rather than strategic communication.

More strategic communication as to where cooling centers are located and the operational hours of these locations is needed. While some emergency managers explicitly noted the location of such resources, other communications were vague. For example, one media outlet noted "These facilities, as well as indoor malls and shopping plazas, can provide relief for persons who do not have air conditioning at home, temporary power outages, or similar" (Argueta 2022). Many locations such as libraries and malls close overnight, yet overnight temperatures significantly contribute to adverse health outcomes as well (Royé et al. 2021, He et al. 2022). Additionally, nighttime temperatures continue to warm faster than daytime temperatures (Murgae et al. 2017, Vose et al. 2017), drawing attention to the importance of overnight heat relief.

Many of the resources gathered highlighted the name but failed to convey the operational times or exact addresses of the cooling center. One survey respondent noted "we do not publish specific locations ahead of time," suggesting an ad hoc process. While severe weather shelters are often demarcated in the community, limited research as to the location or effectiveness of heat mitigation shelters exists (Allen et al. 2022, Adams et al. 2023). Unlike tornadoes or hurricanes that act as discrete weather events, heatwaves may vary in duration and intensity, depending on the time of year or geographic location. Establishing heat mitigation plans before a heatwave is a necessary component to reducing adverse impacts. Ad hoc creation of cooling shelters is not effective for sustainable hazard mitigation planning.

Who is responsible for the development and implementation of heat mitigation strategies (Keith et al. 2021)? Drawing on the survey, some county emergency managers wavered on the issue, suggesting local municipalities were responsible for developing cooling intervention strategies. Other officials referred to state entities as being responsible. In some states like Vermont, emergency management officials take ownership of the communication of cooling locations (Vermont Emergency Management 2022). Other states such as Missouri developed such resources through the Missouri Department of Health (2022). The positioning of cooling centers demonstrated significant variability across scales. While differences exist when comparing urban and rural communities, similar differences also exist when comparing states. How a city, county, or state defined or delineated a cooling shelter varies significantly. State agencies such as the department of health or emergency management organizations may serve as storehouses for cooling refuge information. The National Center for Healthy Housing (2022) may also fill this void, but in many instances, the resource merely recommends contacting local entities by dialing 2-1-1.

The question remains, what role should local, state, and non-governmental stakeholders have in providing cool spaces for residents? Comprehensive resources such as the ones developed by the Tennessee Department of Health (2022) provide a visually appealing resource outlining locations of city buildings, senior centers, and libraries that may be used as cooling refuges. In addition to addresses, contact information is provided. In this instance, it remains unclear as to when the locations are open or what other services may be provided (water, overnight accommodation, etc.). Regardless, the Tennessee portal provides a comprehensive example of how such formal and informal cooling refuges may be communicated to mitigate heat-related health issues. More place-based, social science research could be a fruitful investigation for future studies.

Using these examples, the responsibility of heat mitigation crosses both geopolitical boundaries and sectors. Emergency management professionals must collaborate with public health entities to further reduce the heat burden. Combining resources and sharing information as to what communities are doing to reduce heat risk benefits all and may address equity concerns as it relates to heat mitigation.

CONCLUSION

The geographic placement of cooling centers demonstrates a disconnect between heat as a hazard and efforts to help those who are most vulnerable. This research builds the first known comprehensive database for cooling centers in the southeastern United States. With only 36 percent of the population within a fifteen-minute drive of a cooling center, more work is needed to reduce adverse heat impacts. The southeastern United States remains highly vulnerable to extreme heat — particularly in the face of a warming climate — yet heat mitigation strategies are often not co-located with vulnerable populations. Working alongside vulnerable communities requires cross-agency collaboration and improved hazard mitigation planning. Local governments must work with state agencies and departments of health must coordinate with emergency managers as well as regional and local planning bodies. As shown through the geospatial analysis, cooling center locations can serve multiple jurisdictions — areas that go beyond a municipal/town or county boundary — so intrastate coordination may be just as important as multi-state coordination to serve the largest populations possible.

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DR. MICHAEL J. ALLEN (mallen@towson.edu, @mjallen176) is an Assistant Professor of Climatology within the Department of Geography and Environmental Planning at Towson University in Towson, Maryland 21252. A 2023 U.S. Fulbright Scholar, Dr. Allen explores the intersection of weather, climate, and society with particular interest in bioclimatology, heat hazards, and public health.

DR. JENNIFER L. WHYTLAW, GISP (jwhytlaw@odu.edu; @millennial_gis) is an Assistant Professor of Geography in the Department of Political Science and Geography at Old Dominion University in Norfolk, Virginia 23529. Her research is focused on utilizing geospatial analyses and visualizations to understand how environmental hazard events influence personal understanding of vulnerabilities within communities.

DR. NICOLE HUTTON (nhuttons@odu.edu) is the Assistant Director of Engagement for Old Dominion University's Institute for Coastal Adaptation and Resilience and an Associate Professor of Geography in the Department of Political Science and Geography at Old Dominion University in Norfolk, Virginia 23529. Her research interests include nonprofits and vulnerable populations, using iterative participatory mapping processes to co-produce community resilience building priorities.

DR. JEREMY S. HOFFMAN (jhoffman@smv.org, @Jer_Science) is the David and Jane Cohn Scientist at the Science Museum of Virginia and Affiliate Faculty in the L. Douglas Wilder School of Government and Public Affairs and the Center for Environmental Studies at Virginia Commonwealth University in Richmond, Virginia 23284. Dr. Hoffman was elected as a Fellow

of the American Association for the Advancement of Science in 2022 for his interdisciplinary research that works to engage communities in documenting and responding to differential climate threats in their neighborhoods.

APPENDIX A. SOUTHEAST'S EMERGENCY MANAGEMENT DATABASES.

State	Database
North Carolina Department of Public Safety	https://www.ncdps.gov/our-organization/emergency-management/county-emergency-management-agencies
West Virginia Emergency Management	https://emd.wv.gov/Pages/Area-Liaisons.aspx
South Carolina Emergency Management Division	https://www.scemd.org/who-we-are/county-emergency-managers/
Mississippi Emergency Management Agency	https://www.msema.org/county-ema/
Alabama Emergency Management Agency	https://ema.alabama.gov/county-ema-directory/
Kentucky Emergency Management	https://kyem.ky.gov/Who%20We%20Are/Pages/County-Directors.aspx
Florida Division of Emergency Management	https://www.floridadisaster.org/counties/
Emergency Management Association of Georgia	https://www.emagonline.com/
Tennessee Emergency Management Agency	https://www.tn.gov/tema/prepare/regional-ema-contacts.html