2024

Aging in Place with a Warming Climate: Housing Design and Policies for Aging with Extreme Heat

Nichole M. Kain
Antioch University

AGING IN PLACE WITH A WARMING CLIMATE:
HOUSING DESIGN AND POLICIES FOR AGING WITH EXTREME HEAT

A Dissertation

Presented to the Faculty of

Antioch University New England

In partial fulfilment for the degree of

DOCTOR OF PHILOSOPHY

by

Nichole M. Kain

ORCID Scholar No. 0009-0009-6304-4696

August 2024

AGING IN PLACE WITH A WARMING CLIMATE:
HOUSING DESIGN AND POLICIES FOR AGING WITH EXTREME HEAT

This dissertation, by Nichole M. Kain, has
been approved by the committee members signed below
who recommend that it be accepted by the faculty of
Antioch University New England
in partial fulfillment of requirements for the degree of

DOCTOR OF PHILOSOPHY

Dissertation Committee:

Jason Rhoades, PhD, Chairperson

Meaghan Guckian, PhD

Elicia Ratajczyk, PhD

ABSTRACT

AGING IN PLACE WITH A WARMING CLIMATE:
HOUSING DESIGN AND POLICIES FOR AGING WITH EXTREME HEAT

Nichole M. Kain

Antioch University New England

Keene, NH

Aging populations—particularly in areas prone to extreme heat—are facing unique residential challenges. In the past 10 years, extreme heat has killed more people in the United States (U.S.) than all other weather hazards combined, and it is expected to get hotter, with extreme heat events predicted to happen more often in the future. People over the age of 65 are disproportionately represented as the majority of heat victims, and are likely to perish in their own homes during these events. Every day, 10,000 people turn age 65 in the U.S. and many are choosing to age and retire in places of scientific climate concern such as Arizona. This study reveals that age-adaptive and climate-adaptive housing designs contribute to our quality of life as we age in a warming climate. To better understand potential connections between the homes where we live and survivability as we age with extreme heat, the present research was designed and analyzed utilizing a new conceptual framework of my own making titled PLACE: Preparing Living spaces for Aging with Climate Extremes. Employing a mixed-methods approach, this dissertation was accomplished in three parts. First, an archival review of Medical Examiner reports from the hottest 3 days of 2022 in Maricopa County, Arizona, showed evidence of connections between the built environment and an older person's death in their home, which demonstrates these reports to be a useful inclusion when understanding conditions leading to

death. Second, a digital survey of people ages 65 and older currently living in Arizona highlighted real-world adaptations that were successful in mitigating the deadly impacts of high heat, and thus support aging in place. Lastly, semi-structured interviews with professionals and older Arizonians provided insights into successful ways to enhance age-friendly and heat-adaptive housing. In addition to advancing our understanding of aging in places with extreme heat, this dissertation offers two pieces of applied materials: A residential guide/handout for the general public that combines mitigation for both extreme heat and age-friendly design, as well as a policy research brief promoting the future development of energy efficient and age-friendly housing. Integrating the results provides a preliminary blueprint to promote the standardization of adaptive features that enhance thermal comfort and safety as we age in a warming world. This dissertation is available in open access at AURA (https://aura.antioch.edu) and OhioLINK ETD Center (https://etd.ohiolink.edu).

Keywords: population aging, extreme heat, home design, housing policy, aging in place, climate change

Dedication

For my grandfather, Happy.

Acknowledgements

First, I would like to send a heartfelt thank you to everyone who offered their time to speak with me for this dissertation research. This includes participants interviewed and survey respondents, as well as the numerous colleagues who helped me brainstorm ideas over the years. I would also like to thank faculty and staff within the Environmental Studies department at Antioch University New England. Beginning a doctorate program just as a global pandemic hit created uncertainty to all our lives. However, I was able to thrive due to the calm and considerate way Antioch faculty and staff adapted to our new reality and supported student needs.

Specifically, I am grateful for my advisor, Jason Rhoades, who has been gracious with his time, especially when I would request one of my many "Not a Crisis" Zoom calls. The preceding email would include something to the effect of, "Jason, this is not a crisis, but I think I want to change my entire research plan." His kind and thoughtful guidance became key to recentering on topics which matter the most to me: aging, housing, and climate change. Additionally, I have felt supported by my dissertation committee from the beginning. Surrounding myself with the brilliant minds of Meaghan Guckian, PhD and Elicia Ratajczyk, PhD has not only elevated my writing, but I believe has molded me into a stronger researcher and more curious thinker. Also, thank you to my Antioch editor, Katie Kibler, PhD. Katie has been a source of calm during my document formatting frustrations, as well as providing her invaluable editing skills and thoughtful guidance to help create a cohesive flow throughout the dissertation.

The encouragement and comradery felt within my cohort has continually propelled me. To my cohort, I have learned from each of you and am incredibly honored to consider you as

both colleagues and friends. A special thank you to my long-time writing buddy, Alyssa Johnson, our many hours spent laughing and commiserating will be forever precious to me. While our cohort is currently at different phases of our doctoral journeys, we will continue to walk beside and support one another as our careers evolve.

To my brother, Adam Lawrence, thank you for your contagious enthusiasm and pride for this path I have chosen. To my dear friends in California, Colorado, and Minnesota—thank you for providing a steady source of unconditional encouragement. From honest conversations and texts filled with supportive emojis, court parties to celebrate milestones along the way, and coffee shop work sessions which kept my writing flowing—I am beyond grateful to have each of you in my life.

Finally, to my husband, Julian, thank you. Thank you. I feel deep love and gratitude for the unwavering support received while in pursuit of this dream to earn a doctorate. You have been a solid foundation for our family during my return to school, the pandemic, and also moving to a new state. Our family is thriving because of your kindness and care. Thank you for cooking us delicious healthy meals, nudging me to exercise in order to work my body as well as my mind, and always being available to talk through tricky scheduling or social-emotional challenges with the research process. While our son does not remember a time when mom was not in school, you certainly do. I look forward to returning to weekend family adventures and regular date nights. Words cannot express how lucky I feel to be in this life with you, my partner, always.

Onward!

Table of Contents

List of Tables

List of Figures

CHAPTER I: INTRODUCTION

> The environment that people live in is the environment that they learn to live in, respond to, and perpetuate. If the environment is good, so be it. But if it is poor, so is the quality of life within it.
>
> —Ellen Swallow Richards, *Ellen Swallow: The Woman Who Founded Ecology*[1]

Throughout the evolution of our species, the way we have designed our dwellings has been crucial in helping humans survive inclement climates (Allen, 2015). However, there is a lack of research examining how the design of contemporary homes can safeguard vulnerable residents during climate-amplified weather events (Molinsky & Forsyth, 2022). This issue is increasingly urgent, as the National Academy of Sciences (NAS, 2020) offered projections of climate trends, which suggested that the frequency and intensity of environmental stressors will continue to rise as we experience global changes. Additionally, the Intergovernmental Panel on Climate Change (IPCC) reported that the vast majority of disaster victims around the world are consistently over the age of 65 (Kirk Smith et al., 2014), the majority of whom are found dead in and around their homes (Goodell, 2023; Intergovernmental Panel on Climate Change [IPCC], 2023; Keller, 2015; Klinenberg, 2002). While people over age 65 are not a homogeneous group, predictable changes that occur naturally when aging cause increased vulnerability in the context of a changing climate. These vulnerabilities include limited mobility, the tendency to live alone in certain cultures, and the presence of health conditions that cause negative responses to environmental stressors (IPCC, 2023; Klinenberg, 2018; Kirk Smith et al., 2014). Every day,

[1] Ellen Swallow Richards, best known as founder of the Home Economics Movement in the United States, worked tirelessly to improve the home environment for women regarding safety and efficiency (Swallow, 2014). Importantly, she coined the term ecology (first pronounced *oekology*) and viewed humans as deeply connected with nature. Thus, she argued that a person's home was the most important built environment structure when creating communities that would enable resilient relationships to each other and the natural environment (Swallow, 2014).

10,000 people turn age 65 in the United States (U.S.; Cisneros et al., 2012), and many are choosing to age and retire in places of scientific climate concern, such as arid and mountainous communities (Slack & Jensen, 2020). Thus, the confluence of age-adaptable and climate-adaptable home designs is not only an architectural aspiration; it is the keystone of sustainable, dignified, and secure living in the face of our rapidly changing world.

Aging populations—particularly in areas prone to extreme heat—face unique residential challenges. Extreme heat is a period of high heat and humidity with temperatures above 90 °F for at least 2–3 days (Asseng et al., 2021; Harlan et al., 2013). Prolonged exposure to these high temperatures can cause dehydration, heat exhaustion, heatstroke, and death (Faurie et al., 2022; Khatana et al., 2022). In the past 10 years, extreme heat killed more people in the United States than all other weather issues combined (B. Jones et al., 2021; Khatana et al., 2022). Still, the U.S. is expected to get hotter, with extreme heat events predicted to occur more often in the future (B. Jones et al., 2021; NAS, 2020). Older people are disproportionately represented as the majority of heat victims and, in cases where mortality occurs, the death is likely to be in their own homes during days of extreme heat (Department of Economic and Social Affairs [DESA], 2011; IPCC, 2023; Keller, 2015; Klinenberg, 2018). Still, most research has focused on how physiological risks can be mitigated with better preparedness education targeted toward the at-risk population; for example, encouraging people to have a bag packed and ready for evacuation (Behera, 2021; Chan, 2020). While disaster preparedness is important, inquiry cannot end with the onus for preparation placed on the vulnerable demographic. Researchers have long assumed that older adults are inherently vulnerable during a disaster event due to lack of household preparedness, such as lacking the ability or knowledge to stockpile

medication or prepare an emergency supply bag. For instance, in the book *Disaster Public Health and Older People*, scholar Emily Ying Yang Chan (2020) dedicated only one page of the book to household preparations. Chan (2020) offered guidelines for service providers and suggested that older people are inherently vulnerable, in part because they are unlikely to prepare for emergencies due to factors such as limited resources, cognitive decline, or social isolation.

Recent studies have challenged these assumptions, demonstrating that older people not only can but should take an active role in disaster preparedness (Federal Emergency Management Agency [FEMA] & AARP, 2022; Rhoades et al., 2018). An example is the collaboration between the planning department and aging services advocates within the Rogue Valley Council of Governments (RV-CoG); the city of Ashland, Oregon, surveyed older residents when updating their emergency preparedness plan. An important discovery was the need to create an optional Disaster Registry including a name, phone number, address, and type of assistance needed in the event of a city-wide emergency (C. Saldona, personal communication, June 12, 2022). When wildfire ripped through the city of Ashland in fall 2020, RV-CoG staff were able to use this Disaster Registry to request targeted assistance without the resident dialing 911 first. This decision saved lives when communications to neighborhoods in the wildfire's path quickly failed (C. Saldona, personal communication, June 12, 2022). Therefore, since Ashland engaged older people in disaster planning, lifesaving considerations were implemented. It is essential to elevate the voices of older people when researching design considerations for climate-adaptable and age-friendly housing, which can result in life-changing decisions.

It is important to note that residential climate adaptation inherently varies by location, as climatic needs change drastically between different regions. Due to vast topographic and climatic differences, the U.S. Department of Housing and Urban Development (HUD) Office of Policy Development and Research (2022) began offering climate mitigation strategy suggestions to municipalities that had been successful across the country for wildfires, stormwater management, and sea level rise. While HUD has yet to offer guidance on heat-adaptive housing, known strategies exist for mitigating the impacts of extreme heat, including standardizing energy redundancy. For example, requiring standard solar on each home—or located in a micro-grid—to power an individual's lifesaving equipment if the city electricity goes out (Burgess & Foster, 2019). Other examples include construction of energy-efficient homes that retain cool indoor air as the outside temperature rises, as well as strategically placed windows to achieve a cross-breeze if needed at night (Burgess & Foster, 2019). All of these strategies can help to reduce indoor temperatures, making homes more comfortable and reducing the risk of heat-related illness. However, a critical challenge persists in that these design modifications were developed without the participation or consultation of older adults, meaning the usability of the designs is unknown for this vulnerable portion of the population. Unfortunately, there is limited awareness among designers, builders, and policymakers about the specific needs and vulnerabilities of older adults in the context of climate change (Martín & Arena, 2019; Molinsky & Forsyth, 2022).

A new body of research is emerging from an interdisciplinary collection of scholars focused on engaging older residents as co-collaborators in city-wide disaster-preparedness planning. For instance, environmental science scholars Rhoades et al. (2018) engaged older

community residents as active participants in disaster planning, emphasizing the need to elevate the voices of an age group that is more likely to be marginalized during a disaster. Additionally, in a joint report by the Federal Emergency Management Administration (FEMA) and AARP (previously known as the American Association of Retired Persons) studying disaster mitigation, researchers found that involving older adults in climate readiness planning led to higher participation in disaster readiness among seniors (Stanton, 2022). City planning and disability studies scholars Maisel et al. (2022) celebrated this method of involving older residents in disaster-preparedness planning in the book *Climate Adaptation and Resilience Across Scales*. This participatory action approach emphasized the inherent knowledge, skills, and expertise of older members, which can lead to more effective planning that considers the unique needs of older residents (Maisel et al., 2022). Much of the disaster-preparedness research has focused on a community-wide disaster preparedness approach. However, the design of an older adult's home is rarely considered in methods to mitigate disasters. There is a clear need for research on climate-adaptive and age-adaptive housing, which connects home design to the overall well-being and ability of an older person to survive a disaster.

Age-adaptive housing design has been shown to increase the personal independence and social connectedness of inhabitants (Pynoos et al., 2009). Personal independence and social connectedness are outcomes of personal resilience and are important contributing factors in disaster survival predictions (Timalsina, & Songwathana, 2020). In general terms, adaptation is the ability for something to change in order to better survive a new situation, and resilience is the ability to anticipate and cope with shocks (Mehryar, 2022). With relation to this research, personal resilience is enhanced, in part, through the ability to adapt our homes to changes

which come with both aging and a warming planet. Since the more personal resilience a person possesses the more likely they are to survive a disaster (Timalsina, & Songwathana, 2020), this research is timely as we age into increased vulnerability in a warming world. In this mixed-methods research study, I examined the interplay between residential design and vulnerability of older adults during extreme heat events, with the goal of identifying key housing factors that can be added or modified to enhance safety and well-being as we age in places with extreme heat.

Research Questions

Utilizing a mixed-methods research approach, I investigated the interplay between aging, housing, and climate extremes, with a specific focus on extreme heat in Arizona. To promote U.S. housing policies that could ensure homes are adaptable to both climate change and our aging population, my mixed-methods dissertation research focused on how older adults' climate vulnerability to extreme heat is connected to residential built environment designs. This study addressed the following general research question: *How can the future of housing accommodate both our changing global climate and our physical changes that come with aging?* Arizona was an opportune research site, since it is known for its hot climate, is a popular retirement destination, the Office of the Medical Examiner in Maricopa County (n.d.) has an established protocol for investigating deaths during hot months (Batchelor, 2024), and the city of Phoenix, AZ, has established an Office of Heat Resilience in an effort to address the public health implications as the number of extreme heat days continues to increase (Crimmins et al., 2022).

This dissertation research has been designed as a convergent parallel mixed-methods study, meaning data collection and analysis of both quantitative and qualitative data occurred simultaneously and were then analyzed separately (Bernard, 2011; Saldaña, 2016). Whereby, I intended to create mutually exclusive sets of data that informed each other. However, it is important to note working on one dataset was not dependent on completing the others to proceed. In other words, this convergent parallel mixed-methods research design was intentional and proved to be useful for timely completion due to data arriving in unpredictable intervals.

A critical factor in this research was my creation of a new conceptual framework titled PLACE: Preparing Living spaces for Aging with Climate Extremes. The PLACE framework guided each part of this study. This research is structurally organized into three parts, with one specific research question addressed in each part, reflecting a temporal theme: Past, Present, and Future.

- In Part I, titled "Past," I conducted an archival analysis of coroner reports in Maricopa County, AZ, to address the following research question: *What information in reports from the Medical Examiner's Office in Maricopa County connects an older person's death with the built environment in or around their home during days of extreme heat?* I explored these historical documents with an aim to understand connections between the physical home and deaths of older people in and around their homes during a period of extreme heat. This inquiry and analysis set the stage for subsequent sections of this dissertation.

- In Part II, titled “Present,” I deployed a digital survey targeting residents over the age of 65 to assess risk perceptions and mitigation strategies regarding both extreme heat and age-friendly residential design to answer the following question: *What residential extreme heat and age-related adaptations are most commonly implemented by older adults living in Arizona*?
- In Part III, titled “Future,” I integrated results from Past and Present to shape forward-looking solutions for housing tailored to the needs of our aging population in the context of climate change to address the following question: *What are strategies to advance the goal of mitigating a home most effectively from extreme heat that will not negatively affect people as we age in place*? To answer this question, I conducted key informant interviews with older Arizonians, as well as housing experts, policy-makers, and other stakeholders across the U.S. to gain insights into possible housing adaptations and policy reforms.

Research Objectives and Approach

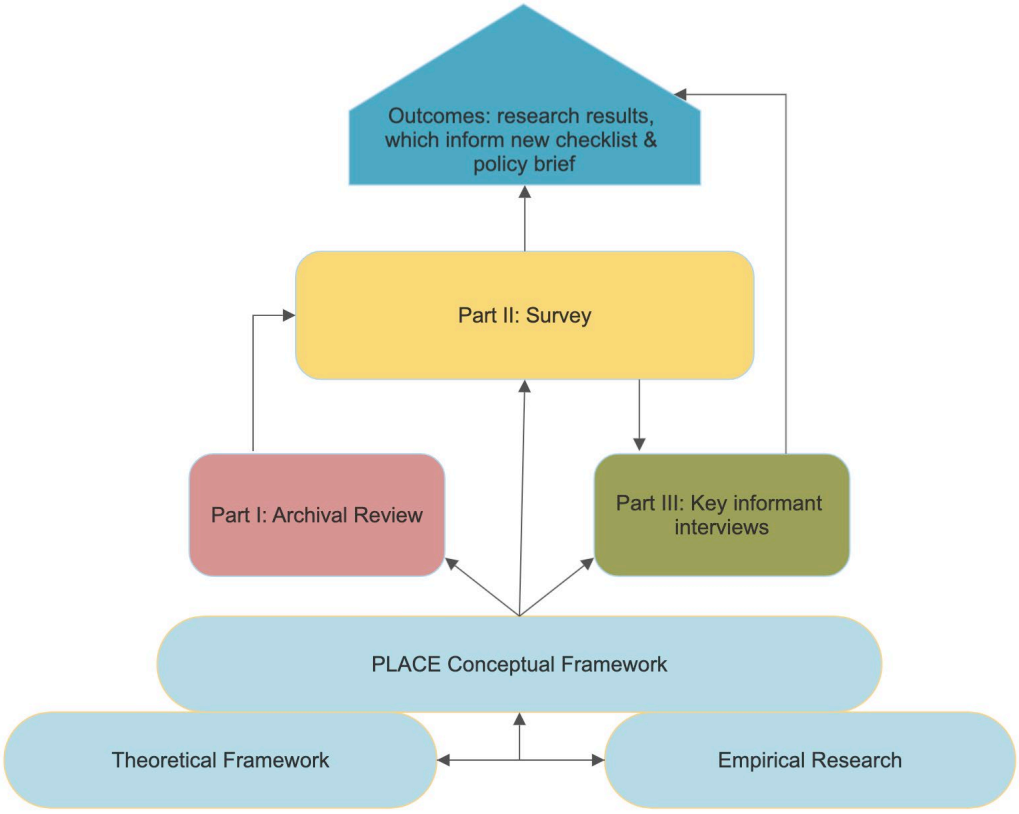
In this dissertation, I address a gap in available research by considering what built environment factors may make older victims more likely to be found dead in and around their homes after extreme heat disasters. The available research is limited by poor understanding of how home design contributes to the survivability of its most vulnerable inhabitants. Therefore, the objective of this dissertation was to identify successful strategies for making homes both adaptive to population aging and extreme heat. Doing so led me to create design and policy

guidelines for dwellings that contribute positively to human health and well-being as we continue to age in place with a warming climate.

The flowchart in Figure 1.1 provides a visual depiction of the structure of this dissertation's research methods as a whole, beginning with a foundational literature review and building to a conceptual framework, which then guided development and analysis for Past, Present, and Future, ending with actionable outcomes.

Figure 1.1

Flowchart of This Dissertation's Structure



Note: Shape is loosely based on that of a house, with a foundation of literature, mixed-methodology structure, and outcomes as the roof.

Findings underscore the vital role of our physical homes in ensuring human survival during extreme heat. Drawing on insights gained throughout this study, I have developed actionable takeaways. These include a handout for the general public addressing both age-friendly and heat-adaptive housing design, as well as policy recommendations advocating for residential regulatory changes to protect older adults in climate-threatened locations.

Dissertation Outline

I created this dissertation using the traditional format of five chapters: Introduction, Literature Review, Methods, Results, and Discussion. Following this Introduction chapter, Chapter II presents a comprehensive literature review in two parts: First, literature related to research questions, then literature used to create the PLACE conceptual framework. In Chapter III, I detail a convergent parallel design research method, featuring my PLACE conceptual framework throughout data design, collection, and analysis. Then, in Chapter IV, I present the study's results organized by the research questions. Finally, in Chapter V, I discuss relevant findings, study limitations, and ideas for future research. Lastly, I offer practical outcomes of this research in Chapter V, which includes the introduction of two tangible deliverables: A handout for the general public (see Appendix E) and a policy research brief (see Appendix F), both centering built environment modifications to increase safety of a home's inhabitants on days of extreme heat. In addition, the Appendices contain all other materials used in this research process.

CHAPTER II: LITERATURE REVIEW

*W*hen a flower doesn't bloom, we fix the environment in which it grows, not the flower.
—Alexander Den Heijer, *Education Can be All That You Imagine*

The design of our dwellings has historically contributed to our species' ability to survive a disaster (Allen, 2015). Unfortunately, there is little research available to increase our understanding of the role of modern homes in protecting vulnerable inhabitants during climate-amplified events (Molinsky & Forsyth, 2022). At the time of writing this dissertation in 2024, the urgency to develop actionable strategies for aging at home with extreme heat was felt acutely nationwide. It was essential for this inquiry to focus on older victims, who are found often in and around their homes after a heat wave (World Health Organization [WHO], 2023). In this chapter, to address these claims and expand into a usable framework for this research project, I explore existing literature in two parts: Previous Research Findings and Conceptual Framework.

Previous Research Findings

In this section, I explore existing literature which highlights limitations to current housing designs, offers diverse housing strategies that address our changing needs as we age, and examine heat-adaptive strategies that municipalities are implementing globally. By highlighting studies and policies exemplifying successful integration of either age-friendly or heat-adaptive housing solutions, we can better understand the foundational information on which to build housing strategies for aging with extreme heat.

Housing Limitations: In and Around the Home

The link between housing designs and the deaths of older people in their homes during disasters is a critical area of concern that needs further understanding, since housing limitations result in lives lost (Keller, 2015; Kelman, 2020). For instance, following any modern climate-amplified disaster in the U.S., media reports typically indicate that a significant proportion of the deceased civilians are over age 65 (M. K. Smith et al., 2022), many of whom are frequently discovered "in and around their home" (Zerkel, 2023, para. 31). In the heat wave which swept through Chicago in July 1995, a staggering 80% of victims were over age 65 (Whitman et al., 1997), most of whom either perished in their homes or died at the hospital after leaving home to seek medical care (University of Chicago Press, 2002). During Hurricane Ian, which devastated southwest Florida in September 2022, 70% of the deceased were over age 60, and *The New York Times* reported that most older victims drowned in their homes (M. K. Smith et al., 2022). During Hurricane Katrina in 2005, older adults accounted for only 11% of the New Orleans population, but people over age 65 comprised 63% of the storm's fatalities (Brunkard et al., 2008). Strikingly similar to 2022's Hurricane Ian, the home was the most common location for an older Hurricane Katrina victim to be found (Brunkard et al., 2008). During 2020's Alameda Fire, which ripped through the Rogue Valley of southern Oregon and forced emergency evacuations of 3,000 residents, people over age 55 accounted for 75% of civilian fatalities, despite this age group representing only 30% of the population (Morgan, 2021); once again, these victims were found in and around their homes. This recurring pattern underscores the necessity to concentrate on understanding how housing-related vulnerabilities and the adaptive capacity of our dwellings contribute to negative outcomes as we age. Next, I

review a history of housing in the U.S., offer available research and knowledge into how heat impacts our bodies as we age and the need for thermal comfort, and discuss housing designs for aging and heat.

Designing for Disaster: Brief History of Housing

Human dwellings have been both essential to our species' survival and have continually evolved with each traumatic event (e.g., a flood or predator attack) experienced by a group. Notable scholar and neuroanthropologist, John Allen (2015), contended that humans have a natural proclivity to build structures in a way that is trauma-informed; in other words, redesigning dwellings in response to a trauma experienced by an individual or group (Schroeder et al., 2021). Allen (2015) explained that early humans learned what types of dwellings best suited their climates and safety needs after traumatic events, and would adapt their dwellings to provide improved protection. However, as agrarian lifeways predominated our human history due to a stabilizing climate (Kolbert, 2021), the human population subsequently boomed, and the concept of land and water "ownership" was invented to control who had access to resources and who was able to make decisions (Williamson, 2013).

The totalitarian process of enclosing common land and turning it into private property—typically for the purpose of farming or other forms of economic exploitation—marked a significant historical juncture in Europe within the 18th and 19th centuries (Linebaugh, 2014). Enclosure resulted in many citizens' loss of common lands and housing, which in turn led to mass migration into urban areas in search of employment (H. Jones, 2019; Winchester, 2021). The Industrial Revolution, for example, was not spurred by great leaps in technology, but first by enclosure of farmlands, which pushed the workforce

needed for industrialization into urban areas (Winchester, 2021). However, the necessary housing to accommodate such an influx was never designed alongside the people who would live there; instead, it was erected quickly and was characterized by a lack of privacy, poor sanitation, and low-cost building materials, placing occupants at risk of fire and disease (Winchester, 2021). These developments disempowered the already vulnerable by restricting their ability to construct or retrofit their own housing, leading to a vast power disparity and often violence (Vasudevan et al., 2008). Therefore, enclosure not only marked the beginning of the Industrial Revolution, but also the start of our learned deference to rely on housing provided by people outside of our known communities.

In direct response to filth and poverty characteristic of urban living, enclosure was again utilized within city-limits to preserve green spaces. At this time, enclosure was accompanied by covenants, which is a legal layer of protection used to preserve the land for only its privatized intended use (McKenzie, 2011). The origins of covenants can be traced to London in the mid-1700s, when it was instituted to set aside parks for private use in perpetuity (McKenzie, 1996). This new legal tool of deed restricted covenants spread rapidly as it coincided with the beginning of suburbanization in England, and was later imported to the U.S. in the early 1800s (McKenzie, 1996). Gramercy Park in Manhattan, NY, established in 1831, is believed to be the first developer-initiated deed restricted park in the U.S. (McKenzie, 1996). Shortly after, Louisburg Square in Boston, MA, was home to the first resident-led covenants; homes were built in 1826, covenants enacted in 1844 (McKenzie, 1996). This came about when wealthy homeowners in Boston chose to legally bind together the homes surrounding Louisburg Square in a Committee of Proprietors to care for the park (McKenzie, 1996). Now called the Louisburg

Square Proprietors, this committee was created by residents to maintain the 6-foot-tall, spiked iron fence in perpetuity, thereby restricting access to the once public but now privately held green space (McKenzie, 1996). Originating from a need to enforce who has access to privatized green space, covenants have grown to control many other aspects of life in a community.

Today, legal zoning requires preservation of open space and dwindling city budgets to maintain open space required by law becomes increasingly challenging. In response, a more restrictive legally binding covenant was created to maintain this green space intended for private communal residential use, now known as a homeowner's association (HOA; McKenzie, 2011). Currently, four of every five new homes in the U.S. are governed by an HOA (W. Clarke & Freedman, 2019) and 58–63% of *all* single-family homes in the U.S. are now overseen by an HOA (Community Associations Institute, 2023). Since developer-built communities are managed by HOAs, these managed ideals are difficult to change. For example, if a homeowner would like to remove the non-native grassy lawn on their property and install a low-water native plant garden, an HOA can mandate they keep the grass to maintain uniformity within the community or be fined daily (McKenzie, 2011). Additionally, HOAs have been known to restrict use of outdoor lines to dry clothing, deny use of rain barrels for water collection and reuse, and prohibit wheelchair ramps or window air conditioners; restrictions are enacted due to the stated desire to maintain visual uniformity within the community (McKenzie, 2011). Some of these prohibitions are a nuisance and some, such as banning air conditioners or wheelchair ramps, impact the health of occupants. Slowly, these HOA-imposed restrictions are being challenged in court with some success (McWhirter, 2023; Sidorowicz, 2024). However, barriers persist to adapting homes in response to a changing climate or to an occupant's changing needs

with age; it has become increasingly difficult for even large-scale developers to build anything except cookie-cutter single-family houses within planned communities (W. Clarke & Freedman, 2019). Therefore, there is a clear need to design housing that is adaptable to both our changing climate and our predictable needs as we age naturally.

Although barriers, such as the legacy of enclosure and existence of HOAs, persist within the homebuilding industry today, it is natural for people to desire to update their dwellings in response to trauma (Allen, 2015; Goldhagen, 2017). Modern examples of trauma-informed design can be more readily found in U.S. commercial spaces, rather than housing. For instance, postmodern architecture—characterized by large buildings of concrete and glass—became widely popular in the U.S. after World War II. Arguably, this postmodern style of architecture was in response to the collective trauma the nation faced during wartime and the urgent need to feel protected (Tullis, 2021). While examples of trauma-informed design can be found in public or commercial buildings in the U.S., homes designed to be disaster-resilient to local hazards are considered unaffordable to the majority (Kelman, 2020; Thompson, 2019). Therefore, an uncomplicated extension is to change building codes and policies to require new dwellings be designed in response to climate-amplified disasters.

Hidden Danger: Why Heat is Increasingly Deadly With Age

Heat can be especially deadly for humans, particularly as we get older. The thermal comfort of residents becomes increasingly important as we age, as our bodies' abilities to effectively pump blood throughout our systems is naturally and predictably reduced due to a multitude of factors (e.g., blood vessel dilation, reduced heart strength, or thickening of the blood itself; Cheitlin, 2003). With these age-related changes in blood circulation, our bodies

automatically retain heat at our cores to protect vital organs, thereby causing our hands and feet to frequently feel cold as we age (Cheitlin, 2003; Kenny et al., 2017). This adaptation works well to keep our aging body healthy and fully functioning for decades, albeit with cold fingers and toes. However, as a result, the human system breaks down when faced with extreme heat events, because our natural change in basal body temperature is a slow adaptation and is unable to respond quickly to large temperature fluctuations (Kenny et al., 2017). In a study comparing strain on the human body when exposed to extreme heat between younger (19–28 years old) and older (55–73 years old) people, researchers in Canada found that older participants retained heat much longer than younger participants (Kenny et al., 2017). Although there were "no clinically observable cardiovascular or temperature changes" between the age groups, within the first 2 hours of the study, the younger bodies had quickly begun self-regulating and had stabilized (Kenny et al., 2017, p. 79). Due to an age-related "impaired ability to increase whole-body sweating" measured within the first 30 minutes of the study, the older participants held more heat internally at their cores, while their arms and legs remained cooler than younger participants' (Kenny et al., 2017, p. 82). This is a crucial finding, meaning that natural aging alone places people at a greater risk of heat-related mortality due to the older body's inability to sweat and to redistribute internal heat held at the core.

Housing design decisions that create potentially dangerous housing characteristics play a role in older people's heat survivability as well. Examples of such housing characteristics associated with heat-related deaths include lack of thermal regulation due to poor insulation and sleeping on a higher floor of a house or multi-unit building, since heat rises (Klinenberg, 2002). Basically, higher floors in a building will become hotter quicker and are often difficult to

cool. Older inhabitants may be at greater risk of death during a climate-related heat emergency if homes lack accessibility features. Such features include wider hallways and doors to easily access cooler interior spaces, at least one zero-step entry to easily enter and leave the home to access cooling shelters, and a bedroom on the main level to avoid sleeping on hotter upper floors (Greenberg, 2014). Inadequate residential insulation, commonly used in an effort to save money in construction, also places medically vulnerable inhabitants at greater risk of exposure to extreme temperatures, which can quickly have deadly health consequences (Gibberd, 2020).

The connection between the design of a home and vulnerability of older residents was especially notable when experts examined the integrated causes of death for older victims of the 1995 Chicago heat wave. Older people most likely to survive this event lived in neighborhoods that had more tree cover, less crime (i.e., people were willing to leave their houses to find relief), and were closer to friends or family (Klinenberg, 2002). As Jane Jacobs (1961) explained, the position of buildings that allows for more eyes on the street helps build community cohesion, allows people to know (and check on) their neighbors, and reduces crime. This community cohesion with neighbors is considered part of a person's social capital, meaning the network of people a person could rely on, and contributes to the likelihood that a vulnerable community member will survive a disaster (Klinenberg, 2018). For instance, an older adult who self-reports chronic health conditions, especially mobility impairments, is less likely to be able to evacuate quickly and independently during a disaster, which increases risk of injury or death (Behera, 2021). However, the same older adult who self-reports living with a mobility impairment is more likely to survive the disaster if they have high social capital in their immediate neighborhood (Behera, 2021), indicating that a higher social capital, comprised of

people who know them and care to check on them, will increases the chance of survivability in a disaster. In *Palaces for the People*, author Eric Klinenberg (2018) explained that social capital can be directly increased or decreased based on design of the built environment (e.g., proximity to neighbors and ease of exit/entrance of the home). Therefore, vulnerability to climate change is not random, it is literally built into the design of our cities and houses.

Urban studies scholar Zoé Hamstead (2023) addressed this limitation to the built environment with her theory of "thermal (in)security" (p. 1) as a form of structural violence. Structural violence is an established principle declared to be a human shortfall when suffering persists although it could have been alleviated (Galtung, 1969). In a recent urban planning study, Hamstead (2023) found that housing policies need to be both adaptable to temperature extremes and affordable. In this study, the researchers explored further the concept of "thermal (in)security" with people directly experiencing this phenomenon (Hamstead, 2023, p. 1). Hamstead (2023) described thermal (in)security in one's own home as a form of structural violence being shaped by atmospheric conditions and vulnerability-related struggles. This insecurity could manifest in poor health conditions due to being unable to comfortably regulate the temperature in homes. Hamstead (2023) and their team interviewed 21 residents of Buffalo, NY, between the ages of 25–64. These residents were low- to middle-income White and Black women living alone—many of whom self-reported living with a disability—predominantly in apartment buildings built before 1920 (Hamstead, 2023). The findings indicated a reliance on make-shift modifications to the homes, such as building a cardboard wall to enclose a room and thereby reducing the space required to heat or cool, or taping crumpled newspaper around each window to prevent thermal leakage (Hamstead, 2023). The State of New York offers

programs to retrofit homes for energy efficiency, and also offers applications to reduce someone's energy bills for a season. Still, the majority of (but not all) participants reported extreme frustration with the complicated system they were required to navigate in order to receive this state aid (Hamstead, 2023). Therefore, Hamstead (2023) suggested that urban policies related to adaptive responses for heat and cold should be informed by people's everyday thermal experiences in their homes. Doing so would better address what people actually need and how residents are best able to access a satisfactory solution. Given the intrinsic link between housing and the vulnerability of our aging society to extreme heat, it is imperative to further explore specific housing designs and policies that could enhance heat resilience of older inhabitants, based on the lived experiences of those most at risk.

Age-Adaptable Housing Innovations

In the United States, we are notorious for designing Peter Pan houses, assuming that inhabitants will never grow old. Currently, only 1% of houses in the U.S. would be considered accessible for a person using a wheelchair, and less than 5% would be considered acceptable to meet the needs of a person with moderate mobility limitations (Black-Plumeau, 2015). Updating standard housing designs to adapt to the needs of people as we age is essential, particularly as the U.S. Census Bureau projects that by 2034, people aged 65 and older will outnumber people aged 18 and younger (Stanton, 2022). This is important because people would like to remain in the community of their choice as they age, and age-related ailments often cause people to move into institutional care, simply because of design limitations of their long-time homes (Binette & Farago, 2021). For instance, one common age-related physical change encompasses the broad category of "difficulty walking," which includes challenges such as

ascending/descending stairs, navigating thresholds, getting into/out of a tub or shower with a lip, and stepping into/out of a house (Greenhouse, 2012). Human's age-related physiological changes—such as difficulty walking—should be considered when designing any type of climate-adaptive housing.

There are two primary methods of designing homes for people with all abilities: accessible design and universal design. First, accessible design focuses on creating custom spaces that can be used by individuals with a specific disability. This includes customized modifications to existing dwellings such as building ramps, widening doorways, and installing grab bars that make it easier for individuals with a specific impairment to navigate and access spaces (Wellecke et al., 2022). An interdisciplinary healthcare research team conducted a qualitative study to capture the clients' perspective after receiving customized accessible home modifications by in-home occupational therapists, and found the clients overwhelming reported an improvement in their perception of safety, accessibility, privacy, and overall independence (Lau et al., 2018). Accessible design is an important aspect of retrofitting a home and can ensure that individuals with disabilities live independently and with dignity within their preferred home.

Universal design, on the other hand, focuses on designing and building spaces from the beginning that can be used by individuals of all ages and abilities; this means designing spaces to be functional, usable, and appealing to everyone, regardless of their age or ability (Center for Inclusive Design and Environmental Access [CIDEA], 2010). Universal design features may include simple design choices such as lever door handles that can be easily opened with an elbow or a hip, lever faucets that can be turned on and off with ease, and at least one entry to

the home without steps (Sanford & Hernandez, 2017). In a recent study, gerontology and architectural researchers collaborated to examine the usefulness of universal design features in affordable housing for low-income older adults (Kaup et al., 2020). Since affordable housing continues to be in high-demand within the U.S., researchers were interested in the efficacy of universal design principles (see Appendix A) within a multi-unit building, which was intentionally built as affordable housing for older adults (Kaup et al., 2020). The research team used a combination of post-occupancy evaluations, interviews, and focus groups to assess the apartments. Results indicated benefits of universal design features when implemented, such as wider hallways and doors allowing ease of travel down hallways and within the units (Kaup et al., 2020). Participants reported a deficit when universal design guidelines were not implemented, such as kitchen cabinets being mounted too high for residents to safely reach all shelves (Kaup et al., 2020). The concept of universal design is an important component to this dissertation research and will be further elaborated on within the Conceptual Framework section of this chapter.

There is a connection between the climate vulnerability of older people and their dwellings, since safe housing plays a significant role in protecting people from the impacts of climate change (Molinsky & Forsyth, 2022). Older adults are often more vulnerable to a changing climate due to a variety of factors including physical limitations, cognitive and mental health impacts, limited mobility, and financial vulnerabilities (DESA, 2011; IPCC, 2023; Klinenberg, 2018). Additionally, the lack of accessible homes directly contributes to the vulnerability of older people, which makes it difficult for older residents to access life-saving services and amenities, such as medical care and transportation (Stanton, 2022).

Climate-adaptive housing, which is also responsive to an aging population, is essential to our collective survival as our climate rapidly changes. Recognized scholars of universal design Steinfeld & White describe designing for all age groups as an evolutionary process, “the idea is to strive for a broader and broader range of people ... like sustainable design, there is always another level of performance to achieve” (as quoted in CIDEA, 2010, p. 35). Put simply, climate-adaptable and age-friendly housing can help to reduce the environmental impact of buildings, and support long-term livability for inhabitants.

Heat-Adaptable Housing Innovations

The impacts of climate change are being felt in the U.S. housing market. In a 2021 *Climate Change Catastrophe* report, researchers at the think tank CoreLogic (2022) summarized that one tenth of U.S. homes were affected by a major hazard event in 2021, resulting in $56.9 billion in property damage. Unfortunately, there is little evidence to support the hope that homeowners will fortify their homes against regional climate risks on their own (Tierney, 2019). Homeowners often opt not to take steps to fortify their homes against climate threats due primarily to a low perception of the risk (Meldrum et al., 2021), and secondarily to a combination of financial constraints and limited mitigation guidance available to the general public (Greenberg, 2014; Meldrum et al., 2021; Tierney, 2019). In other words, our current U.S. housing stock is at continual risk of damage due to climate change and homeowners do not have the resources to adapt.

In response, a growing number of researchers and municipalities are dedicated to finding the most effective and cost-conscious material solutions to fortify new homes against various hazards (Meldrum et al., 2021). As an example, architectural and technical building

scholars completed a study connecting housing and climate change (Aleksić et al., 2016). The researchers found a need for systemic future solutions that integrate both sustainable and climate-adaptive home designs due to our rapidly changing environment (Aleksić et al., 2016). While still voluntary, published guidelines for building with regional disasters in mind are readily available, but it is up to individual homeowners to know about and request these upgrades (Thompson, 2019). Many modern designs for climate-adaptation return to the concept of vernacular architecture, which is an architectural design model simply described as building for a local climate with local materials (Dabaieh, 2011). For instance, in China, Zhou et al. (2011) found prefabricated bamboo houses exhibited superior fire-resistant and heat-adaptive performance compared to light-gauge steel panel houses. Another equally sustainable and vernacular use of materials in parts of North America, is the incorporation of residential straw bale construction, which was explored by a building science research team when testing multiple outcomes including the thermophysical properties, energy performance, lifecycle assessment, acoustical performance, and wildfire resilience of this building material (Koh & Kraniotis, 2020). This team found that using straw bales in the construction of homes could provide satisfactory outcomes to meet local building code requirements as compared to conventional materials (Koh & Kraniotis, 2020). In the race toward progress, many are looking to building methods of the past.

In addition to constructing new housing to be more climate-adaptive, researchers have also been exploring options for retrofitting existing homes. A team of civil and environmental engineers in the United Kingdom explored the usefulness of ivy covering the outside of bare masonry walls for thermal performance of the building (Pichlhöfer et al., 2023). For this

research project the team used a residential apartment building with split ownership, constructed around 1911, where ivy was allowed to grow on one half of the building but not the other (Pichlhöfer et al., 2023). The team used the following methods to determine the initial thermal conductivity of the raw materials without ivy; meaning, how well the masonry materials retain or distribute heat or cold: surface temperature, heat flux density, and heat transfer coefficient (Pichlhöfer et al., 2023). According to the building owners, the ivy was planted for the purpose of insulation and neighborhood beautification, and took 7 years to cover the entirety of the 4-story building with little maintenance required (Pichlhöfer et al., 2023). The research team found the ivy had a significant impact on the thermal performance during summer. When measured during a heatwave, where the outside ambient temperature reached 113 °F, the exterior surface temperature of the building side covered with ivy was 86 °F (Pichlhöfer et al., 2023). While this study was not measuring indoor air temperature, the results do support previous research indicating that external shading (i.e., shade sails, patio umbrellas, or trees) can improve the thermal performance of a building, thereby improving thermal comfort for occupants (Babaizadeh et al., 2015; Heidari et al., 2021; Sorooshnia et al., 2023). In other words, preventing heat from reaching the walls of a home will help keep the home cooler.

Similarly, current research on the heat resilience of built environments in the U.S. focuses primarily on reducing urban heat island effects, which is an established phenomena of the built environment's impact on surface energy, which causes urban areas to be significantly warmer than rural areas (Dare, 2021). This research is important, as the urban heat island effect directly threatens public health by increasing heat-related mortality risks within urban areas (Dare, 2021; Roth, 2013). I organized a representative sample of efforts to mitigate heat islands

into Table 2.1. However, a primary limitation is that the focus on city-wide external heat reduction, such as street trees or cool roofs, neglects an exploration of internal heat reduction within the home itself.

Table 2.1

Summary of Efforts to Mitigate Urban Heat Islands

Study	Building Modification	Findings	Location
Alexandri and P. Jones (2008)	Green roofs	Reduce ambient temperatures at 1.0 m above the roof surface by up to 26 °C in Riyadh and 15.5 °C in London.	Riyadh, Saudi Arabia & London, England
Middel et al. (2016)	Shaded areas under photovoltaic and tree canopies	Have a daytime temperature difference of up to 2.0 °C compared to sun-exposed areas at Arizona State University in Tempe.	Tempe, AZ, USA
Shashua-Bar and Hoffman (2003)	Street trees	Reduce ambient temperatures at 1.5 m above the ground by up to 2.1 °C in Tel Aviv.	Tel Aviv, Israel
Akbari et al. (1998)	Cool roofing	Technologies increasing the average albedo of roof surfaces from 0.20 to 0.60 result in a reduction of about 25 °C in roof surface temperature in northern California.	Northern California, USA
Middel et al. (2020)	Uncoated asphalt concrete compared with reflective pavement	Surface temperature difference between uncoated asphalt concrete with albedo 0.6–0.8 and reflective pavement with albedos 0.18–0.25 can be as much as 6.0 °C during midday in Los Angeles.	Los Angels, CA, [redacted]

City leaders in locations affected by extreme heat are struggling to balance affordability, equity, and available technology when trying to integrate heat adaptation into housing policies

(Martín, 2022). For instance, the mayor of Phoenix, Arizona, recently outlined their heat resilience plan. There is little guidance for specific residential designs that protect inhabitants against extreme heat other than planting trees equitably across residential areas of cities, installing cool pavement rather than traditional concrete to reduce urban heat, and suggesting that all new housing construction meets energy efficient standards (Gallego, 2023). In an examination of the deadly heat wave that swept through Phoenix in 2016, researchers at the U.S. Department of Agriculture found that many people who died in their homes owned an operational air conditioning unit, but the device was not turned on (Iverson et al., 2020). Simply requiring that all new homes are equipped with a modern and energy efficient air conditioner is necessary, but not sufficient.

Zoning to discourage building housing in high-risk areas is another key climate-adaptation strategy, and extreme heat is frequently not the only climate stressor experienced by a community. In many western states, such as Arizona and Colorado, there is not enough groundwater to support new housing and entire communities have been abruptly stopped mid-construction (Flavelle & Healy, 2023; Padden, 2023). Similarly, researchers in California suggest land use planning should be considered as an essential component to hazard risk management and that consistently applied policies based on residential pattern may provide substantial benefits for future risk reduction (Syphard et al., 2013). Newman et al. (2013), a forestry scholar in Florida, supports this argument and suggests that assessing structural conditions and existing capacities of localities is a first step in fostering local adaptation in communities affected by hazards; for example, the capacity of the local fire department should be taken into consideration when allowing new residential developments.

However, in the U.S., our modern technology and legal structures are struggling to keep pace with the rapid global climatic shifts we are experiencing. Therefore, it is imperative. decision-makers adapt legal frameworks to better accommodate the urgent realities of our changing climate.

While current efforts show promise, there is a clear need to consider both building material resilience and user-friendliness in the effort to create heat-adaptive homes suitable for older residents. Current research into climate-adaptive housing, though informative, does not adequately explore design features that contribute to heat vulnerability as we age. Therefore, by curiously questioning elements of design that directly influence heat vulnerability, we can begin to narrow the gap between research and real-world applications.

Connecting Population Aging, Extreme Heat, and Housing

At the time of this writing, available research into the connection between extreme heat, housing, and aging populations had been exploratory. For instance, during heat waves, many publicly available information encourages behavioral changes of older vulnerable people, such as leaving their homes and seeking relief at local cooling shelters (Kim et al., 2023; Luber & McGeehin, 2008). However, a city's heat mitigation plan that emphasizes evacuation to cooling shelters is problematic, as Sampson et al. (2013) found in their study with 173 participants in New York, NY; Philadelphia, PA; and Phoenix, AZ. The research team learned that the people they classified as most vulnerable to high heat were the least likely to leave their homes to seek cooling opportunities (Sampson et al., 2013). The team reported that the reduced likelihood of the most vulnerable evacuating during high heat was due to multiple intersecting factors: age, living alone, limited physical mobility, low income, and lack of personal transportation (Sampson

et al., 2013). In other words, individuals most susceptible to adverse effects of heat were the most likely to remain in their homes during a heat wave. Unfortunately, municipal assistance frequently takes the form of cooling shelters, which requires people to leave their homes.

The discrepancy between the public's desire to remain home during high heat and the problematic response of offering cooling shelters was on full display during a prolonged heat wave in Maricopa County, AZ, during the summer of 2016. Vulnerable people experienced a lack of transportation, physical mobility limitations, and compounding medical conditions (Iverson et al., 2020). All of these factors prevented older adults from leaving their homes to seek shelter from the heat when their homes became unbearable. Since vulnerable older people demonstrate a preference to remain in their homes during heat waves (Behera, 2021; Sampson et al., 2013), it is essential to consider home designs that could help to prevent heat-related deaths.

This phenomenon of older residents' preference to shelter at home is not relegated to traditionally hot places. In a recent study engaging elders in Bridgeport, Connecticut, a city-wide disaster preparedness planning project found strikingly similar results (Rhoades et al., 2018). While the study did not focus solely on housing, participants shared many housing-related adaptive techniques implemented to help them manage on days of extreme heat. The primary adaptive strategy was reliance on air conditioning and sheltering in place within their residences (Rhoades et al., 2018). However, it is noteworthy that economic constraints limited the utilization of air conditioning for participants, thereby depleting financial reserves earmarked for other essential expenditures (Rhoades et al., 2018). In other words, due to the high cost of electricity during days of prolonged heat, people were left to make immediate and difficult

choices—deciding whether to run their air conditioner at all and for how long. Financial constraints also hindered the implementation of proactive measures to modify residences in response to climate stressors, thereby preventing people from implementing adaptive measures (Rhoades et al., 2018) such as improving insulation or planting shade trees. Lastly, in a discussion of possible power outages during the summer months, acute concerns included medication spoilage, inability to operate air conditioning, and impairment of essential medical equipment needed for survival (Rhoades et al., 2018), including oxygen or power wheelchairs. This all reflects an urgent need for housing to not only adapt to the challenges and impacts of climate change, but to also be accessible and affordable.

With our rapidly aging population at higher risk of injury or death during a disaster, and a growing number and severity of hazards due to climate change, it is essential that we begin building houses that can adapt to both climate and age-related changes. While the United Nations (U.N.; Economic and Social Commission for Asia and the Pacific [ESCAP], 2022) identified the lack of "hazard-proof housing" (p. 28) as a key component of older adult vulnerability to climate change, the following quote contains the only guidance provided by the U.N.:

> Vulnerability of older persons to climate risks can be addressed by providing inclusive and affordable universal social protection schemes, insurance solutions or hazard-proof housing and infrastructure. Action to reduce exposure to climate risks would include resettlement from areas at high risk of climate change impacts, risk-sensitive land use planning and early warning systems and evacuations that take into account accessibility and mobility constraints of older persons. (ESCAP, 2022, p. 28)

Unfortunately, the U.N. does not offer any additional insights into what types of hazard-proof housing would be beneficial beyond the need to build "high-quality energy efficient housing" (ESCAP, 2022, p. 30). The Intergovernmental Panel on Climate Change (IPCC, 2019) offers

similarly vague guidance, noting that hazard-proof housing and infrastructure are one component of reducing vulnerability for coastal communities.

The current stock of housing in the U.S. is unprepared for both climate change and the needs of our aging population. It is unclear how many homes have some level of climate resilience for their locations (Climate Mapping for Resilience & Adaptation [CMRA], n.d.). Still, we do know that less than 4% of residences have age-friendly design features, such as a step-free entrance, single floor layouts, and wide doors for mobility devices (Scheckler et al., 2022). According to a new study in the journal *Nature Climate Change*, approximately 10% of all properties in the U.S. are at risk of increased flooding due to climate-amplified factors such as sea-level rise or inland river flooding. Still, these properties are overvalued and do not reflect the real climate risk (Gourevitch et al., 2023). According to a 2022 report from the Harvard University Joint Center for Housing Studies, just 0.15% of all housing units in the U.S. are fully wheelchair accessible and only about one third of all homes have some features that could be modified for future accessibility needs (Scheckler et al., 2022). Unfortunately, given our modern-day labyrinth of construction regulations, only a select few people have the privilege of deciding what and where to build, which results in vulnerabilities built directly into our homes (McKenzie, 1996; Rothstein, 2017). Therefore, due to the lack of climate-adaptive and accessible housing options for new construction, and the financial difficulty of retrofitting (Scheckler et al., 2022), the majority of our current housing stock in the U.S. places older people—especially those who are medically vulnerable—at risk of injury or death during a disaster. Ultimately, human-made dwellings have been, and will continue to be, central to the life or death of our species (Allen, 2015; Kelman, 2020).

I contend that current research does not go far enough into exploring potentially lifesaving residential design features for climate vulnerability. Therefore, in the next section of this chapter, I outline a novel conceptual framework I developed for this dissertation, which was needed to address gaps noticed in the literature and limitations of previous conceptual frameworks.

Conceptual Frameworks

This section reviews previous conceptual frameworks and introduces a new conceptual framework titled PLACE, which is an acronym for Preparing Living spaces for Aging with Climate Extremes. By introducing PLACE, this chapter not only contextualizes current research but also provides a foundation for the methods used within this dissertation, which PLACE has been incorporated throughout data collection and analysis.

Previous Conceptual Frameworks

Limitations of current frameworks include the social-ecological systems (SES) framework, which is used as a tool to determine resilience within complex coupled human and natural systems (Partelow, 2018). The SES framework is particularly popular as a tool that provides scholars with a method of categorization, taking into consideration both the social and ecological needs of the study (Ferreira et al., 2018). While the widely used SES framework could have been a good choice for my study, it has faced criticism for its lack of ecological guidelines (Epstein et al., 2013), which would limit the critical and cohesive inclusion of climate extremes in this study.

When considering existing frameworks within the field of gerontology, the Ecological Model of Aging (EMA) is frequently employed as a valuable resource (Greenhouse, 2012). This

conceptual framework—initially introduced by Lawton and Nahemow (1973) and later expanded upon by Cvitkovich and Wister (2002)—was designed to elucidate the relationship between older individuals' physical capabilities and the built environments they frequent most. Critics of Lawton and Nahemow's (1973) original work claim it is too static and is incapable of adapting to changing environmental conditions, instead relying on "docility" toward the environment (Bernardin-Haldemann, 1988, p. 458). In response, Cvitkovich and Wister (2002) updated the EMA to the Multi-Level Person-Environment Model (MLPEM). The MLPEM expanded on the EMA to include personal perception of variables, while still emphasizing the person-environment fit, which may include perception of one's own physical abilities combined with real or perceived risk posed by design of their neighborhood (Cvitkovich & Wister, 2002). The inclusion of personal perception variables, which may align well with the concept of risk perception of climate extremes, made this updated model particularly appealing for my study. However, MLPEM retains a deliberately broad scope with an emphasis on the neighborhood as a system. It lacks the depth and singular focus on an individual's home, which is a central aspect of my research. While often overlooked, exploring the nuances of housing was integral to my inquiry. Therefore, while the EMA and MLPEM frameworks offer valuable insights into aging and housing individually, they do not fully encompass the distinctive considerations at the heart of my research.

Lastly, the IPCC's 5th Assessment Report (AR5) incorporated risk perception into the AR5 framework and showed promise for inclusion in this study, as it emphasized the importance of a person's risk perception in disaster related decision-making (Das et al., 2020; Oppenheimer et al., 2014). The IPCC (2019) even used this framing in a recent document outlining potential

solutions for vulnerable populations facing costal hazards, highlighting the need for hazard-proof housing as an action to reduce vulnerability. However, while the AR5 framework is strong in its ability to examine risk through all contributing factors, it lacks the ability to go into depth on a particular component of the risk. Therefore, creating a new conceptual framework for this dissertation provided a foundation to emphasize and assess climate-adaptive housing that can meet the specific needs of climate vulnerable older people.

New Conceptual Framework: PLACE

I designed a new conceptual framework to help explain the theoretical underpinnings of housing created to be both adaptive to climate extremes as well as adaptive to our predictable changes that come with natural aging. I call this conceptual framework PLACE: Preparing Living spaces for Aging with Climate Extremes. In building a conceptual framework for this dissertation, I synthesized six schools of thought spanning key theories, constructs, and variables (see Table 2.2). Integrating these key theories, concepts, and variables into a cohesive conceptual framework anchors this research project in the available literature.

Table 2.2

Key Components of the PLACE Conceptual Framework

Type	Name	Summary	References
Theory	Vulnerability Theory	Posits that certain populations are more susceptible to harm, and the government has a responsibility to care for its most vulnerable members of society.	Adger & Kelly (1999), Fineman (2010, 2019), Klinenberg (2018), Stanton (2022)
Theory	Theory of Environmental Press	Proposes that people function best when their environment matches their competence level; residential built environment should minimize	Kendig (2003), Lawton (1977)

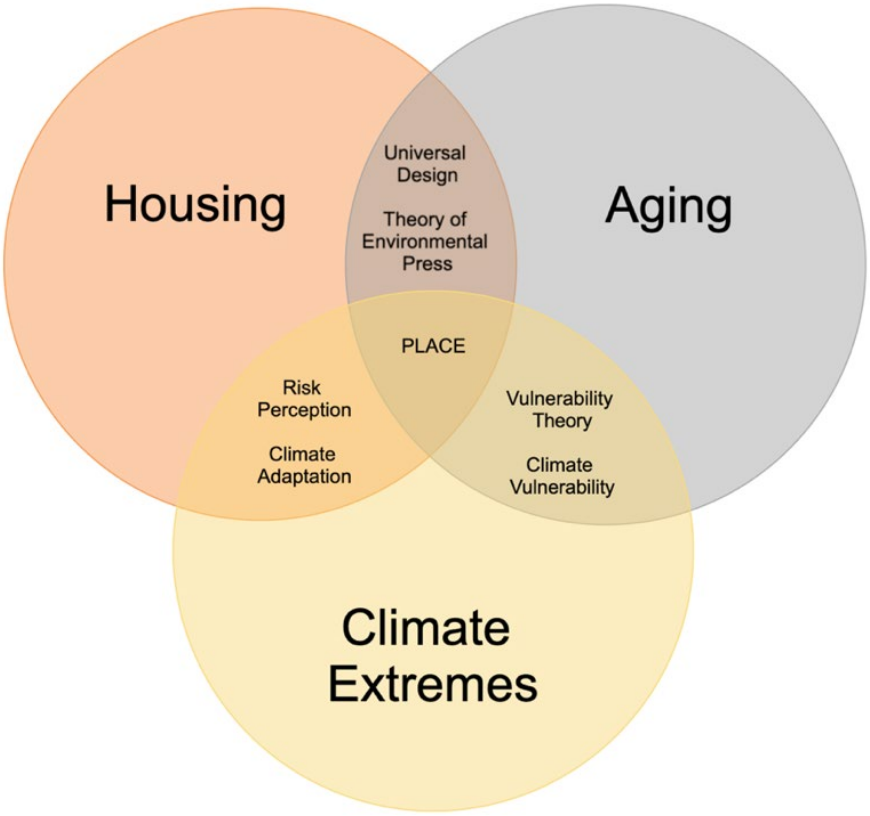
Type	Name	Summary	References
		“press" on older inhabitants to improve well-being.	
Construct	Concept of Personal Risk Perception	Suggests that individuals’ perceptions of risk significantly influence their behaviors and decisions connected to climate risks.	Löckenhoff (2017), Paton (2019), Tierney (2019), Kahneman and Tversky (1973), Tversky and Kahneman (1974)
Construct	Concept of Climate Vulnerability	Refers to the susceptibility of a system, community, or individual to be harmed by climate change impacts.	Greenhouse (2012), IPCC (2007, 2023), Klinenberg (2002), Tierney (2019)
Variable	Principles of Residential Universal Design	Focus on designing homes to be usable by all people, without the need for adaptation. Examples include step-free entrances and wide hallways.	Dolph (2021), Greenhouse (2012), CIDEA (2010)
Variable	Guidelines for Residential Climate Adaptation	Emerging area of interest; utilizes existing resources for built environment climate adaptation, with a focus on heat adaptation for the dissertation.	Martín and Arena (2019)

As further visualized in Figure 2.1, each component of the PLACE framework is interconnected. Together, they provided thematic guidelines for the overall research design, informed development of the survey, as well as guided data analysis. Theories of environmental press and vulnerability offer foundational insights, shaping our understanding of the amplified risks older adults face due to natural aging at home (Fineman, 2010, 2019; Lawton, 1977). Concepts of personal risk perception and climate vulnerability deepened the lens of this inquiry, which allowed me to explore the willingness of older people to take adaptive measures, as well as to explore the intricate interplay of housing design with climate-related threats (Kahneman &

Tversky, 1973; Löckenhoff, 2017; Tierney, 2019; Tversky & Kahneman, 1974). Furthermore, principles of universal design and guidelines for residential climate adaptation were intertwined throughout this research, providing a basis to evaluate potential design solutions that will nudge a home to be more accessible, adaptable, and climate resilient (Greenhouse, 2012; Martín & Arena, 2019).

Figure 2.1

Venn Diagram Illustrating Connection Between Components of the PLACE Framework



There is balance to the design of the framework in that two of each (theories, variables, and constructs) were chosen, thereby overlapping two primary themes of either housing, aging, or climate extremes within the Venn diagram. The PLACE conceptual framework provides a holistic approach and facilitates an enriched understanding of the intersection of aging, housing,

and climate extremes. In the following sections, I explain components of the PLACE framework in more detail, address known barriers, and conclude with review of implementation for the conceptual framework throughout this dissertation.

Environmental Press and Related Theories

The theory of environmental press suggests that people's physical and social environments can significantly impact their behavior and well-being. These impacts can be shaped by the continually evolving characteristics of the environment in connection with the continually evolving needs of the person (Greenhouse, 2012). When introducing the theory of environmental press in the 1960s and 1970s, prominent gerontologist Powell Lawton laid the foundation for an interdisciplinary field known today as environmental gerontology (Kendig, 2003). Explaining the gerontological theory of environmental press, Lawton (1977) claimed that the physical and social environments where older adults live can influence their behavior and well-being. This theory was sculpted using a wide array of disciplines that have historically explored human/environment relationships including archeology, architecture, and psychology. The theory of environmental press suggests that built and natural environments inherently "press" an older adult in ways that cause them to modify behaviors and decisions (Lawton, 1977). In other words, press of the environment on a person shapes their actions and decisions. Lawton (1977) contended that the levels of environmental press can vary depending on the specific characteristics of the environments. He explains,

> Press may be positive, neutral or negative. For example, a television set in an older person's dwelling may be considered a positive press because its presence has the potential for eliciting turning-on-and-watching behavior. In contrast, a lack of heating fuel would be a negative press if it elicits physical exertion beyond the point of tolerance of the older person. However, the TV set or the empty fuel tank may be neutral for other people who do not comprehend TV or in other situations, such as in August when no heating fuel is need. (Lawton, 1977, p. 8)

The theory of environmental press is rooted in a multi-faceted understanding that the design of human dwellings has been essential to our species' survival, has continually evolved as human needs change in response to trauma and available technology, and can help or hinder a person's ability to perform at their highest capacity of health and well-being (Greenhouse, 2012; Kendig, 2003; Lawton, 1977).

Historically used to evaluate the built environments of older adults, environmental press is a useful theory when examining the overlap between climate-adaptive housing and age-friendly housing. For instance, since environmental press has been used for decades to understand the relationship between an older person and their home, climate stressors could be incorporated with little effort. Researchers Park and Choi (2022) interviewed 250 older adults in Jeollanam-do, South Korea and found a direct connection between an elder's satisfaction in their home and reported depression. The authors found that by focusing mediating efforts on modifying troubling aspects of the home, elders reported a decrease in depression (Park & Choi, 2022). In other words, fix what is causing problems for the older people in their home to improve well-being. This finding shows promise for use with climate adaptation work; indicating that an important component of climate resilience as we age will be the ability to modify our homes in order to address challenges caused by climate extremes. Additionally, the theory of environmental press provides a tool for evaluating potential climate-adaptive housing designs

and provides opportunities for predicting anticipated outcomes for older adults in climate-adaptive dwellings. For instance, medical professionals and scholars have a deep understanding of predictable, age-related physical and cognitive changes (Ferrucci et al., 2016), which can be overlaid onto a design consideration for a climate-adaptive home.

To illustrate the theory of environmental press, imagine that a person you know over age 65 has broken their ankle and is not able to put weight on the foot while the injury heals. During this time, they might move slowly and use an assistive device, such as a knee scooter. Now, imagine this person lives in a standard single-family home in the U.S., which has six steps to enter and a handrail on only one side of the steps. According to Lawton's (1977) theory of environmental press, this person's broken ankle would mean they have a reduced ability to compensate for the persistent environmental press caused by the stairs; therefore, they are at more risk of a negative affect and/or maladaptive behavior. The press coming from the stairs has not changed, but the person's ability to compensate for the press has. According to the theory of environmental press, marginally adaptive behavior is likely to result in this example scenario (Lawton, 1977) and might include keeping a knee scooter in the car, using crutches to hop down steps, driving instead of walking to the store, and asking a neighbor to bring groceries inside for them. However, there are dynamic forces at play here, because both the person's ability to compensate and the environmental press are subject to change. With increasing frequency and severity of climate change related events, we are all more likely to experience disasters in our lifetimes that will impact the function and use of our homes (Martín & Arena, 2019). Imagine that a severe snowstorm and deep freeze with sustained sub-zero temperatures sweeps through the region. Unable to shovel the snow due to a broken ankle, and now with a layer of

slippery ice, the front steps are no longer usable. The environmental press on this person has now increased due to the change in weather. In this scenario, maladaptive behavior might include isolation within the home until the ankle has healed, not being able to evacuate in an emergency, or eliminating the possibility for outdoor exercise opportunities, resulting in poor healing and prolonged isolation.

Some critics of the theory of environmental press challenge how profoundly the environment influences human behavior and well-being, claiming that it is mediated by more than just built structures (e.g., culture, social norms, personal experiences, or technological advances; Anthoney, 2011). Critics argue that the environmental influence on behavior and well-being is oversimplified and overstated, adding that individual characteristics (e.g., personality, values, and beliefs) are more important determinants of behavior than the environment (Anthoney, 2011). Additional criticism emphasizes that the theory of environmental press does not adequately account for the role of other factors, such as economic, political, religious, and technological changes in shaping behavior and well-being (Ysseldyk et al., 2013). However, there is significant risk in moving our attention away from how housing designs can—positively or negatively—press on the needs of older adults. This is especially true since most fatalities during disaster events occur in and around an older person's home (M. K. Smith et al., 2022). Nevertheless, both followers and critics of the theory of environmental press would probably agree that the environment's influence on behavior and well-being is more complex and nuanced than the theory suggests, and other factors may also play a role in shaping behavior and well-being.

Universal Design and Related Principles

Universal design focuses on designing and building spaces—from the beginning—that can be used by individuals of all ages and abilities; this means designing spaces to be functional, usable, and appealing to everyone, regardless of a person's age or ability (CIDEA, 2010). Universal design features may include simple design choices such as lever door handles that can be easily opened with an elbow or a hip, lever faucets that can be turned on and off with ease, and at least one entry to the home without steps. The now well-established seven principles of universal design (see Table 2.3, as applied to lever door handles) emphasize the creation of spaces, products, and built environments that are fully usable by as many people as possible, regardless of their age or ability (CIDEA, 2010). A detailed description of the seven identified principles of universal design created at the Ron L. Mace Universal Design Institute can be found in Appendix A. However, the following table offers direct quotes summarizing the principles (Connell et al., 1997, para. 2):

Table 2.3

A Summary of the Seven Principles of Universal Design

Principle	Description
1. Equitable Use	"The design is useful and marketable to people with diverse abilities."
2. Flexibility to Use	"The design accommodates a wide range of individual preferences and abilities."

Principle	Description
3. Simple and Intuitive	"Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level."
4. Perceptible Information	"The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities."
5. Tolerance for Error	"The design minimizes hazards and the adverse consequences of accidental or unintended actions."
6. Low Physical Effort	"The design can be used efficiently and comfortably and with a minimum of fatigue."
7. Size and Space for Approach and Use	"Appropriate size and space are provided for approach, reach, manipulation, and use regardless of the user's body size, posture, or mobility."

What is lacking from these design types is the need to include place-based considerations—such as local weather—into the conversation of age-friendly housing design. This inclusion would weave the environmental and climatic considerations into the location-specific designed home, thereby eliminating cookie-cutter homes and encouraging vernacular architecture. In the context of this dissertation, universal design principles play a crucial role in developing climate-adaptive and age-friendly housing. This study contributes to creating living spaces that not only mitigate risks associated with extreme heat but also cater to the diverse needs of people as we age, thereby enhancing overall quality of life and reducing the likelihood of negative impacts during a disaster. Due to the established seven principles (see Table 2.3), universal design becomes the most suitable approach to housing design, and can

play a crucial role in developing climate-adaptive and age-friendly housing, and thus seamlessly aligns with my PLACE framework (see Figure 2.1, Table 2.2).

The inclusion of universal design in the PLACE framework is essential. While 53% of households in the U.S. are either single people living alone or couples with no children, only 12% of the housing stock is smaller spaces, such as studio and one-bedroom homes (Broikios & Stanton, 2019). In other words, we have a surplus of single-family houses, and we lack the variety of housing options people need to age in their chosen homes.

To explain this discrepancy in U.S. housing stock, I looked to psychologists for answers. I was curious about how different types of homes could change human behaviors and emotional responses. Environmental psychologist, Colin Ellard (2015), and their team modeled three different homes: An early Frank Lloyd Wright model centered on a hearth, the simplicity of a Sarah Susanka minimalist home, and a standard suburban single-family home. The team invited participants to complete walk-throughs of each model using virtual reality and participants were asked to consider each one as if they were interested in purchasing it (Ellard, 2015). While there was a visible change in the participants when entering the light filled Susanka home, and a positive reaction to the natural materials in the Wright home, all the participants chose the standard suburban home to purchase even though they did not like it the most (Ellard, 2015). Ellard (2015) reported, “They told us that though they found the designer homes interesting and attractive, they gravitated toward the kind of houses they were most likely to be able to find in the current market” (p. 65). Researcher and design psychologist, Toby Israel (2003), offered an explanation that the participants’ attraction to the suburban home was not necessarily due to what was available in the housing market, but what they considered to be “home,” based on

the setting in which they grew up or spent time. Since we have a surplus of standard single-family houses, this type of housing is becoming the default image of a home in the U.S.

This image of home is problematic because, with few exceptions, current building code requirements throughout the United States do not demand that single-family homes meet any age-friendly design standards (U.S. Access Board, 2014). Thus, nothing requires that the majority of the housing available in the U.S. will adapt as our needs predictably change with age, which often results in older adults being forced to move from beloved homes (Binette & Farago, 2021). However, there are two voluntary methods of designing homes for people with all abilities: accessible design and universal design (CIDEA, 2010; Sanford, 2016). Therefore, incorporation of one of these design methods into the PLACE framework (see Figure 2.1, Table 2.2) is essential to ensure the outcomes will adapt to people's predictably changing needs as they age. Incorporating universal design into the PLACE framework as an established principle to follow is an essential step to ensure homes will be able to adapt to our changing human needs.

Vulnerability and Related Theories

At the core of vulnerability theory lies an argument that humans are constantly susceptible to changes in physical and social well-being (Fineman, 2010). Popularized by the celebrated legal scholar Martha Fineman in the 1970s, vulnerability theory argues that human vulnerability should be at the heart of our systems and policies, and governments must protect (i.e., legal or policy implementations) the shared vulnerability of our human condition (Fineman, 2010).

The key to modern interpretations of vulnerability theory is the connection between inherent human vulnerability and the need for state protection (Fineman, 2010). Since

vulnerability theory is often used to understand factors contributing to the vulnerability of individuals and communities, this theory is becoming increasingly popular to help scholars understand vulnerability resulting from climate change. For instance, social workers and sociologists have utilized vulnerability theory to help identify individuals who may be more susceptible to harm (Dominelli, 2012; Wisner & Kelman, 2015). Ecologists further expanded on this theory to examine an ecological system's potential weaknesses or resilience to projected shocks (Janssen & Ostrom, 2006).

Geographer Ruth Wilson Gilmore (2008, 2023) used vulnerability theory to build the concept of organized abandonment, which speaks to the systemic and implicit inequity of vulnerability. The theory of organized abandonment explains how a person's vulnerability to harm—such as premature death—is not a result of an individual's failure, but is a system-wide decision to abandon an entire group of people (Gilmore, 2010). Gilmore (2008) primarily used their theory to explain inequality within the U.S. incarceration system. However, the theory can also help to assess our current pattern of building institutional care centers to warehouse people as they age, rather than creating an intergenerational cultural shift. Such a shift would emphasize care for our most vulnerable age groups at every level of government decision-making. Therefore, Gilmore (2023) encouraged a paradigm shift, and stressed that vulnerability occurs when lives that were once organized become disorganized (i.e., formerly prominent structure and certainty are stripped away). For instance, the devastation of experiencing a disaster event completely shifts how people understand themselves in the world and in relation to one another—breaking relationships and creating new ones—and forces

people to figure out how to renovate old structures to solve new problems (Allen, 2015; Gilmore, 2023; Tierney, 2019).

The inclusion of vulnerability theory in the PLACE framework provides an approach to instigate change, due to this theory's emphasis on needed government responses to protect the most vulnerable from harm (Fineman, 2010). This connection between the PLACE framework and vulnerability theory provides a pathway for including needed government actions and policies aimed at safeguarding the well-being of older people, who are at a higher risk of harm due to climate change.

Climate Vulnerability and Related Constructs

In the early 2000s, the IPCC convened a special working group tasked with incorporating human adaptation and vulnerability into the IPCC's Fourth Assessment Report. Due to this working group's contribution, the IPCC (2007) report explained human vulnerability to climate change as "a multi-dimensional, dynamic phenomenon shaped by intersecting historical and contemporary political, economic and cultural processes of marginalization" (p. 52). The IPCC report echoed previous scholarship on vulnerable populations that summarized human vulnerability to climate change as a social construct, which weaves together a unique combination of individual and collective vulnerability (Adger & Kelly, 1999). Thus, local or national governments should offer protections (e.g., updated building codes or policies) to mitigate inherent human vulnerabilities (IPCC, 2023), such as predictable age-related changes.

Vulnerability theory suggests that older adults may be particularly at risk to the impacts of climate change due to a combination of physical, social, and economic vulnerabilities, and that the government should offer protections to mitigate vulnerabilities (IPCC, 2023). However,

when considering changes to climate vulnerability as we age, it is important to note that older adults are not a homogeneous group and individual vulnerability will vary widely based on a multitude of factors. Such contributing factors to climate vulnerability as we age include socioeconomic status, race, physical limitations, lack of access to resources, location of residence, income, social isolation, and social capital (Adger & Kelly, 1999; Cornell et al., 2012; Daddoust et al., 2018; Klinenberg, 2018). Although an individual's vulnerability to climate change will differ from their peers, the fact remains that the United Nations consistently reports that older people are far more likely to die during a disaster event than other age groups (DESA, 2011; ESCAP, 2022). Therefore, it is important to understand how specific vulnerabilities to the impacts of climate change can lead to increased risks for older adults.

Considering climate change considerations along with our changing human needs that accompany natural aging is essential. When interviewing older residents during a disaster preparedness research study, Rhoades et al.'s (2018) findings succinctly summarized an older person's risk into four characteristics that contribute to their heightened vulnerability to climate change: disability, living alone, low income, and non-native English speaker. The following points summarize these key climate vulnerability considerations as we age:

- *Disability*: Aging causes a decline in physical abilities, and may cause a decline in cognitive abilities, which corresponds to an increased risk of chronic health conditions (Greenhouse, 2012; Molinsky & Forsyth, 2022). Thereby making individuals more susceptible to the health impacts of climate change, such as extreme heat, air pollution, and the spread of vector-borne diseases (Greenberg, 2014; Rhoades et al., 2018). Additionally, aging-related limited mobility can make

it difficult to evacuate or seek shelter during a climate-related emergency, thereby increasing risk of injury or death during a disaster (Greenberg, 2014; Greenhouse, 2012; Stanton, 2022).

- *Living alone*: Older adults are more vulnerable due to the loss of social connections, support systems, and familiar home environments, which are often disrupted many times throughout life by changes to family and social systems (Dolph, 2021; Greenberg, 2014; Rhoades et al., 2018). Importantly, limited social connectedness directly and negatively impact a person's ability to survive a disaster (Timalsina & Songwathana, 2020).
- *Low income*: Older adults who live on a fixed income may face increasing vulnerability to the impacts of climate change, such as the cost of evacuating to a nearby city or repairing/rebuilding homes damaged by extreme weather events (Greenberg, 2014; Rhoades et al., 2018). An additional layer of vulnerability is present when considering broad economic impacts of climate change, such as job losses or price increases for essential goods and services (Stanton, 2022).
- *Non-native speakers of country's primary language*: Older residents who do not fluently speak the primary language of the city in which they reside face life threatening challenges to receiving warnings for evacuation or shelter recommendations for severe weather (Rhoades et al., 2018). This challenge is compounded if municipal long-term disaster preparation plans are not communicated clearly, which prevents household-level planning such as preparing for evacuation or sheltering in place (Greenberg, 2014).

Humans have a long history of modifying built and natural environments to suit our needs. The interdisciplinary uses of vulnerability theory, combined with climate change considerations for older people, highlights how certain populations are at a higher risk of being left behind and highlights the need for government intervention to standardize protection. In accordance with vulnerability theory, the state should play a more significant role in policy to encourage or require development of housing that safeguards vulnerable older adults from the consequences of climate change (Fineman, 2019; Stanton, 2022). However, without emphasizing the built environment needs of occupants, we will continue to build disabling housing environments that dominate the U.S. housing stock, thus continuing to risk lives of our society's most vulnerable. Therefore, the inclusion of climate vulnerability considerations into the PLACE framework is essential to spotlight predictable human vulnerability to climate change as we age.

Personal Risk Perception and Related Constructs

Personal perception of risk plays an interesting role in the future of climate-adaptive age-friendly housing. The concept of risk perception originated from the field of psychology, but it is used across disciplines and has proven helpful when attempting to understand how individuals perceive and respond to risks (Tierney, 2019). When considering risk in the context of disasters, scholars stress the intersectionality of risk perception and state that personal risk perception is influenced by a multitude of factors: social, cognitive, emotional, life experiences, gender, socio-economic status, place attachment, physical location, and race (Paton, 2019; Tierney, 2019). All these factors contribute to an individual's perceived likelihood of a risk occurring, the severity of the risk, and the consequences of the risk (Tierney, 2019). However,

previous work has not examined the risk perception and decision-making processes specific to older adults, which is essential foundational knowledge when discussing the need for building climate-adaptive age-friendly housing throughout the U.S. In developing the PLACE framework, I incorporated prospect theory, assemblage theory, and a gerontological framework of late-life decision-making to understand how the construct of personal risk perception may change as we age.

Natural hazard scholars have documented that a person's decision to move or adapt their home is more likely to occur after multiple disasters have been experienced in the same location (Schwartz, 2020). A recent study found that people living in the mountain town of Bailey, Colorado, many of whom were over 65—although this study was not focused on age—had a vastly lower perceived risk of wildfires than their actual risk (Meldrum et al., 2021). The residents surveyed perceived their homes as being at low risk of wildfire damage, even though risk modeling from the U.S. Forest Service and the National Oceanic and Atmospheric Administration (NOAA) classified their homes as at high risk of destruction from a wildfire (Meldrum et al., 2021). Specifically, 70% of respondents categorized their situation at low to moderate risk, while only 19% were placed in the low to moderate risk category by experts (Meldrum et al., 2021). In other words, the perceived risk is low, and the real risk is high. This helps to explain potentially harmful choices seen during other nearby wildfires, such as not fortifying homes or not heeding evacuation warnings until the flames were at their doors (Tierney, 2019).

Kahneman and Tversky's (1973) prospect theory is useful when attempting to understand disaster-related decision-making, which assists in connecting how a person's

perception of risk influences their decision-making (Tierney, 2019). Prospect theory demonstrates that people are more sensitive to possible losses than possible gains (Kahneman & Tversky, 1973). When deciding to move post-disaster or retrofit a home to be more climate resilient, this pattern of loss v. gain is referred to as the endowment effect (Tierney, 2019). For instance, as people stay in a community, they accumulate a store of locational advantages and disadvantages (e.g., you live next to your favorite coffee shop, but you have noisy neighbors) that together form an endowment (Clark & Lisowski, 2017). The higher the endowment (the net positive advantage), the more risk averse a person is likely to be and the less likely they will be to move out of their community after a disaster. In an interview with author Michael Lewis (2018) during his research for "The Fifth Risk," Kim Klockow-McClain, a meteorologist and behavioral scientist, succinctly described this phenomenon as people associating home with safety. Klockow-McClain (as cited in Lewis, 2018) further elaborated:

> This feeling was reinforced each and every day that nothing happened inside of it. People acquired a false sense of confidence that they would not be hit. Some inner calculation led them to believe that, if it's never happened here, it never will. (p. 203)

When considering prospect theory in the context of risk perception and decision-making for older adults living in high heat, people may opt against moving if they have a high endowment (Ash et al., 2020; Clark & Lisowski, 2017). Instead, they could choose to stay and retrofit, stay and modify their behavior to seek cooler buildings during high heat, or stay and do nothing different, the latter of which places the person at a greater health risk.

At its core, assemblage theory provides a framework to examine social complexity by emphasizing fluidity and exchangeability; meaning, within any given system, the component parts can be exchanged for other parts due to their relationships (Deleuze & Guattari,

1980/1987). This theory has implications for understanding social interactions, suggesting that the perception of social connections has properties that emerge through actions of compiling its parts, not just when fitting the parts together (Deleuze & Guattari, 1980/1987). In other words, acknowledging the weight carried by certain social connections in an older adult's life is key because those people could nudge an older adult's perception of risk and/or decision-making about a real or perceived risk (Tierney, 2019). In the context of the PLACE framework (see Figure 2.1, Table 2.2), the way a person assembles their social network is important to consider, since *who* a message is coming from could matter more than *what* is being said.

As we age, our social connections are more significant in both risk perception and decision-making (Löckenhoff, 2017). For instance, an older adult's decision to move or modify their home after a disaster will be highly influenced by their close social connections. Specifically, how an older adult assembles the component parts of their decision will demonstrate which social connections carry more weight to sway the ultimate risk-related decision (Kahneman & Tversky, 1973; Löckenhoff, 2017; Tversky & Kahneman, 1974). Since older adults tend to defer or delegate decisions, confidants and family members play a key role in the decision-making process of older adults (Löckenhoff, 2017). Due to an "age-related emphasis on emotionally meaningful relationships," older adults are more likely than younger adults to be responsive to the wishes and actions of others close to them (Löckenhoff, 2017, p. 8). Therefore, older adults are more likely to take the opinions and actions of people in their social network with greater weight when assembling the components of their own decisions.

According to the theories and frameworks previously discussed, we know an older person living in an area that is increasingly threatened by disasters is statistically most likely to

age in place, to defer decision making until a later date, or to delegate the decision to another person (Löckenhoff, 2017). However, if the same older adult is considering mitigating their home from heat risk or selling their home to move away from risk, that older adult is likely to base their decision on what they perceive as avoiding a greater risk—to their own health, to the health of loved ones, or to their loss of social connections and key service providers (Löckenhoff, 2017). Incorporating considerations for personal risk perception into the PLACE framework becomes essential as we seek to understand how lifesaving information can be relayed.

Residential Climate Adaptation and Related Principles

Representing the intentional inclusion of place-based solutions into the PLACE framework, considerations for residential climate adaptation is an important avenue for highlighting regional climate vulnerabilities and built environment solutions. In applying the PLACE framework, it is important to take into account local climatic and geographic considerations and future projections. Thereby situating the conversation about housing to consider place-based challenges and solutions.

Designing homes to withstand climate-amplified disaster events is an emerging area of scholarly and practical interest. In response, a niche market called resilient design is growing to assist homeowners when designing and building new single-family homes that can withstand the lion's share of regional environmental hazards and bounce back quickly after the hazard has passed (Thompson, 2019). This topic has even reached outside of academia and into public awareness. For example, national publications such as *The New York Times* recently profiled homes designed to address specific environmental hazards. For instance, the Q-Cabin, a modular, half-dome shaped, single unit home claims to be wildfire proof, customizable, and

constructable without the help of professionals (Jackson, 2021). In California and Oregon, the flexibility offered by this unit is appealing to many wildfire survivors interested in remaining in their communities (Jackson, 2021). Additionally, geodesic dome designs are becoming popular in many parts of the U.S. due to their ability to deflect wind, making the shape ideal for areas prone to high winds from hurricanes, tornadoes, and wildfires (Flavelle, 2023). While these designs are of interest to survivors with the financial means to rebuild after a destructive event, little actionable guidance exists for generalizable climate adaptive home design. The inclusion of strategies for residential climate adaptation within the PLACE framework provides a pathway to incorporate the most recent and disaster-relevant building science as advances are made available.

Summary of the PLACE Conceptual Framework

In general, a conceptual framework is useful to guide the research inquiry by providing a model of anticipated relationships between key components; namely theories, constructs, and variables, and their interrelationships (Lapan & Quartaroli, 2009). Taken as a whole, the Preparing Living spaces for Aging with Climate Extremes (PLACE) conceptual framework highlights theories, constructs, and variables relevant to understanding the confluence of older adult vulnerability and housing in the context of climate-related impacts. Theories of environmental press and vulnerability theory provided an academic foundation for the framework, on which I was able to provide support with the constructs of climate vulnerability and risk perception, and integrating finishing touches through variables of age and climate-adaptive housing designs. In summary, PLACE provides a framework for understanding climate vulnerability through the lens of aging within our homes; thereby offering valuable

insights for policymakers, researchers, and practitioners as we consider how to address human survival in our warming world. In the following chapter, I will provide details on how I utilized the PLACE framework within each aspect of this mixed-methods dissertation.

CHAPTER III: METHODOLOGY

The Research Approach

Prior to this study, architectural scholarship on adaptable building designs was primarily focused on overall sustainability and energy performance of commercial buildings (Schmidt et al., 2010). However, ideas for residential climate mitigation are growing in popularity as the global climate changes and more households are in harm's way. While adaptive buildings could provide unique solutions for regional sustainability challenges, they are not optimally designed to protect medically vulnerable people, who are most often the victims of climate disasters (Molinsky & Forsyth, 2022). There is a present need to develop agreed-upon solutions for regional building standards that address the confluence of climate change and an aging population.

To address this need in this dissertation, I used my PLACE conceptual framework (see Figure 2.1, Table 2.2) to design a mixed-methods research study exploring the intersection of age-friendly and climate-adaptive housing in the context of extreme heat in Arizona. Mixed-methods research is a prevalent approach in environmental studies that combines quantitative and qualitative data to comprehend minimally understood phenomena (Stern, 2018). Since there is limited existing research on the topic of older adults' residential vulnerabilities to climate change (Martín & Arena, 2019), a mixed-methods approach was most appropriate to explore the complex issues examined in this dissertation (Bernard, 2011).

I chose convergent parallel mixed-methods research to answer the research questions in this study, collecting both quantitative and qualitative data simultaneously but analyzing the data separately (Bernard, 2011; Saldaña, 2016). My mixed-methods, convergent parallel

research design was organized into three studies that follow a temporal theme of Past, Present, and Future. This approach allowed for the creation of mutually exclusive datasets that informed each other. It is important to note that data collection for each study was independently administered and analyzed, ensuring the progress of one study did not hinge on another. I chose this approach deliberately to reduce potential research delays caused by various challenges—limited access to archives, extended survey analysis, or difficulties in scheduling interviews with key informants—all of which occurred. In the context of this dissertation, in which the aim was to unravel how housing design impacts vulnerable older adults living in places with extreme heat, the flexibility in application of mixed-methods research became particularly valuable.

In Part I of this dissertation, titled "Past," I conducted an archival review to address the following research question: *What can we learn from archival reports from the Medical Examiner's Office in Maricopa County about the relationship between the built environment of an older person's home and their death during days of extreme heat?* In Part II, titled "Present," I created and deployed a digital survey to address the following research question: *What residential extreme heat and age-related adaptations are most commonly implemented by older adults living in Arizona*? Finally, in Part III, titled "Future," I conducted key informant interviews to explore the following question: *What are strategies to advance the goal of adapting a home most effectively from extreme heat that will not negatively affect people as we age in place*? In this Methodology chapter, I discuss each study in detail, while providing an overview of the rationale, description of data collection methods, and explanation of how the data was analyzed.

Site Description

Identifying a precise location for this study was somewhat challenging, since vulnerable people living throughout the U.S. are exposed to the risks of extreme heat (Raymond et al., 2020). Notably, people who live in cooler states face a higher risk of death during extreme heat due to many homes not being equipped with air conditioning (Randazzo et al., 2020), as was evidenced in the deadly heatwaves in Chicago in the summer of 1995 (University of Chicago Press, 2002) and the Pacific Northwest in June of 2021 (Burlotos at el., 2023). However, since my research emphasizes the needs of those aging with extreme heat, I focused on several regions across the U.S. with experience managing and adapting to extreme heat, in addition to having a large number of older residents. Therefore, I chose to center my research in a state known for high temperatures in an effort to learn from this lived experience. In the following paragraphs I guide the reader through my decision-making process that led me to focus this research inquiry on Arizona.

Several regions throughout the U.S. are known to have an outsized number of residents who are aging with extreme heat. According to National Oceanic and Atmospheric Association and the U.S. Census Bureau, the following states could have fit my research criteria (Abatzoglou & Williams, 2016; Blackwell, 2022; Caplan, 2023; Crimmins et al., 2022; Mankin et al., 2021):

- The Pacific Northwest, which includes Washington and Oregon, is prone to high heat. While the climate in this region is generally cooler and wetter than other regions, it has experienced an increase in deadly heat waves and drought conditions in recent years. The percentage of older adults in this region is not as

high as some other areas, but is still significant, and it is a booming destination for retirement migration.

- The Rocky Mountains, which run through several states including Colorado, Wyoming, Idaho, and Montana, is an area also prone to extreme heat events. The dry, windy conditions in many areas of the Rockies, in addition to the high elevations and intense sun exposure, can worsen extreme heat days. However, these states have fewer older residents than others.
- The Southwest region of the U.S. (including Arizona, New Mexico, and southern California) is known for its arid climate, high temperatures, prolonged droughts, and water scarcity. These conditions make this region prone to extreme heat events. Further, of the Southwest states, Arizona has the largest population aged 65 and older (18.0%).
- Florida is vulnerable to extreme heat in addition other climate-related hazards, such as hurricanes. Florida has the highest percentage of older adults of the possible site selection examples, with more than 20% of the population aged 65 and older.

Since Florida and Arizona have similar populations of older residents and are both known for high heat, I continued to narrow my site selection criteria. Next, I explored access to archival coroner data, which I learned was available in both states. Then, I turned my attention to humidity levels and surrounding landscapes; as previously discussed, hot temperatures combined with humidity levels can become deadly for humans because it is difficult for the body to cool down and regulate its internal temperature (Abatzoglou & Williams, 2016). Humid

air prevents our bodies from sweating, thereby hindering the ability to release excess heat (Matthews, 2018). However, dry heat feels cooler due to sweat evaporation, which places people at a greater risk of heat exhaustion or death since humans do not feel the physical effects of heat as acutely in places with dry heat (Matthews, 2018; Raymond et al., 2020). Additionally, prolonged drought conditions in Arizona amplify the presence of dry vegetation, which is a notable element in the occurrence in extreme heat events; dry vegetation contributes to the aridity and lack of moisture in the air, worsening the impact of extreme heat conditions for humans (Blackwell, 2022; Klinenberg, 2002; Mankin et al., 2021). Ultimately, both states were excellent candidates for this study.

Arizona was selected for this dissertation, due in large part to proximity (I lived in Colorado at the time of research design) and my existing professional connections in the mountain west region. Within Arizona, I chose Maricopa County when requesting archival data for two reasons: Maricopa County being the largest metropolitan area within the state offered a bigger dataset, and Maricopa County is one of the few medical examiner offices in the country to have a protocol in place for collecting heat-related cause of death information (Batchelor, 2024). Maricopa County's Office of the Medical Examiner (OME) offers insight into the office's process to better understand heat-impacts to their community, which include incorporating heat surveillance since 2006 and noting data on air conditioners in the home since 2012 (Batchelor, 2024). Key to successful heat surveillance, the medical examiner's office has created a team with the title of "death investigator" (para. 6), whose job it is to visit the scene of a death and catalog potential heat-related contributing factors to the death (Ritchie, 2023). A recent National Public Radio report explains further (Borunda, 2024):

> Every time the office gets a call about a body, they send a "death investigator" to suss out the context in which someone died. Between April and October, those investigators ask about heat. They check the temperature of the rooms people were found in. They ask whether they were having trouble paying their electric bill because of air conditioning. They see whether a phalanx of fans was set up in front of the I in which someone died. (para. 36)
>
> All that context feeds into the decisions pathologists make when examining the body and filling out death records and goes into the official records themselves. They coined the term "environmental heat exposure" to encapsulate heat-related factors that contributed to someone's death without necessarily being the primary driver. (para. 37)
>
> "There is some art in deciding'what's significant or not," Johnston [Maricopa County's Chief Medical Examiner] says. Hard science, yes, but also nuance, and curiosity and creativity in trying to piece together the last fragments of someone's life. "It's hot every summer: 103, 105. The question is, what's too hot?" (para. 38)

Given the intentional inclusion of heat-related indicators in a decedent's home, archival records from Maricopa County Office of the Medical Examiner were chosen for inclusion in this dissertation.

In summary, an important consideration in addressing my first research question was availability and use of data in a cohesive analysis. Though it varies by state, archival medical examiner reports are publicly available in Arizona. Additionally, Arizona was a good fit to address my second research question about residential heat adaptation with a digital survey. According to the U.S. Census Bureau (2023), about 18% of Arizona's population is aged 65 and older, which is higher than the national average. Importantly, I used a digital survey as my research modality because Arizona was named the fourth most tech savvy state for seniors in the country, with 87% of people over 65 having access to the internet and only 6% not owning a computer (Ramakrishna, 2023). Lastly, while not known for progressive politics, the Arizona county of Pima was the first jurisdiction in the U.S. to enact a "visitability" requirement into the

local building codes; meaning that since 2002, all newly constructed single-family houses must meet the new standard of:

> At least one entrance with no step, and doors at least 32 inches wide, lever door handles, reinforced walls in ground-floor bathrooms so it's easy for an occupant to install grab bars, switches no higher than 48 inches, and hallways 36 inches wide throughout the main floor. (Center for an Accessible Society, 2003, p. 1)

This legal precedent proved insightful for successful efforts to update residential building codes. By offering cohesive policy recommendations, the results of this study will benefit professionals (e.g., public health professionals, policy-makers, and healthcare personnel) who are motivated to improve the safety of city inhabitants. By focusing on these specific challenges in this dissertation, I have provided crucial tools and guidelines for developing climate adaptive housing policy and design. Most importantly, these results have the potential to save older people's lives in and around their homes.

Data Collection

Part I (Past): Archival Review

I conducted a retrospective archival review using publicly available data from the Maricopa County, AZ, Office of the Medical Examiner. I reviewed death records for the hottest day of the previous year. On July 11, 2022, it reached 115 °F in Maricopa County. I also used data from 1 additional day before and after, for a total of 3 days. I obtained this information freely and directly from the Office of the Medical Examiner in Maricopa County, Arizona.

While the use of archival data is still an emerging area of scholarship within the field of environmental studies, archival data is most often used in concert with other sources to explore environmental questions. For instance, Fraser and Stringer (2009) explored the vulnerable systems that contributed to agricultural collapse in southern Romania. The authors used

archival documents such as newspapers, farm journals, and land ownership titles—which helped explain past demographic and political changes—combined with interviews of farmers and political decision-makers (Fraser & Stringer, 2009). Additionally, education scholars McLeod and O'Connor (2020) championed the increased ease of access for what they call "small data" (p. 524). The authors described small data as contextually rich, usually produced from qualitative studies—such as interview transcripts—and can be preserved for potential future research.

The archival data that I used could be categorized as small data. While arguing that this small data contributes to "knowledge [as] power" (p. 524), McLeod and O'Connor (2020) also cautioned researchers that archiving and re-using extrapolated data contributes to an ethical dilemma by inherently overlooking the context of data collection. The authors explained that, "It is widely acknowledged that qualitative data cannot be readily extracted from the context of its production but needs to be read and understood in relation to the material, cultural and affective conditions in which it was produced" (McLeod & O'Connor, 2020, p. 525). Therefore, since guidelines have yet to be established for the use of small data in research studies, McLeod and O'Connor (2020) called for continued critical discussion of ethical considerations when using archived education data for research that the data was not initially intended for.

Due to the widely varying views and lack of agreed upon interdisciplinary guidelines for use of archival data within research studies, I followed guidance from the medical profession in this dissertation. The Council on Ethical and Judicial Affairs has recommendations, including comments from the College of American Pathologists, that were adopted by the House of Delegates of the American Medical Association. The Council stated that, "Disclosure of medical

information postmortem for research and educational purposes is appropriate as long as confidentiality is maintained to the greatest possible degree by removing any individual identifiers" (Maixner & Morin, 2001, p. 1192). In the United States, there is no national standard for information included in local Medical Examiner Offices' reports. Therefore, coroner reports vary by state or county and may include the cause of death, an autopsy summary, toxicology results, and interviews with people who knew the decedent (Maixner & Morin, 2001). For instance, in the state of New Hampshire, coroner reports are considered medical records and anyone requesting a report must provide written consent from the next of kin before the document is delivered (New Hampshire of Justice, n.d.). Alternatively, coroner reports in Arizona are not classified as medical records and are therefore public information and available for anyone to request (Maricopa County, n.d.). While Arizona does not consider coroner reports as medical information and does not impose restrictions on use of the data, I upheld the ethical standards suggested by the Council on Ethical and Judicial Affairs when utilizing medical information in research, as I describe in the Ethical Consideration section of this chapter.

Archival Sampling

In 2022, heat related deaths in Maricopa County grew by 25% from the previous year (AZFamily Digital News Staff, 2023), and are projected to grow faster than any other municipality in the U.S. over the next 5 years (Levenson, 2023). People over age 65 were disproportionately represented among 2022 heat victims in Maricopa County, and the over 65 age group is consistently considered at high risk of death during heat waves (Associated Press,

2022). Therefore, I focused criteria for archival inclusion in this study on the impact to older people in Maricopa County during one heat event in 2022, based on the following:

- *Geographic Relevance*: I chose Maricopa County, Arizona, due to its current and projected vulnerability to extreme heat events (Levenson, 2023; State of Arizona, 2022).
- *Demographics*: Maricopa County has a significant population of older adults. According to the U.S. Census Bureau (2023), about 18% of Arizona's population is aged 65 and older, which is higher than the national average of 16.8% (Caplan, 2023).
- *Data Availability*: The Maricopa County Medical Examiner's Office provides reports upon request.
- *Specific Disaster Event*: To obtain a clear picture of the impact of a single extreme heat event and to avoid potential confounding factors, I focused on coroner reports from a specific heat event. This approach allowed for a focused analysis of the direct and indirect effects of this event on the older population in their home environments.

I collected data directly from the Medical Examiner's office and stored it securely, with two levels of encryption, on my personal computer. Information and details provided in the actual reports examined for this dissertation varied widely based on the particular medical examiner completing the report, some of whom provided a detailed account of all information known to them and others who wrote minimally. For instance, some examiners provided detail about the environment in which the deaths occurred, whereas others commented primarily on

the bodies' conditions upon arrival and subsequent toxicology reports. Therefore, I chose inclusion criteria based on the available variables in all reports (see Table 3.1).

Table 3.1

Inclusion and Exclusion Criteria for Archival Sampling

Inclusion Criteria:	Exclusion Criteria:
Age 65 or older on day of death	Age 64 or younger on day of death
Decedent was housed at time of death (not living on the streets or in a shelter)	Unhoused
Resided in the community (zoning for ages 55+ is included in what is considered "community" for this study, as these subdivisions are simply age-restricted zoning and not institutional care)	Primary residence located in an institutional setting (assisted living, nursing home, hospital, or prison)
Resident, visiting Arizona, or undocumented (no need to be a legal resident of AZ)	Primary cause of death related to drug overdose
Manner of death: accidental or natural	Manner of death: homicide, suicide, or undetermined
Death was connected to something in or around the home (e.g., inside a dwelling or within property line of single-family home, or within property of a shared community, such as the common space of a condominium building)	Death connected to an event away from the home (e.g., car accident)

Importantly, the presence or absence of heat-related information in the archival records did not influence whether I included or excluded a case from this study, since listing thermal considerations is not required for autopsy reports in Maricopa County. Nevertheless, all reports provided information on the decedents' ages, genders, and residential statuses (i.e., housed or unhoused). However, demographics such as race, address, and income were not provided in the raw version of medical autopsy reports I received for this research project. Therefore, I

chose criteria for including and excluding cases (see Table 2.3) based on known available data within the reports.

Part II (Present): Survey Development

To investigate the relationship between climate-adaptive and age-friendly housing designs, I created a survey that focused specifically on older adults in Arizona. The purpose of this survey was to gain a snapshot of the "present," thereby contributing to a better understanding of what residential extreme heat mitigation and age-friendly design decisions have been implemented by people over age 65 living in high-risk areas.

A survey is a method of gathering information from various people. Different data collection methods may be used to gather survey results and could include internet or postal mail, self-administered questionnaires, and personal interviews (de Leeuw, 2011). I chose a digital distribution method for this survey, as opposed to a mail-in format. Williams et al. (2018) argued that there has been an increase in standardizing survey uniformity for large organizations and governments to make comparisons across areas and over time; with the proliferation of digital surveys, this dissertation contributes to a growing digital dataset.

Limitations to using only a digital survey include not being able to capture feedback from older adults who do not actively use computers. Also, self-selection bias could have been a factor if only older adults who were interested in this topic were more inclined to take the survey. To address these potential limitations, it was important for me to note that the digital survey was created with accessibility in mind. Older adults could have a range of physical and cognitive abilities, and I designed the survey to be as accessible as possible. I chose the Qualtrics software to administer the survey due to its embedded accessibility features such as

being able to adjust font size, text to speech options, and seamless transition for use on all brands of digital devices on both mobile and desktop computers.

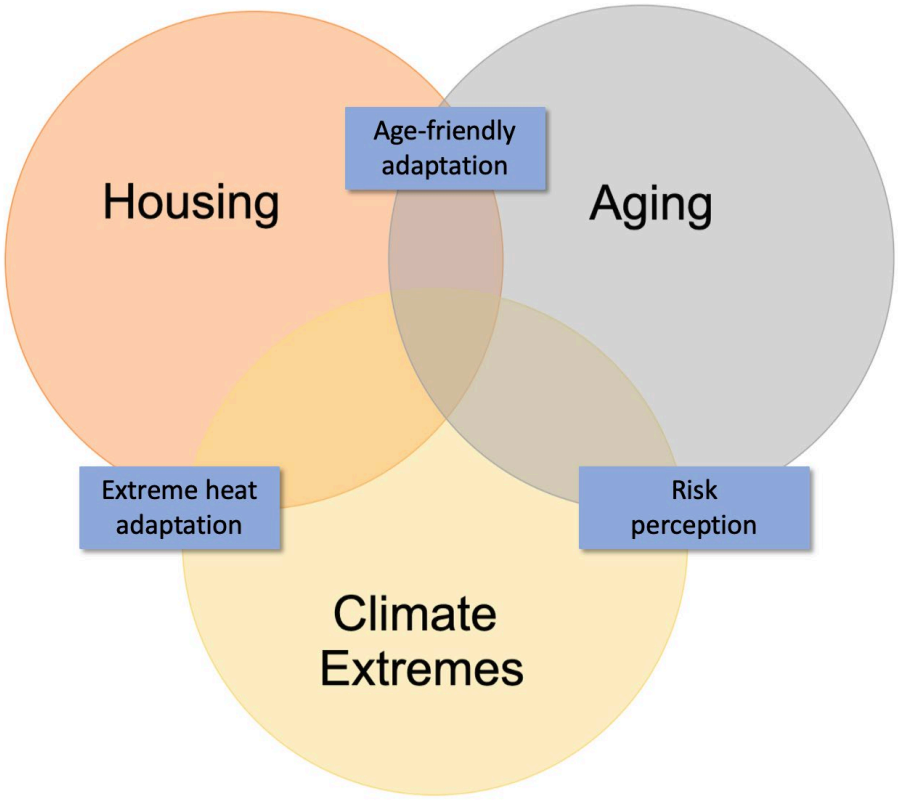
Most scholars would readily agree that knowing your research question before designing a survey will lead to clearer results. However, Kreuter et al. (2020) took this argument one step further and suggested that researchers visualize the data they would like to use as they are designing survey questions. In other words, Kreuter et al. (2020) believed that imagining the charts and graphs a researcher wants to generate will help to inform the design of the survey questions. It is true that—in recent publications of survey design methodologies—many sources support the relationship between the design of survey response scales and the quality of responses. However, it does not necessarily follow that practical rules exist for designing these scales. DeCastellarnau (2017) filled a gap in the literature by providing extensive reference tables that include the following information about presentation of results: characteristics, design choices, theoretical arguments, and empirical evidence on data quality. Recent literature reviews like DeCastellarnau's (2017) shed new light on unique connections between emerging research in this field, which previous literature reviews had yet to address.

I developed a survey for this dissertation through a thoughtful and adaptive process. The goal of the survey was to gain a snapshot of risk perceptions and understanding of heat-adaptive and age-adaptive measures currently being implemented by older people living in an area prone to high heat. Therefore, I first consulted the PLACE conceptual framework when building the survey to identify the key topics for inclusion. As such, I added three primary sections to the PLACE framework (see Figure 3.1) to build the survey structure: risk perception,

extreme heat residential adaptation, age-related residential adaptation. I also included survey questions on participants' general demographics that are included in the final results.

Figure 3.1

PLACE Venn Diagram Including Blue Boxes Highlighting Key Topics in this Study's Survey



Use of Checklists

With the survey structure established, I began to outline the overall organization of, and questions for, the survey. I chose to use existing checklists, such as AARP's (2021) HomeFit Guide for aging in place, which were designed to help people make decisions about how they can adapt their homes to either extreme heat or aging. These checklists helped me to build questions for the extreme heat and age-friendly portions of the survey. Using established checklists was a strategic decision for several reasons. First, these checklists are typically the

result of research and refinement, and I took care to include only resources with evidence-based information. Moreover, using checklists for adapting homes to better suit our predictable needs that come with aging—or to withstand extreme heat directly—addresses the core questions of my research. Most importantly, utilizing checklists to develop survey questions ensured the survey could be well organized to capture necessary data to answer the research inquiry. While I did not encounter examples of a survey created with the use of preexisting checklists in the literature, I found it to be a logical method of survey development for this particular research goal.

While existing resources for protecting a home from extreme heat are limited, the few checklists available emphasized individual actions for personal safety, such as leaving to seek a cool public space, like a library. Furthermore, most checklists do not directly address design considerations for the home. For instance, the Environmental Protection Agency and Centers for Disease Control (EPA & CDC, 2016) provided a lengthy support guide to inform citizens about the deadly impacts of heat to their health. However, the EPA and CDC (2016) resource has only one page dedicated to residential mitigation solutions, many of which are prohibitively expensive (e.g., installing a green roof or using cool paving materials to replace a driveway).

Available checklists for age-friendly designs are plentiful. Many, such as AARP's (2021) HomeFit checklist, have been continuously refined to be trustworthy resources (personal communication, Anne Long Morris, April 22, 2005, a foundational developer of AARP's checklist in the 1990s). Additionally, many age-friendly residential checklists provide suggestions to change key areas of the home, such as the placement and type of knobs on the stove to achieve increased access (CIDEA, 2010). However, care must be taken when choosing checklists. Since

there is near market saturation, some published checklists may be adapted from reputable sources (but modified and not subsequently tested) or may not utilize evidence-based literature. There are limited offerings for publicly-oriented information to address high heat and it is difficult to locate reputable checklists for age-friendly home design. Thus, there is a market need for an integrated checklist that addresses housing updates for new construction and retrofitting to address both heat and aging. To address these limitations, only age-friendly checklists utilizing verifiable, evidence-based guidance were included in this survey (see Appendix B).

Checklists Used in This Survey. First, I compiled existing checklists (see Appendix B) of suggested best practices for either high heat or age-friendly housing designs. I located the checklists using a combination of general web searches, literature reviews, social media inquiries, webinar attendance, and casual conversations with industry professionals. I designed the following eligibility considerations to ensure the relevance and applicability of the selected checklists to the study's objectives and target population:

- National residential checklists:
    - The checklists must be specifically designed for residential settings at a national level, catering to the needs and requirements of homeowners or renters, and obtained from a reputable source who uses evidence-based information. This criterion ensured that the checklists were relevant to the study population and the research objectives, and could be broadly utilized.

- Extreme heat or aging focus:
    - Checklists must target one or both of the following themes: Modifying a home for either extreme heat *or* aging.
- Practical and actionable:
    - The checklists should include practical and actionable recommendations or steps that can be implemented by homeowners or renters to improve the safety, adaptability, or accessibility of their homes.

I chose not to include the following checklists:

- Non-Residential checklists:
    - Checklists designed for commercial, industrial, or other non-residential settings were excluded, as they did not align with the research objectives and may not be directly applicable to residential environments.
- Non-Targeted themes:
    - Checklists that focused on themes unrelated to extreme heat or aging were excluded, as they were not relevant to the study's objectives.
- Overly technical or specialized checklists:
    - Checklists that were heavily focused on technical or specialized aspects that cannot be reasonably applied by homeowners or renters were excluded, because the study aimed to explore

practical and actionable solutions that can be implemented by the general population without specialized knowledge or training.

Table 3.2 summarizes checklists integrated into the survey. The checklists were not utilized as a whole for survey creation, instead only checklist prompts that could help answer the research question were woven into survey design. Please see Appendix B for access to an AirTable, which provides sourcing for each survey question.

Table 3.2

Checklists Utilized in Survey Creation

Focus Area	Source	Title	Description
Extreme Heat	CDC (2024a)	Tips for Preventing Heat-Related Illness	Measures for home and family protection during heatwaves, like AC, ventilation, hydration, and emergency planning.
Extreme Heat	U.S. Environmental Protection Agency (EPA, 2024a)	Heat Island Reduction	Strategies for reducing heat islands including cool and green roofs, shading, and landscaping.
Extreme Heat	American Red Cross (n.d.)	Extreme Heat Safety	Preparing for heatwaves with steps to take before, during, and after.
Extreme Heat	U.S. Department of Energy (n.d.)	Home Cooling Systems	Energy saving tips to keep homes cool.
Extreme Heat	U.S. Department of Homeland Security (2024)	Extreme Heat	Resources and tips for preparing for extreme heat events, including home cooling measures.

Focus Area	Source	Title	Description
Age-Friendly Design	AARP (2021)	HomeFit Guide	A checklist for creating a safe, comfortable, and accessible living environment in various areas inside and outside the home.
Age-friendly Design	CDC (2017)	Check for Safety	A checklist to identify and address potential fall hazards in homes with recommendations for modifications.

Risk Perception

Utilizing the PLACE framework (see Figure 2.1) when building the survey tool indicated that an additional level of inclusion was still needed. In addition to directly addressing the research question of what age and climate adaptive measures households currently employ, I incorporated questions related to personal perception of risk. I accomplished this by utilizing an existing risk perception scale, created for the different climate amplified events of brushfires/wildfires, and modifying the questions for extreme heat. The Householder Brushfire Risk Perception Scale (HBRPS-4) is a tool developed in Australia to understand individuals' personal perceptions of brushfire risks related to their households (Hall et al., 2022). This tool fit my study since it directly incorporates disaster risk in relation to a person's house; however, the emphasis on brushfire needed to be modified to reflect my study's inquiry into extreme heat. Therefore, Table 3.3 provides the risk perception questions used in this survey, and the

corresponding HBRPS-4 question from which they were inspired; all survey questions offered 5-point Likert scale answers.

Table 3.3

Risk Perception Survey Questions and the HBRPS-4 Questions That Inspired Them

Survey Question	HBRPS-4 Question
In your opinion, how likely is it that your life will be threatened by an extreme heat wave next season?	What do you think your home's brushfire risk level will be next brushfire season?
If there was a heat wave in your city lasting more than 3 days, how dangerous could this be for members of your household?	If there was a brushfire close to your home, how dangerous could this be for you and the members of your household?
How confident are you that your home could protect you during a heat wave if your neighborhood lost power?	How concerned are you about a possible threat to your home?

Pilot Testing

With the checklists and risk perception scale identified, I then completed the survey draft with standard demographic inquiry (see Appendix B for final survey). After completing the draft survey, I used a method called Cognitive Interviewing to pilot test the survey questions (Thaler & Sunstein, 2008). Seven volunteers between the ages of 26 and 68 were recruited to test the survey. Through individual interviews and email communications, I asked participants the following three questions after answering a random assortment of survey questions:

- In your own words, what is this question asking?
- How did you arrive at your answer?
- How sure are you of your answer?

By completing this targeted pilot test, I was able to clarify and simplify my survey. Feedback from the pilot study indicated that the survey was too lengthy and incorporated

industry-specific terms that created confusion among participants. In response to this feedback, I substantially revised it; the length was reduced to ensure it was not overly burdensome for participants and industry-specific terms were either eliminated or clarified to ensure broader understanding. This sharpened focus allowed for a more detailed examination of the specific challenges posed by extreme heat for older adults and aligned with the study goals as a whole.

After the final draft of the survey was complete, and I integrated my dissertation committee's feedback, the survey and all relevant information was professionally translated from English into Spanish by Gengo, a professional translation service (see Appendix B). All participants were asked to choose their preferred language before receiving informed consent and beginning the survey. Data was collected and stored using Qualtrics software. Participants were referred to my website, Home and Place Project (www.HomeandPlaceProject.com), for additional information about me and the study.

Overall, this iterative approach to designing the survey allowed me to investigate effective ways that climate-adaptive and age-friendly home design elements can be integrated effectively, while addressing the potential barriers and exploring policy implications for positive change in residential settings.

Survey Sampling

The survey was open to any adults aged 65 or older, who were currently living in Arizona or who owned a home anywhere in Arizona. Before beginning the survey, participants were informed about the study objectives, the confidentiality of their responses, and their rights to withdraw at any time; specific language used can be found in the Ethical Considerations section of this chapter. When striving for diversity and representation of the over age 65 population

currently living in Arizona, I selected the sample survey participants using a combination of random sampling and targeted recruitment methods. Targeted recruitment methods were essential to reach a broader representation of the population. For instance, people over age 85 are consistently hard to reach for surveys due to a variety of factors such as limited technology use, isolated living arrangements, and cognitive or physical limitations (Liljas et al., 2019). Therefore, my targeted recruitment methods to contact the hard-to-reach included:

- Direct requests of family and friends known by the researcher;
- partnering with two senior centers in Tempe, AZ, to hang flyers in the center and send an email with the survey to all members;
- sending press releases to media outlets in the state, in an attempt to be interviewed on-air about this survey;
- hanging flyers for the survey in areas with a higher concentration of the over age 65 population in the Phoenix metro area; and
- snowballing requests of participants within the survey via a prompt at the end, wherein the survey participants could refer other individuals who may have valuable insights relevant to the study (Bernard, 2011).

Appendix B includes the detailed marketing plan and suggested outreach templates, including a press release and suggested email communication. In-person communication was limited to me hanging flyers in the Phoenix metro area and partnering with two Tempe senior centers, due to time and financial restrictions allowing for only summer travel to the Phoenix metro area.

Part III (Future): Key Informant Interviews

The goal of the key informant interviews was to gain insight into successful methods for implementing residential extreme heat and age-friendly housing designs. Key informants fell into two categories: professionals and older Arizonians. It is important to note that the inclusion of older Arizonians in the key informant interviews was in addition to the professionals, not in replacement of any professions. Further, interviews with older residents did not replace any portion of the PLACE framework, but enhanced the potential outcomes by soliciting the opinions of older residents as experts in their own heat adaptation.

Professionals as Key Informants

The Venn diagram in Figure 3.2 demonstrates how I used the PLACE framework to build subcategories for potential key informant professionals. The diagram represents a compilation of professions that influence housing systems in the U.S. that I adapted from housing systems researchers (Clark, 2021; Eskinasi, 2014; Martín & Arena, 2019; Wieck et al., 2020). Table 3.4 expands upon the professions highlighted within the PLACE framework. The PLACE framework allowed for a holistic examination of the factors and professions that influence the adoption of age-friendly and climate adaptive housing options.

Figure 3.2

Venn Diagram Utilizing the PLACE Framework to Organize Subcategories of Professions, From Which the Key Informants Were Sampled

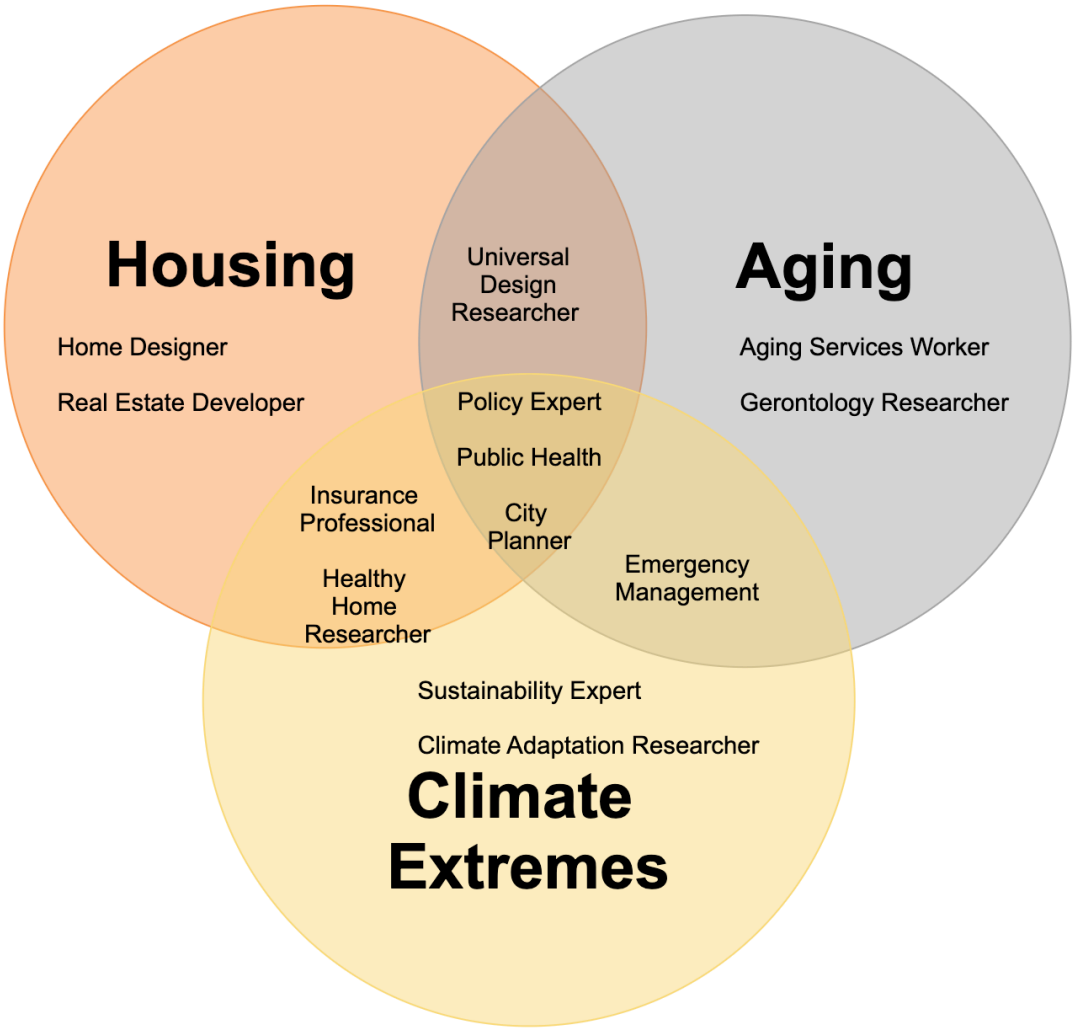


Table 3.4

Summary of Professional Subcategories in Venn Diagram

Profession Type	Examples	Connection to PLACE Framework
Irban or City Planners	Urban Planners, City Planners, Zoning Experts	Shape zoning regulations, community-level strategies, and policies; influence rules and structures guiding climate-adaptive and age-friendly housing development.

Profession Type	Examples	Connection to PLACE Framework
Real Estate Developers	Housing Finance Experts, Builders	Contribute to constructing homes, offer insights into market trends, and identify challenges, costs, and practical implications of implementation.
Policy Makers and Advocates	Legislators, Housing Policy Advocates	Create and enforce regulations and guidelines, and advocate for policies promoting safe and affordable housing. Potential to make substantial policy changes.
Public Health	Social Workers, Allied Health Professionals, Coroners	Play a crucial role in disaster response and community disaster-preparedness, advocate for evidence-based interventions, and contribute to health-related aspects of housing solutions.
Sustainability Experts	Consultants, Developers, Thought Leaders	Provide knowledge on innovative design and construction techniques for addressing climate-adaptation while living with extreme heat; identify resources and incentives to encourage best practices.
Gerontologists/Aging Specialists	Researchers, practitioners, Allied Health Professionals	Deep understanding of older adults' needs, preferences, and limitations. Ensure human-centered design of age-friendly housing solutions.
Emergency Management Professionals	Emergency Managers, Disaster Risk Experts	Expertise in disaster risk reduction. Contribute to strategies for mitigating risks associated with extreme heat for older adults; promote resilience in the face of environmental challenges.
Researchers	Academic Researchers, Journalists, Community Scientists	Provide emerging considerations, forward-looking projections, and scholarly insights into climate-adaptive and age-friendly housing; help bridge the gap between academia and practical application.

I purposively sampled professional key informants to ensure diverse perspectives on the research topic. I used the following sampling methods to recruit professional participants:

- Identified potential key informants through professional networks, referrals, and research on relevant organizations or institutions.
- Contacted potential key informants via email or phone, briefly explaining the study's purpose, and inviting them to participate in an interview.
- Utilized snowball sampling when talking with participants.

Table 3.5 summarizes inclusion and exclusion criteria for professional key informants.

Table 3.5

Inclusion and Exclusion Criteria for Key Informant Interviews With Professionals

Inclusion Criteria	Exclusion Criteria
Currently working in any profession related to the research topic.	No relevant professional experience or expertise in the subject matter
Possessing relevant expertise in topics being studied.	Unwilling or unable to participate in the key informant interview
Willing to participate in a semi-structured interview.	

When selecting specific professionals within each category for the key informant interviews, it was important to consider several criteria to ensure information gathered was relevant and reliable. Fleming et al. (2022) provided a cautionary tale of key informants not being able to fully represent their groups, as informants can inherently only speak from their personal experiences and training. Ideally, having multiple representative interviewees from each category summarized above would have offered the greatest insights and allowed cross coding with other respondents. However, this level of inquiry was outside the scope and capability of this research project. Therefore, I considered the following criteria for selecting key informants:

- *Expertise*: Key informants needed expertise in at least one field of inquiry from Figure 3.2.
- *Diversity*: Key informants should have represented a diverse range of perspectives and experiences. This could have included individuals from different geographic regions, age groups, socioeconomic backgrounds, and professional disciplines.
- *Relevance*: Key informants needed direct experience with the issues being studied, which could have included individuals who had recently implemented, researched, or developed policies or programs related to the issues being studied.
- *Availability*: Key informants had to be available and willing to participate in interviews. This required flexibility in scheduling interviews to accommodate the availability of the informants.

The interviews with all key informants were conducted and recorded via Zoom using a semi-structured approach. Semi-structured interviewing allows the researcher to ask additional questions as prompted by the participants' responses, while also enabling flexibility in the conversations based on interest and expertise of the interviewees (Bernard, 2011; Rossman & Rallis, 2017). A full summary of possible semi-structured interview questions for this study can be found in Appendix C, but the following list provides examples of possible questions:

- In your experience, what are the most significant challenges or barriers to incorporating both climate-adaptive and age-friendly design elements into residential housing, especially in regions prone extreme heat?

- Can you share examples of successful projects or strategies that have effectively integrated age-friendly design with climate-adaptive measures against extreme heat?
- What lessons can we learn from these projects to advance the dual goals of climate resilience and age-friendliness in residential design?

I told key informants in advance that the interviews would be recorded and asked them to provide their verbal and written consent before the interviews began (see Appendix C for all materials related to the key informant interviews).

Older Arizonians as Key Informants

In addition to incorporating perspectives from professionals working in fields connected to the PLACE framework (see Figure 3.2), it was essential to include voices of older Arizonians. There are four primary characteristics that contribute to older adults' vulnerability to climate change: disability, living alone, low income, and a language barrier (Rhoades et al., 2018). For this study, I interviewed older Arizonians who experienced at least one of these contributing factors to climate vulnerability. Table 3.6 summarizes my primary considerations for inclusion of older Arizonian participants in key informant interviews.

Table 3.6

Inclusion and Exclusion Criteria for Key Informant Interviews with Older Arizonians

Inclusion Criteria	Exclusion Criteria
Willingness and availability to speak one-on-one with the researcher via Zoom or phone.	Younger than age 65.
Experiences at least one area of climate vulnerability: disability, living alone, low income, or non-native English speaker.	Unwillingness to participate in a recorded interview.
	Does not live in or own a home in Arizona.

The semi-structured nature of these interviews allowed me to focus on the personal experiences of older Arizonians, enabling the conversation to flow; initiated by my prompts but directed by the participants. To accommodate participant needs and overcome potential technological hurdles, I offered various locations for conducting interviews, which included phone and Zoom. This semi-structured interviewing approach ensured that each interview remained flexible in order to capture the individuals' experiences of aging in conditions of extreme heat. The following are some examples of key informant questions I used for older Arizonians with lived experiences aging in a hot climate:

- How did you become interested in this topic of aging in place with extreme heat?
- How long have you lived in Arizona? (Year round or seasonally?)
- How do you stay cool in your home?
- Have you ever fallen in your home? (How?)
- Is there an area of your home that you don't spend much time? (Why?)
- What areas of your home do you spend the most time? (Why?)
- Barriers:

- Do you ever keep your air conditioning low (or not turn it on at all) because of high cost to operate it?

I sampled older Arizonian participants with purposeful outreach, utilizing two primary methods: survey follow-up and community partner outreach. First, the final question of the survey (see Appendix C) offered participants an opportunity to add their email or phone number if they wanted to speak more about this topic. Inclusion of this final survey question enabled me to follow-up and schedule interviews with those interested in sharing their opinions and experiences. Second, I emailed and called community-based organizations serving older residents in Arizona, requesting that they share this opportunity to talk to me with their constituents. This purposeful sampling approach worked to mitigate bias, thereby enabling inclusion of diverse perspectives spanning the key characteristics of climate vulnerability. While there remains a risk of participation bias—as people interested in the topic may have been more likely to self-select—maintaining a purposeful sample ensured participation of people experiencing diverse contexts.

Data Analysis

Part I (Past): Archival Review

I analyzed the archival data in two parts. To begin, the first round of coding—also called first-cycle coding (Saldaña, 2016)—was deductive, meaning that I analyzed each document using a previously developed codebook of themes. Deductive analysis is a top-down approach, in which the researcher begins by developing a codebook with an initial set of codes (Bernard, 2011; Saldaña, 2016). The codebook, outlined below, was In collaboration with my dissertation committee and reflects the PLACE conceptual framework (see Figure 2.1). Then, I conducted a

second cycle of coding to reanalyze the data, using an eclectic coding method for inductive analysis. Eclectic coding was chosen for this second-cycle to incorporate grammatical, elemental, and exploratory methods, which was especially helpful when analyzing for emerging themes (Saldaña, 2016).

This project was not intended to be open ended and exploratory. Thus, deductive analysis enabled me to remain focused on the research question: *What residential extreme heat and age-related adaptations are most commonly implemented by older adults living in Arizona*? However, qualitative scholars Linneberg and Korsgaard (2019) clarified that a combination of deductive and inductive coding is often used to allow for insights evolving from the literature itself. They explained that:

> Generally, the codes in deductive coding are theoretical concepts or themes drawn from the existing literature. In a deductive coding approach, the number of codes will typically be relatively limited, with maybe just five to ten codes derived from the theoretical framework. During coding, the coding frame can be adjusted if interesting differences emerge within a given code or if some new and interesting things come up that are not captured by existing codes. (Linneberg & Korsgaard, 2019, p. 261)

Therefore, to reduce researcher bias, my dissertation committee and I collaboratively agreed upon a codebook of themes before I began the archival review. The themes were rooted in the PLACE conceptual framework and allowed flexibility for adjustment as the research progressed.

Using this codebook technique—which provides data analysis transparency and enables anyone interested in examining the data after the completion of this project to do so easily—ensured that codes were applied consistently (Saldaña, 2016). The purpose of deductive coding following the PLACE framework was to help me stay focused on the research question being explored. The inclusion of one inductive code enabled curious exploration and allowed for unexpected patterns to emerge from the data. Table 3.7 lists my suggested preliminary

codebook themes that follow the PLACE framework, as well as examples of topics that would fit into each.

Table 3.7

Preliminary Codebook Themes and Examples

Category	Description	Examples
Vulnerability	Intersectionality of vulnerabilities	• Basic demographics such as age, gender, socio-economic status • Known medical conditions like heart disease or respiratory issues • Living situations like residing alone or in a high-risk area
Built Environment	Residential design factors, inside or outside the home	• Presence or absence of air conditioning • Age-friendly design elements like no-step entries and grab bars • Heat-adaptation features like insulated curtains or cool roofs
Risk Perception	Interpretation of risk perception based on archival data, including insights into decision-making	• Presence of air conditioner in home, but device was not used, suggesting a low-risk perception
Other	Space for unexpected and interesting patterns to emerge	• Adaptive behaviors or unusual patterns in coping strategies • Unique community responses or grassroots initiatives

This archival data provided insights into the specific risk factors within and around home environments that may exacerbate the effects of extreme heat events for older people. Additionally, this empirical understanding grounds the overall study in real-world observations.

Part II (Present): Survey

As previously mentioned, I used the PLACE framework to provide the organizational design of this study, as well as to analyze the data. The quantitative data obtained from the closed-ended questions were analyzed in Microsoft Excel. I used descriptive statistics to summarize the demographic information and adaptation practices. I conducted qualitative analysis of open-ended responses using both deductive and inductive methods following the same agreed-upon themes from the PLACE framework as used in the archival review. The theme of "Vulnerability" highlighted the intersectionality of various vulnerabilities, such as presence of an air conditioner or preexisting medical conditions. The "Built Environment" theme focused on residential design factors affecting individuals both inside and outside their homes. "Risk Perception" was explored through questions about an individual's perception of their risk, and the "Other" category was reserved for emergent patterns not anticipated by the initial framework, indicated by this bonus code. This comprehensive approach allowed me to cohesively understand the survey research question, while also connecting analysis to the larger dissertation inquiry.

Part III (Future): Key Informant Interviews

I conducted a qualitative analysis of Zoom interview transcripts. I cleaned the transcripts by hand, reviewed them with the video for accuracy, and used a software program called Taguette (Rampin et al,. 2021) to organize codes. The purpose of this analysis was to identify

commonalities and differences among the responses with a distinct intention to discern possible solutions. The analysis involved coding the transcripts using a deductive coding technique for key themes that followed the PLACE conceptual framework, while also allowing for the emergence of new themes using inductive coding. The analysis technique and committee-agreed upon themes were the same as those used in Part I and Part II.

Ethical Considerations and Limitations

There are ethical considerations when conducting any study with human participants. This dissertation addressed housing needs of older adults who may be survivors of a disaster and their adaptation strategies against extreme heat. Therefore, I took additional ethical considerations into account. Of particular importance is the matter of informed consent, which was necessary for all survey participants and key informant interviews. I provided clear and easy-to-understand explanations of the study's purpose and procedures, in both English and Spanish, including the potential risks and benefits of participation. It was important to ensure that participants fully understood the purpose of the survey and interviews, their rights as participants, and any potential risks or benefits associated with participating. I accomplished this through clear and concise language, use of visual aids on my web site, and by participants being able to contact me directly with questions.

Similarly, limitations are present in research studies. For instance, a limitation which was felt throughout all three research inquiries was that this dissertation focused on exploring challenges with new construction rather than retrofitting existing homes. This was an intentional choice in an effort to create suggestions to build home to be more heat-adaptive and age-friendly, but this choice may pose limits on suggestions for adapting existing homes for

people to safely age in place. In the following subsections, I review the unique ethical considerations and limitations for each part of this dissertation research.

Part I (Past): Archival Review

While the conversation about ethical considerations for broad use of archival data is still maturing, ethical considerations for qualitative research with publicly available social media data has become animated in recent years. Due to the rise of personal information that social media users willingly share online, anyone with a computer and internet connection can access this data, which has raised ethical considerations for researchers (Chen et al., 2022). Golder et al. (2017) conducted a systematic review of attitudes toward the ethics of research that uses publicly available social media data. They found that attitudes varied from overly positive to very concerned, with underlying reasons related to issues such as the purpose and quality of the research, researcher affiliation, and potential harms (Golder et al., 2017). Specifically, Webb et al. (2017) and M. Williams et al. (2017) discussed ethical challenges of publishing Twitter (now X) data for research dissemination, highlighting issues such as informed consent, anonymization, and minimizing harm. While this dissertation was not focused on social media directly, I drew on these critiques to integrate ethical standards into archival data collection, storage, and use.

As proposed, the archival review portion of this dissertation was exempt from Institutional Review Board (IRB) review since it solely used publicly available data. Confirmation of exemption was received in writing from Antioch University New England's IRB Chair (see Appendix D). However, as discussed in this chapter, I followed ethical considerations offered by the Council on Ethical and Judicial Affairs (Maixner & Morin, 2001) to respect privacy and

maintain confidentiality of the people represented in the archival data. Despite the IRB exemption, I adhered to the following ethical considerations:

- When organizing data:
    - Names were removed upon receiving reports, so neither my Committee nor I were privy to this information.
    - If printed, names on physical documents were redacted and kept in a secure location within my primary dwelling until securely shredded upon completion of the data analysis.
    - Digital documents sent from the Office of the Medical Examiner were organized in a secure drive located on my computer. Original documents were not and will not be Inly anonymized data was organized within Microsoft Excel and was only shared with my committee to enable our collaboration.
- When reporting data:
    - Pseudonyms were used instead of names.
    - A small age-range was used rather than decedents' specific ages.
    - If available, location of residence within Maricopa County was not disclosed.

By including only information pertinent to this study, my intention was to protect the identity of the deceased. Information that I report in this study's results (Chapter IV) includes sex, age range, and how the death was connected to the home environment.

Potential limitations to using an archival review method included the available documents offering incomplete or nonstandard data, which could have limited my ability to establish causal relationships between data points (Subotic, 2021). Reporting guidelines differ for each county's Office of the Medical Examiner throughout the country (Schaechter et al., 2003). Thus, it was important for me to note information that was excluded from Maricopa County's archival death reports that could have been useful in correlating data points, including address, specific type of home (e.g., single family vs. condo), estimated time of death, income of deceased, education level of deceased, race of deceased, or decision-making capability of the deceased. To be clear, this information is collected by the medical examiner to be used in aggregated data, but is not included in the available report used for this dissertation.

To address these limitations, I chose the inclusion and exclusion criteria described earlier (see Table 3.1), as well as methods of data analysis, to enable use of only the available information; thereby, eliminating the need for inferences or speculation. For instance, I specifically chose a deductive coding method for analyzing the archival data to offer opportunities to explore relationships between themes. Given that this study explored specific residential built environment contributions to deaths of older adults during a heat wave, I did not filter for cause of death limited to only heat exposure. Instead, I analyzed every death of the over age 65 population that occurred during one heat event in Maricopa County in 2022, looking specifically for clues of residential design decisions that may have contributed to a death occurring during the deadly heat.

Part II (Present): Survey

According to the World Health Organization, older adults are considered a vulnerable group (de Leeuw, 2011). When utilizing any method of data collection (e.g., questionnaires, interviews, or focus groups) with vulnerable populations, it is essential that participants are in control of stopping the process if needed. Potential power dynamics between researchers and participants should be considered, since this risk is inherent in studies involving human subjects (Adams et al., 2021; Bernard, 2011; Saldaña, 2016). Therefore, being aware of this potential dynamic, I took the following precautions to mitigate any potential harm to participants: I provided full transparency of how data would be used, offered multiple opportunities for requisition from the study, and provided opportunities to express opinions or concerns. By taking these precautions, I attempted to mitigate any potential harm to the older participants.

I was also made aware of additional barriers to garnering older adult participation for survey responses during a training, which provided insights for researchers. Folta (2019, para. 54) highlighted the following known barriers of recruiting and retaining older adults as research participants when using surveys:

- Participants' barriers to study participation included:
    - Physical/cognitive impairments
    - Distrust of researchers
    - Literacy level
    - Family opposition
- Elements of an effective recruitment plan:
    - Who is my target audience and where can I find them?

    - What worked in the past? What is the evidence for the proposed strategies?
    - What information do I need to develop to reach my audience? What language should I use?

- Biggest reasons for older adults to decline participation in a survey:
    - Death
    - Unclear expectations (e.g., poor communication)
    - Psychological (e.g., if study staff are unpleasant)

To address these limitations, I tried to recruit a diverse and representative sample of participants (see Appendix B for detailed recruitment materials). Additionally, creating the survey in collaboration with my dissertation committee was an attempt to reduce my bias.

Part III (Future): Key Informant Interviews

Ensuring confidentiality is essential to ensure participants feel comfortable sharing their experiences and perspectives. A researcher must take care to protect participants' privacy, including ensuring all data collected is stored securely and anonymously. Older adults could be hesitant to provide personal information, such as their age or location, if they are concerned about the security of their data (Adams et al., 2019). In this study, participants received informed consent information that included a section explicitly outlining the measures that I would take to ensure confidentiality (see Appendix B), specifically using a pseudonym for all older Arizonians and not publishing identifiable information within their quotes. No participant contacted me following an interview with questions, but I provided my phone number and email address in case further communication was needed.

A primary limitation for this dissertation was difficulty recruiting older participants for interviews, which persisted throughout months of data collection. Upon reflection and discussion with colleagues, I determined that this limitation was most likely due to my research being unconnected to a local Arizona organization. Without name recognition for a local university or government entity, older participants could have been hesitant to trust my research project. I overcame this limitation by reaching out to friends with family living in Arizona, professional connections I made while traveling to Arizona during the summer, as well as snowball sampling after successful interviews.

CHAPTER IV: RESULTS

In this chapter, I present the results of this study in three sections, organized by the primary research foci. In section one, titled "Past," I review data drawn from coroner reports to understand how homes' design features might have contributed to the deaths of older individuals during a heatwave. In section two, "Present," I summarize findings from a state-wide survey that was available to anyone over the age of 65 living in Arizona. Lastly, in section three, "Future," I analyze the semi-structured interviews I conducted with professionals and older Arizonians.

Part I (Past): Archival Review to Answer Research Question 1

In Chapter III, I outlined methods I used for gathering and analyzing publicly available coroner reports from Maricopa County, Arizona. My aim was to understand connections between the physical homes and deaths of older people in and around their homes during a period of extreme heat. In this archival review, I addressed the following research question: *What information, found in official reports from the Medical Examiner's Office in Maricopa County, connects an older person's death with the built environment in or around their home during days of extreme heat?* This section of the chapter is organized first with an overview of the reports received and additional details about study-eligible reports. Then, I highlight findings—organized by themes from my PLACE framework (see Figure 2.1, Table 2.2)—and conclude with an emerging theme: heat.

Overview of Archival Reports

All information I used for this study was free and available to the public upon request. I received a total of 220 documents directly from the Medical Examiner's Office in Maricopa

County, Arizona. These documents represented the culminative case files, including summaries and the examiners' opinions of causes of death, autopsy reports, and toxicology results for 106 deaths occurring during the hottest 3-day period in 2022: July 10–12, 2022. Among the total decedent reports received, 74.5% were male, 25.5% were female, and 24.5% were age 65 or older at time of death. The majority of all 106 decedents were found in or around their homes (52.8%), some were found in their neighborhoods (23.0%), and others in or around businesses (5.7%). Additional locations where fewer decedents were discovered included nearby desert land or recreational trails, nursing homes, a bus stop, and transient camps. There are no standard requirements for including narrative information in Maricopa County coroner reports. Therefore, descriptive information found within each report varied based on the preference of the individual Medical Examiner.

Of the 26 decedents aged 65 or older, only 12 met the criteria established for inclusion in this study (see Table 2.3). Of the eligible decedent reports, eight were male and four were female, with an age range of 68–92 years old at time of death. Among the eligible sample, 58.3% died from natural causes and the rest were classified as accidents. Not all decedents over age 65 whose deaths were connected to their homes were included in this study, since decedents who died from suicide or accidental drug overdoses did not fit the criteria for inclusion. The results of my analysis of the eligible reports reveal numerous similar indicators of vulnerability among the decedents; primarily, a presence of medical complications, living alone, dehydration, and a ground level fall preceding the death.

Theme 1: Vulnerability

The results of my archival review indicate that decedents exhibited multiple factors that could have contributed to their climate vulnerability. Most notably, multiple decedents lived with medical conditions known to increase the risk of injury or death during exposure to prolonged heat, such as diabetes mellitus (33.3%), some form of pulmonary disease (41.6%), and high blood pressure (75%). All decedents (100%) shared the presence of some form of documented cardiovascular disease listed as either a primary or secondary cause of death.

Additionally, the majority (58.3%) of decedents lived alone, 33.3% lived with another person at time of death, and one decedent lived in an unknown household arrangement. Dental health, which can be used a proxy for financial stability (Kailembo et al., 2018; Kuthy et al., 1996), indicated that the majority of the decedents' (58.3%) teeth were in either poor condition or teeth were missing. The reports showed that 16.6% of decedents' teeth were in either fair or good condition. Lack of information on the condition of teeth in 25% of reports meant the autopsies for those decedents were not completed, resulting in an incomplete understanding of end-of-life teeth health for all study-eligible reports. In summary, decedents represented in this research sample exhibited numerous known health predictors of climate vulnerability.

Theme 2: Built Environment

Mention of the home environment was present in each report I analyzed, because the decedent being found in or around the home was a key criterion for inclusion in this study. However, how the home was mentioned varied between reports, yet was most often included within details of where the decedent was found. For instance, the following direct quotes from

the Medical Examiners' reports exemplify mentions of the home environment within the dataset:

- "Found unresponsive in bed inside of his secured residence by law enforcement officers conducting a welfare check."
- "Found unresponsive in his room, lying supine on his bed. … Found by his brother in their shared trailer."
- "Found unresponsive on bathroom floor."
- "Found in a state of decomposition within her residence."
- "Found decomposing on his couch within his residence."
- "Sustained an unwitnessed ground level fall in the shower of his residence."

Descriptions of the built environment are not standard inclusions within coroner reports. However, I commonly found passing mentions of aspects of the homes within the open narratives. Therefore, references to the surrounding environment in which the decedent was found, while not universally present, helped me to create narratives that piece together the circumstances of deaths connected with both the heat and the home.

Additionally, a recurring pattern was noticed within this data, indicating that sustaining a fall at home was often a precursor to an individual's death. Exactly half (50%; six reports) of decedents analyzed sustained known falls that preceded their deaths. Of those, three reports listed complications of the fall as a primary or contributing cause of death and the other three simply mentioned knowledge of a fall that had occurred recently. In addition to the six reports already mentioned, the autopsies of an additional three decedents reflected evidence of external or internal injuries that may have resulted from a fall. For instance, in one report of a

decedent with no known recent fall, their body exhibited the following that may have resulted when bracing themselves during a fall: “Multiple dark red/purple ecchymoses [bruises] are present on the bilateral upper extremities [both arms] and range up to approximately 5 inches in greatest dimension found on upper extremities.” Another report of a known fall indicated that the decedent’s fall caused additional complications, leading to a “cascade of illness” once arriving to the hospital:

> He was hypertensive, tachypneic, tachycardic, and hypoxic necessitating supplemental oxygen use. After neurosurgical consultation, a back brace was recommended for his thoracic compression fracture. He developed increasing shortness of breath, cough, and right chest pain. Laboratory studies revealed hyponatremia and he was also diagnosed with a chronic obstructive pulmonary disease exacerbation and respiratory failure. His supplemental oxygen requirements increased, and he developed respiratory distress. … His clinical condition continued to decline despite medical interventions. He had a do not resuscitate order. Given his poor prognosis, next of kin was consulted and opted for comfort care.

Information related to recent falls was not available in the remaining three reports because the bodies were immediately released to the families without autopsies. In other words, physical evidence of a fall was present in all completed autopsy reports.

Theme 3: Risk Perception

I also examined the concept of risk perception through available behavioral clues within the coroner’s reports. For instance, the presence of a working air conditioner in the home but it being set in the “off” position was found upon the discovery of the deceased in four of the 12 reports. A common explanation in the medical reports—when available—was that the decedent was acclimatized to the Arizona heat:

> Her air-conditioning was reportedly in the OFF position but functional. According to her friend, she commonly left the front door open for air supply. Three deceased dogs were also in residence. … Carbon monoxide testing is within normal limits, despite the decedent being found in a state of decomposition with the air-conditioning off. The decedent was known to keep the doors open and was likely acclimatized to the heat. There were no suspicious circumstances or signs of foul play.

In another example, the decedent's air conditioner was operational but set to heat rather than cool:

> Her residence was warm with the thermostat registering 99 degrees Fahrenheit and thermostat set to heat. Per the son, the decedent was acclimated to the heat in the area and preferred her residence warm. He was not aware that this air-conditioning was set to heat though.

An additional consideration of personal risk perception was a pattern of dehydration among decedents. It is important to note that testing for dehydration is not required during an autopsy, and therefore information was not available for each decedent. However, when evidence of dehydration was mentioned in three of the 12 reports, there were accompanying behavioral clues about the decedent's personal perception of their risk of dehydration when exposed to extreme heat. For example, the following decedent was found in her backyard surrounded by gardening tools:

> The decedent was found outside during a period of markedly elevated environmental temperatures. … Survey of the residence revealed a back door that was closed but unlocked with ample food and beverages available in the home which the decedent would have been able to access. Reportedly, the decedent would have to be reminded to hydrate and rarely drank water unless she was prompted.

This particular decedent had evidence of caffeine and tobacco in her system, but no food, and additional lab results indicated dehydration. Another decedent's lab results showed evidence of dehydration in addition to having alcohol in their system.

Emerging Theme: Heat

While heat could be woven into each of the themes I presented above, it also emerged as a stand-alone theme in addition to the themes that were pre-identified as part of the PLACE conceptual framework. Heat was listed as a contributory cause of death in only two of the reports eligible for this study. However, elevated interior temperature of the residences was mentioned in four reports; interior temperatures of other homes were unknown. Of the four reports mentioning heat, three decedents were female and one was male. The following was noted in the report of a male decedent, for whom heat was determined to be a contributing cause of death:

> The thermostat inside of the residence reported the temperature as 99°F. The temperature inside of the bedroom at the time of investigator arrival was measured as 93°F. The air conditioner was reportedly non-functional for several days preceding the decedent's death.

For the other three reports mentioning heat, air conditioners were confirmed to be working but either off or set to heat rather than cool.

In summary, the information found in Medical Examiner reports from Maricopa County that connected an older person's death with their home varied depending on the Examiner who completed the report. However, pertinent information included narrative comments about the physical environment where the person died, sometimes including temperature of the home, and autopsy results indicating evidence of a fall.

Part II (Present): Survey to Answer Research Question 2

The purpose of this study's survey was to gain a snapshot of current adaptive strategies implemented by older Arizonians, and to answer the following research question: *What residential extreme heat and age-related adaptations are most commonly implemented by older*

adults living in Arizona? The survey was open to all people age 65 or older who lived in or owned a home in Arizona. The results contribute to better understanding of what residential extreme heat mitigation and age-friendly design decisions have been implemented by people over age 65 living in high-risk areas. I begin this section of the chapter with an overview of survey participants' demographics, then I highlight findings connected to the research question, and I end with a finding that emerged when analyzing the open narrative portion of survey responses.

Demographics

There were 22 responses to the survey, and of those, three participants were not able to progress past the first filter question: "Are you age 65 or older?" Of the 19 remaining respondents, only 11 fully completed the survey, resulting in 11 complete datasets that I used in analysis. The age distribution within the participant group was diverse, with the largest proportion falling within the 85–89 age bracket (36.4%), followed by 75–79 (27.3%), 70–74 (18.2%), and 65–69 (9.1%). The participants were primarily males (72.7%) who predominantly resided in single-family houses (63.6%), with the remaining residing in mobile homes and condominiums. A significant majority of the participants owned their homes (90.9%). The majority reported income of $31,000–$60,000 (45.5%). Just over half of participants lived in homes not managed by a Homeowners Association (54.5%). The duration of participants' residence in their current homes varied widely, with some having lived there for less than 3 years and others for over 40 years.

Heat Adaptation

The survey findings revealed a variety of heat adaptations. A majority of respondents (81.8%) had air conditioning systems installed in their homes. Central air conditioning (72%) was the most prevalent type of cooling system used, followed by swamp coolers (18%) and window units (.09%). Additionally, nearly half (45%) of the participants reported relying on supplemental methods of electric cooling, such as floor or ceiling fans. However, it was evident that cost considerations came into play, as 63.6% of the respondents reported that they delayed using air conditioning due to the associated high energy expenses. Cost of energy is particularly problematic for low-income renters, as exemplified by this quote, when the survey prompted participants to consider what more their city could do to help residents stay cool: “Make sure landlords are providing energy efficient air conditioning in all rental properties. Mandate utility company cannot shut off during the hot season and create generous and helpful programs for those who cannot afford.”

Moreover, all but one of the participants reported that their homes had effective insulation. Narrative responses indicated that participants perceived insulation as a proactive approach to maintaining cooler indoor environments. For instance, when reflecting on the effectiveness of keeping a well-insulated home cool, one participant shared the following suggestion for their city to be more proactive about improving the energy efficiency of all homes in the region: “[The city should] provide free energy related inspections with advice on how to help the homeowner with energy saving methods.”

In addition to cooling their homes, participants reported employing additional strategies to avoid extreme heat, including: drinking more water, going to the pool, riding an

air-conditioned public bus, and changing their routine to get up earlier in the day. Some individuals opted to temporarily relocate to second homes in cooler regions during summer months.

Age Adaptations

In addition to heat adaptations, the survey respondents also identified age-specific adaptations adopted by older adults in Arizona (see Table 4.1). Age-friendly home features, including well-lit exteriors (90.9%) and exterior walkways free of tripping hazards (90.9%), were prevalent in participants' homes. Furthermore, in 81.8% of homes, the bedrooms, bathrooms, and kitchens were located on the main level. Just over half (63.6%) of participants' homes were built with no steps to enter the front doors.

Table 4.1

Age-Adaptable Features that Participants Reported in Their Homes on the Survey

Survey Question	Percentage of Yes Reponses
Is the entrance door easy to lock, unlock, open, and close?	90.9%
Are the exterior walkways safe and free of tripping hazards?	90.9%
Is the home's address number clearly visible?	90.9%
Are the hallways well lighted? (i.e., Can people see what is in front of them on the floor?)	90.9%
Is there lighting above the sink, stove, and other work areas?	90.9%
Does one shower in the home have a step-free entry?	90.9%
Are the toilets a comfortable height?	90.9%
Are the hallways well lighted? (i.e., Can people see what is in front of them on the floor?)	90.9%
Do all of the exterior doors have a secure lock that won't accidentally lock someone out?	81.8%
Are the doorways and hallways at least 32 inches wide?	81.8%
Is there "blocking" (e.g., a wood stud or other surface) behind the bathroom walls so grab or assist bars can be securely	72.7%

Survey Question	Percentage of Yes Reponses
installed in the bathroom, shower, and toilet area?	
Is there a bedroom, full bathroom, and kitchen on the main level?	72.7%
Does the stove or cooktop have controls near the front of the device?	72.7%
Are the kitchen cabinets and shelves easy to reach and use?	72.7%
Is there at least one step-free entrance to the home?	63.6%
Does the kitchen have a lever, touch, or sensor-style faucet?	63.6%
Does the kitchen have a work surface that can be used while seated?	54.4%
Do the cabinets and drawers have easy-to-grasp, D-shaped handles?	54.4%
Does the most commonly used entrance to the home open out?	45.4%

Within the open narrative survey questions, participants offered recommendations for age-specific adaptations they believed should become standard in Arizona homes, including: lever doorknobs, wider hallways and door openings, good lighting, grab bars in showers, and no steps to enter the home.

Risk Perception

On average, respondents rated the likelihood of their lives being threatened by a heat wave during the next season as moderately low, with a mean score of 3.2 out of 10. The perceived danger for themselves and household members during prolonged heat waves was somewhat higher, averaging 3.7 out of 10. However, participants' confidence in their homes' abilities to protect them during power outages caused by a heat wave was also low, with an average score of 2.8 out of 10. These results indicate a low level of concern about the risks associated with heat waves, and participants' low level of confidence in their homes' abilities to protect them during power outages.

None of the participants reported having ever used one of their city's cooling shelters. While 72.7% of respondents reported having an existing household plan to stay cool during days of prolonged heat, the plans primarily involved staying inside their homes with curtains drawn and the air-conditioner on. None of the participants offered modifications to that plan if their region lost power. The most common response being, "I have not lost power before."

Additionally, it was revealed that despite participants' low perceived risks related to extreme heat, two of the 11 participants had experienced heat exhaustion, and four needed to alter their plans to reduce the impact of extreme heat. Although participants reported low risk perceptions, their actions of modifying their plans to avoid the most intense heat of the day demonstrated contrasting behaviors.

Emerging Theme: Self-Reliance

In addition to the pre-identified themes established with the PLACE conceptual framework, an emerging theme of self-reliance also arose within the narrative survey responses. This theme did not immediately revel itself, but I began to notice it after reading only one comment suggesting a community-based solution for a condominium complex: "We could have a neighbors-helping-neighbors to ensure that all residents are cool and safe. We have an air-conditioned club house and pools for residents to use to keep cool if needed." This suggestion was an outlier, with the majority of responses focusing on self-reliance within their own homes and difficulty reaching out to their city or neighbors for assistance. For instance, the following comment exemplifies a predominant concern that many of the participants expressed:

Question: "In your opinion, what is the biggest challenge to staying cool in your home?"

Answer: "Humility when [help] is needed."

I explore this emerging theme of self-reliance further in Chapter V.

Part III (Future): Key Informant Interviews to Answer Research Question 3

I utilized semi-structured interviews to explore the following research question: *What are strategies to improve residential extreme heat resilience and enhance living conditions for people as we age in place with heat?* I used these interviews with key informants throughout the U.S. to shape forward-looking solutions, which will be discussed in Chapter V. I conducted and recorded these one-on-one interviews via Zoom between September 2023–April 2024. In this section of the chapter, I begin with an overview of the interview participants, and then I highlight the findings, as organized by four themes—vulnerability, built environment, risk perception, and other—and explained through the introduction of related sub-themes. The section concludes with an overview of emerging themes.

Overview of Participants

A total of eight key informants participated in the one-on-one semi-structured interviews. Of those participants, five were professionals (see Figure 4.1) and three were older Arizonians (see Table 4.2). The professionals were given the option of anonymity, and each chose how they wanted their name and title recorded for use in the written dissertation. Per IRB approval, the older Arizonians remained anonymous and are referred to in this dissertation only by their participant identifier.

Figure 4.1

PLACE Venn Diagram With Professional Key Informant Location Overlay Indicating Their Representation of PLACE Framework

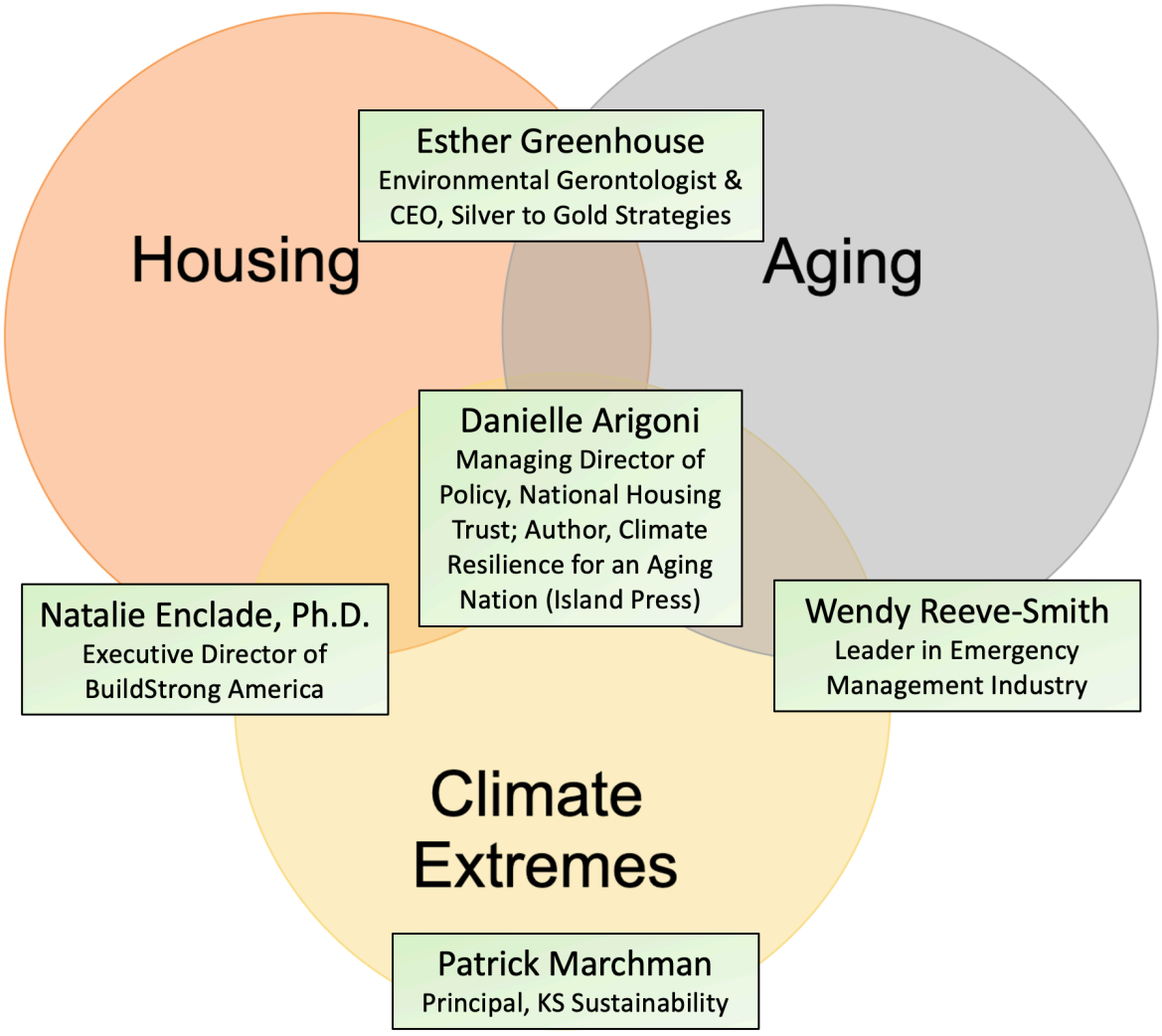


Table 4.2

Anonymized Demographic Information for Older Arizonian Interview Participants

Participant identifier	Age	Sex	Location	Years in Arizona	How many people live in the home	Self-reported medical condition	Low Income
A	79	Male	Phoenix suburbs	26	2	No	No
B	68	Female	Far west AZ	18	2	Yes	No
C	78	Female	Phoenix metro	43	1	Yes	Yes

Theme 1: Vulnerability

Within the broader theme of vulnerability, three sub-themes emerged: health and safety concerns, climate change and insurance impacts, and adaptation (see Table 4.3).

Table 4.3

Vulnerability (Theme 1) Sub-Themes

	Theme	Frequency of Times Mentioned	Number of Participants	Examples from Interviews
Theme 1	Vulnerability			
Sub-Theme 1a	Health & Safety Concerns	19	6	"We're building another home that hopefully will be done before this summer before the heat of summer. We want to do our move before the heat gets treacherous here."
Sub-Theme 1b	Climate Change & Insurance Impacts	11	5	"There are new vulnerabilities that are that are becoming exposed by virtue of climate change and by virtue of the [insurance]

	Theme	Frequency of Times Mentioned	Number of Participants	Examples from Interviews
				mapping that goes along with it."
Sub-Theme 1c	Low Income	4	3	"It's expensive, and so, they choose between air conditioning and food."

Sub-Theme 1a: Health and Safety Concerns

Several concerns emerged connecting the home environment with the health and safety of older adults during periods of extreme heat; notably, a dependence on electricity, mobility considerations, and isolation. Wendy Smith-Reeve, leader in the emergency management industry, described some of the challenges with electricity-dependency in medically vulnerable households in Arizona:

> One of the bigger concerns are those that are dependent on electricity. So, when you have blackouts or brownouts, or if the power goes out for any reason, in a specific area and you have triple digit temperatures, you create health problems for those individuals, especially if they are dependent upon oxygen or something else that requires electricity in order to provide for their livelihood. There are a lot of cooling centers, but many of these individuals are not able to get to those cooling centers.

Mobility considerations and the need for age-friendly home designs were top of mind for many interviewees. Participant B shared their story:

> [In our current home] we walked the stairs many, many times, many, many times, and it's up this flight and then up this flight, and we decided that it would behoove us to have an elevator, because some of our family members would not be able to get upstairs, and my husband also had numerous surgeries on his knee. He's had many surgeries and ligament transplants and all sorts of things. So, his knees are a little that way. So, our next home [being built] is all single level. … So those are definite considerations, not just for ourselves, but for our family members that are the same age as we are or older.

In addition to age-friendly design, Participant B is actively considering the extreme heat in Arizona for their new home, “We’re building another home that hopefully will be done before this summer before the heat of summer,” stating, “We want to do our move before the heat gets treacherous here.” Entertaining and hosting guests is important to Participant B and her family, but the increasing intensity and longevity of the heat had prompted reconsidering long-standing family plans:

> My sister can’t even come visit anymore; she is so miserable. She’s so used to the cooler climate and we can’t keep her cool enough. We can’t even keep the air conditioner low enough for her to be comfortable when she comes. I tend to be on the colder side, although I don’t tolerate heat quite as well as I did when I was younger. I enjoyed the heat better when I was in my 30s and early 40’s, but as I’ve aged, I don’t tolerate the heat as nearly as well.

Unprompted, each older Arizonian interviewed spoke about one specific concern: falling in a parking lot during the summer. While not directly connected to the home, this built environment concern has prompted people to remain in their homes during the day to protect against the fear of serious burns from a fall on hot pavement. Participant C highlighted this fear:

> Another really big issue for Arizona is if a child or an elderly person falls, especially elderly people, because they can’t get up from those falls. They end up with extremely serious burns. Last year in July we had our burn unit, which is through our county hospital was absolutely way beyond capacity because of people with serious burns from falling on the pavement. I go to a physical therapist, and my physical therapist was treating a number of older people that had fallen and had received burns so severe that they had to have long term physical therapy even to be able to move again. So, it’s dangerous to walk across the pavement. You want to be really careful that you’re steady on your feet.

The result of this trepidation among participants was self-isolation at home during most daylight hours. Participants explained their adaptive behavior choices, such as shifting errands and outdoor exercise to the mornings, as exemplified by Participant A when talking about how summers had changed during their time living in Arizona:

> We used to talk about 100 days over a hundred degrees, and now we're starting to talk about how many days over 110 degrees. So, there's there is that, at least in my mind, there's a number change that's happening. But from being out in it; I exercise a lot, and in the summer, I play pickle ball and in the summer the game is over at 9am. Now, in the winter it starts for me at about 9 a.m., all different.

In summary, professionals whom I interviewed identified external vulnerabilities, such as electricity dependency, which become amplified with extreme heat, and older participants discussed adaptive measures they have introduced to manage during the hottest days.

Sub-Theme 1b: Climate Change and Insurance

The evolving risks associated with climate-amplified disasters were discussed primarily through the lens of repercussions felt within an individual's homeowners' insurance. Natalie Enclade, Executive Director of Buildstrong America, considers today's changing insurance rates to be an indicator of what is to come:

> [Climate change] gets quantified in the form of insurance. That's a very visible kind of indicator. The risk in purchasing this property 30 years ago is different than the risk it is today; that risk is not a constant. …There are new vulnerabilities that are that are becoming exposed by virtue of climate change and by virtue of the [insurance] mapping that goes along with it.

The unpredictability of insurance rates and coverage reductions becomes a significant problem for homeowners. Danielle Arigoni, Managing Director of Policy for the National Housing Trust, and author of *Climate Resilience for an Aging Nation* (2023), explained:

> It only becomes apparent for people when they get that insurance premium bill, or when they get the notification from [the insurer] that all of a sudden, flip payment. … I was stunned by a statistic that I found from AARP about older adults foregoing basic needs to pay a utility bill. And they had to do that for more than 1 month of utility bills in the past year. I can't believe that it is that bad and I also can't believe that more people aren't furious. How do we believe that's okay? And that's what federal programs are normally designed to do, fill that gap. Why are those programs not working? This is what people are having to do.

Wendy Smith-Reeve elaborated on insurers pulling out of markets and offered a cautionary look toward the future:

> As we know, we're only getting hotter. The temperature is only increasing and we are also seeing more frequent large hazards befall communities. So, when you look back over time, as far as the significant events, weather related events that have impacted the nation, from even just 10 years ago versus today, we get $1 billion disasters, multiple times a year. The frequency has grown exponentially. And now you've got insurance industries that are taking themselves out of certain markets, which only means that's going to fall to the Federal Government that can't even take care of the flood insurance programs that they manage, which should not be the Federal Government's to manage, they're not good at it. We need it to be with the insurance professionals. Just as an example, the increase in those types of [extreme weather] events are only going to get more frequent and the frequency is going to soon have a very much more of a crippling effect on the nation as a whole.

This instability of homeowners insurance increases a person's climate vulnerability two-fold. First, vulnerability increases due to the financial strain of an increasing payment amount. Second, vulnerability increases if the insurer decides to no longer insure their home for the climate risk, leaving the homeowner without protection if a disaster strikes.

Sub-Theme 1c: Low Income

Beyond climate change insurance challenges, living on a low income significantly contributes to a person's climate vulnerability risk. This issue becomes especially urgent for older adults who are on low or fixed incomes. Patrick Marchman, Principal of KS Sustainability, summarizes the challenge, "It's expensive, and so, [low-income people] choose between air conditioning and food."

Dependence on electricity during periods of prolonged heat, as discussed earlier, is compounded by financial constraints. The cost of electricity and cost of the cooling equipment prompted difficult decisions among participants, Wendy Smith-Reeve elaborated on the

difference in health outcomes between available cooling sources (e.g., central air conditioning vs. swamp cooler) and varying income groups (e.g., low income vs. high income):

> If [older Arizonians] do not have the financial ability to keep their home cooled to a comfortable temperature, then that is going to have a negative impact on their health. If they don't have any AC because they've got swamp coolers on their house, or all they have is a box unit sitting in a window it will lead to negative health outcomes. So, it's really those people who have even more significant stressors [such as low income], are more at risk than those who have the means to provide for a more comfortable environment.

Moreover, Participant C discussed compounding health risks for low-income individuals who struggle to maintain proper hydration, often consuming sweet beverages that further dehydrate:

> The other thing that's really, really important, we really have a lot, especially elderly, and children that don't stay hydrated don't drink enough. And if they drink, they drink sweet stuff, life soda, which really dehydrates and puts people in more harm.

This topic of low income as a climate vulnerability amplifier will be discussed further in Chapter V.

Theme 2: Built Environment

The older Arizonians I interviewed generally supported making energy efficient updates to housing design and policy (see Table 4.4); for example, temperature control units, such as smart thermostats or mini-splits, being either standard or easily available to homeowners and renters. The most readily accepted suggestion from older residents I interviewed was to change the building code to require all new homes be built with increased insulation.

Table 4.4

Built Environment (Theme 2) Sub-Themes

	Theme	Frequency	Number of Participants	Examples from Interviews
Theme 2	Built Environment			
Sub-Theme 2a	Historic Context and Resulting Barriers for Cooling	18	6	"These decisions can be deadly, and that's mainly what I'm seeing with each [HOA decision] is the barriers rather than the benefits."
Sub-Theme 2b	Housing is Disabling for an Aging Population	6	3	"We have enough information that we can be predicting a lot of scenarios, right? And we're not designing for them. So, we need to design [housing] with flexibility for older adults in mind."
Sub-Theme 2c	Adaptations	17	4	"We don't have to any steps in our showers in our new home, and that was a design in a specific choice, not necessarily for handicapped reasons, but just because, aesthetically, we like the way it looks when you just you just walk into it."

Sub-Theme 2a: Historic Context and Resulting Barriers for Cooling

The historical context of the built environment in the U.S. reveals various factors that have contributed to the current housing insufficiency and inability to provide adequate cooling during times of extreme heat. Key informants who I interviewed reflected on the U.S.'s history of urban planning that often placed affordable housing in disaster-prone areas due to racially motivated land use policies and economic considerations, thereby underscoring the need for modern climate adaptive building codes. Climate scientist Patrick Marchman lamented that modern buildings often lack simple features such as operable windows or climate-adapted architecture, such as porches that could facilitate natural cooling. He continues, "Housing, the way we designed our cities and our building codes, we need to move back. I was raised with most of our food was grown in our garden, and we need to move back to that." Current concerns among professionals highlight vulnerabilities such as the reliance on air conditioning and the power grid, which if compromised, could lead to dire situations. Patrick Marchman, Principal of KS Sustainability, summarized the concerns:

> I worry about what happens during heat waves. And it's not just the heat, it's the fact that it's going to be taxing the power grid. … The power grid is a vulnerability. So, we could set up everyone with an air conditioner, but if the power grid goes down it doesn't matter. It does not matter. So, we have to be thinking about a how do you get cooling centers for people, make sure they're accessible, and people know where they are.

Design limitations of homes have proved dangerous for older residents. Participant B reported that their custom home builder offered no resources when designing their new single-family home for heat resilience. Participant C elaborated on barriers for cooling when describing dangers with the stair railing in her condominium complex:

> You know, this last summer. I've been here for 45 years or so, so I'm used to heat. But when we had that spell last July, it was the only time I would run out at 6 o'clock in the

> morning and get a little food, and other than that you didn't want to stick your nose out the door. … I have this metal railing on my stairway, going down from my condo, because I'm second floor, and I had to take a hot pad to be able to hold on [to the railing] because I have some health issues that that require me to hang on to the to the railing, and that was the only way I could do it, because I would get burned from just holding the railing. It used to be the steering wheel on cars and the door handles and cars were also would burn your hand, but those [designs] have gotten better.

The primary barrier to built environment adaption mentioned by interviewees highlighted challenges with local homeowners' associations (HOAs). Participants discussed a variety of HOA barriers, which have prevented people adapting their home to extreme heat. Some of these barriers include HOAs prohibiting the installation of: window air conditioning units, wheelchair ramps, solar panels on roofs and carports, outdoor shade sails, and planting of shade trees. Wendy Smith-Reeve, leader in the emergency management industry explained, "These decisions can be deadly, and that's mainly what I'm seeing with each [HOA decision] is the barriers rather than the benefits."

Natalie Enclade narrowed in on one particularly challenging aspect of living in an HOA-managed community—the added levels of complexity required to make any updates to your home.

> Going back to the idea of barrier of entry, the more you have to do to protect your home, the less likely you're going to do it. For example, if you have to fill out all this paperwork to be able to modify anything on your house [for climate resilience] many people will not do it.

Natalie continues by sharing experience from her work at BuildStrong America:

> If you [as the homeowner] are wanting to modify your home to a research-backed fortified standard, the HOA will turn it down if it's not pretty … And there's no way for potential buyers to know how [unsupportive] the [volunteer HOA] board is at any moment.

Participant C offers a personal example form their condominium complex, beginning with a discussion of their desire to purchase an electric car and the infrastructure challenges faced at home:

> I have no ability to charge an electric car, or even install a charger, because the way we were we're designed I have to walk several hundred feet to my parking spot. There's no electricity or any cover over my parking spot, but I don't have a garage, and there's no electricity ability. If I wanted to install a charger there, I couldn't do it. I would love to also add solar on my roof, or at least solar water heater. But our Homeowners Association won't allow it, although there are some things in our state law that I think they should. But I would have to challenge it in court to do it, you know. So, it's not something that's affordable, because they've said no several times. They say that the way our roofs are designed, and the way our building is designed that it would interfere with other people. There could be some truth to that. That's why it's important to get the building codes in place and put in that infrastructure in when things are being built, rather than trying to retrofit.

Ultimately, the lack of heat-adaptive design features in the U.S.'s built environment further increases the vulnerability of the aging U.S. population. A persistent barrier is, and will continue to be, HOA legal controls preventing residential adaptation to climate stressors.

Sub-Theme 2b: Housing is Disabling for an Aging Population

Participants talked about the urgent need for radical redesigning of housing and community infrastructure to support accessibility, safety, and independence, particularly for older adults and those with disabilities. Esther Greenhouse (2012)—Environmental Gerontologist and CEO Silver at Gold Strategic Consulting, and leader in enabling people to maintain their physical and financial independence as they age—summarizes the challenge, "We have enough information that we can be predicting a lot of scenarios, right? And we're not designing for them. So, we need to design [housing] with flexibility for older adults in mind." She goes on to highlighted limitations with current U.S. housing designs that do not adequately adapt to our changing needs that come with aging:

> It's just extraordinary. The emotional, psychological, physical, financial, logistical pain and suffering that the majority of our nation is experiencing and will experience because of long-term care needs. And the built environment is really a huge missing variable. The notion of home modifications is really a Band-aid solution. It's crucial, and home modifications can make all the difference whether or not somebody could successfully age-in-place, but they usually come too late after somebody has already either been disabled by a health event or chronic health conditions, or by the design of their home or both. The other issue is that typically home modifications are done in a very utilitarian way, and because of that, when the person who is benefiting from them no longer needs them because they've moved out or they've moved on. Typically, they're ripped out. So, this speaks to a lot of things that we should be doing differently. [It is time to] end the disabling and discriminatory status quo of the design of our housing and communities, with the goal of designing them to harness their power to enable people to maintain their physical and financial independence as they age.

The participants' overall critique emphasized the lack of foresight in home design and community planning, thereby advocating for a more inclusive, flexible approach that anticipates a variety of living scenarios and needs. Patrick Marchman considered how climate-adaptive designs could be incorporated into new construction homes in order to provide protection from extreme heat:

> In many newer buildings you can't open a window. [It would be nice to] build front porches, these architecture things we forgot, and maybe we have to import some more Southernly architecture into areas that didn't have it before. But we have to make sure [climate adaptive plans] can work, we have to be thinking differently. [For example] prioritizing heat pumps instead of an AC system.

The current standard of housing and urban design is insufficient for an aging population, and transformative changes are needed that enable people to maintain their independence and manage health-related issues within their own homes. Patrick Marchman provided a dose of caution if prioritizing too many electricity-dependent designs:

> We think of systems in isolation, right? Sort of how we think of ourselves. Theoretically, you could have a house with an elevator [or power lift] to get up the outside steps, and everyone can get in if you're walking or rolling your wheelchair. And so that sounds nice, right? What happens if electricity goes out? Then you're just stuck. So, you have to be thinking indefinitely, like putting in a ramp instead of a lift. Same with the air conditioning. I think we're going to have to get to the point of creating cooling sources that can function even when the electricity goes out, because I think that's going to be a huge issue.

Sub-Theme 2c: Adaptations

Overall, older Arizonians whom I interviewed for this study reported having already made modifications to their homes or daily actives to adapt to both the heat and aging. Examples of heat adaptations include running errands in the early morning, drawing shades to block direct sunlight, updating weatherization inside walls and around the interior of windows, using a smart thermostat or having backup air conditioners (for higher income people), and making difficult choices about when to turn on the AC and use electricity (for lower income people). Another adaptive technique discussed was migration away from Arizona during the summer; these migrants are also known as "sunbirds" (S. Smith & House, 2006, p. 232). Examples of adapting a home to foster healthy aging included front entries with no steps, one level ranch-style homes, and an outside area for a garden or a shaded gathering space.

Some participants even unintentionally incorporated aspects of universal design; not because they were considering age-friendly choices, but because it created a desirable outcome. Participant B explains their choice in shower design for the main bedroom:

> We don't have to any steps in our showers in our new home, and that was a design in a specific choice, not necessarily for handicapped reasons, but just because, aesthetically, we like the way it looks when you just you just walk into it.

While older Arizonians discussed adaptions they have made for extreme heat, professionals offered broader examples of climate-resilient home building they have collected

throughout their careers. Natalie Enclade uses a hurricane example to stress the mission of her organization at BuildStrong America:

> The best example I've got is after hurricane, I believe it was, Michael in Florida. A lot of the Habitat for Humanity homes were more resilient because a lot of the volunteers that built the Habitat homes were like, "Oh, one nails is good, let's put in a few extra here." And so, the way that the roofs were fastened onto the homes were actually put on stronger just because there were extra nails. So, it's not this big expense, just extra nails to fasten the roof. It's not that it's a huge expense to do these things, and it doesn't have to be costly and doesn't necessarily have to be months and months and months extra to build these homes. You just have got to look at the long-term impacts.
>
> Let's build it stronger because on the back end we're going to save, not just dollars, we're saving lives.
>
> Our biggest mission is to reduce disaster costs, and for every $1 [to build stronger] you could save up to $13 or $14 on post-disaster costs. … However, according to NAHB (National Association of Homebuilders), [if implementing] the latest edition of building codes we're saving about 600 lives when you're building to code, and you can't put a price on one life, much less 600 lives. … In new construction, it is easier to implement the latest edition of codes.

This example is an important reminder that municipalities are not required to adopt the most modern building codes, which have been specifically designed to protect people and property during a disaster. The Federal Emergency Management Agency (FEMA, 2020) reports that 65% of all cities, town, and counties in the U.S. are not utilizing modern building codes.

Theme 3: Risk Perception

Within the broader theme of risk perception, three sub-themes emerged: present vs. future risk, ageism and language, and adaptation (see Table 4.5).

Table 4.5

Risk Perception (Theme 3) Sub-Themes

	Theme	Frequency	Number of Participants	Examples from Interviews
Theme 3	Risk Perception			
Sub-Theme 3a	Present vs. Future Risk	28	7	"My experience is they [older friends] really don't want to even think about it [if the power went out]."
Sub-Theme 3b	Agism and Language	23	8	"We are an ageist and ableist society, people are terribly frightened of getting older and losing their abilities."
Sub-Theme 3c	Adaptation	13	5	"When we built it we took out the big windows that were intended, in order to keep the temperature of the home more comfortable."

Sub-Theme 3a: Present vs. Future Risk

As mentioned earlier, participants expressed concern about leaving their homes during the day due to the substantial cascading injuries of a fall in a scalding parking lot. However, while older participants were aware of the dangers of the heat, it was rare for someone in this study to acknowledge the possibility of their area losing power during extreme heat. Wendy Smith-Reeve said it is "when, not if" these areas of Arizona will lose power during days of high heat, and most older residents expressed no concern stating, "It hasn't happened yet":

> Researcher: If it's really hot during one of those over 110-degree days, and the neighborhood electricity goes out, do you have a family backup plan?
>
> Participant A: Well, no. A short answer. No. I can't remember it ever happening in the last 25 years, either. So, no, we don't.
>
> Researcher: With the older people that you talk with in your work, volunteering, and friend circles, do people have an idea of what they would do if the power went out? Do you get a sense if people have a plan?
>
> Participant C: No. They don't have a plan for the power going out. And people really don't want to even think about it. In Arizona, even though we have a lot of concerns and issues with our utility company, they have been very reliable. Even in the summer when there's huge demands, it has been very rare. So, I think they've done a pretty good job of addressing having enough power.

Danielle Arigoni discusses possible considerations an older person living with extreme heat is faced with, based on risk perception to a changing climate as compared to the risk perception connected to everyday living:

> I think it's in part because it comes from a lack of understanding of how, for example, heat interacts with medication. Or how heat interacts with isolation. Or the fact that someone who lives alone is already implementing measures to minimize her financial risk by keeping the temperature at particular level because [high electricity bills] is a greater risk. Because, you can perceive, if I don't keep [electric bills] under control I'm going to be vulnerable to something else, such as eviction.

Wendy Smith-Reeve considered how risk perception can influence decisions and behavior from the perspective of an emergency manager. Especially challenging has been conveying the health dangers if a community losing power during days of extreme heat, when the area has never lost power before:

> [Risk perception] is really: What have they experienced previously? If they've never had to look at a situation and say, "But what if this happens? Then what am I going to do?" We are of a very different mindset in the emergency management community because that's really what we're looking for. We always think about what is the absolute worst thing that could happen, and what am I going to do to mitigate my circumstance and also mitigate that same situation for others in the community because they're not going to know what to do. And so, our role in emergency management is to tell them, "This is what you need to do, and here's where you're going to find that resource." We have to think about that for them. We have to make plans and put actions in place, identify those partners that are going to provide that service and support in that time of greatest need.

Danielle Arigoni discusses the prevalence of affordable housing and particularly subsidized housing in relation to climate change and risk perception:

> Areas that are more disaster prone for lots of reasons, [such as] legacy land use policies and cost of land, are things that literally locate housing [in riskier areas]. This is housing, which is meant to serve the most vulnerable people in our community, [is placing people] in riskier places and less desirable locations.

Danielle Arigoni continues by connecting a person's risk perception back to insurance providers:

> [Insurance] is a visible indicator. The risk in purchasing this property 30 years ago is different than the risk it is today. That risk is not a consistent. … I think, for the vast majority of people, unless there's one of those [big disaster events that] triggers an insurance premium and notifications, people aren't perceiving risk. They're not recognizing the risk.

Sub-Theme 3b: Agism and Language

Unanimously, participants mentioned the influence of language on how older adults perceive their own vulnerability to extreme heat, at times even limiting proactive measures for climate adaptation due to internalized ageism. Ester Greenhouse explained further, "I often find that clients who are themselves older adults do not want to be connected with the older adults that we're trying to serve." She continues, "We are an ageist and ableist society, people are terribly frightened of getting older and losing their abilities."

When considering our choice of language, the terms “vulnerability” and “climate change” prompted some key informants to urge thoughtfulness with the use of these words. Danielle Arigoni elaborated on the term vulnerability in relation to older adults:

> This notion of vulnerability being a charged term that many people don’t want to cast all older people as being vulnerable. I think that feeds into the preconception that they’re frail and unable. All these negative attributes are ascribed to [vulnerability], but I also believe that there are true vulnerabilities that exist among older adults and that we need to be present and upfront about those. It doesn’t mean that an individual is vulnerable. It means that they live with vulnerabilities that increase their service profile.

Furthermore, language barriers or dismissive attitudes toward terms like “climate change” can hinder open discussions about risk and necessary protective measures. Patrick Marchman gave an example from a recent interaction with a government official in a rural county:

> When I mentioned climate change, he literally shut the door and said, “Don’t say that so loud here.” … Every single farmer will say, “Oh, yeah, the weather's been getting weird these days.” Every single one will say we're getting heavier rains; we're getting longer droughts. So, the heavy rain erodes and they start seeing the conditions. They were saying, “Yeah, we can handle it right now. But we're going to have some real problems if this keeps going.” … It's interesting when we're talking about language in the different localities.

Such awareness of the implication behind certain words is essential. Because the use of charged terms, such as vulnerability or climate change, could not only prevent effective communication but also impede the adoption of strategies that could mitigate the impact of heat on older populations, ultimately affecting their health and safety.

Sub-Theme 3c: Adaptation

Respondents noted that awareness of one’s own personal risk to extreme weather conditions increased their likelihood to proactively adapt their home for heat resilience. For instance, a climate professional, Patrick Marchman, chose his current home due to its partially

underground living room, which naturally mitigates heat during summer months. Additionally, Participant C, who works in climate advocacy, replaced all their appliances with Energy Star and updated weather stripping around doors and windows. Participants also demonstrated an increased awareness of the heat risk for people visiting their homes, which was a consideration for the thermal comfort of one custom home:

> Researcher: [When designing your new home] was there any consideration to where the sun will travel? Considerations for solar reflection or overhang of roof, so that the direct sun is not quite as bright inside the house during the summer?
>
> Participant B: Yes, particularly on the back patio, because we do a lot of indoor-outdoor living and entertaining on the back patio. We have a built-in barbecue center that we're working on, and the overhang; we check the sun and the sun coming into the patio at several different hours of the day to see what it is. The home faces a little bit north, and when we built it, we took out the windows, the big windows that were intended, and the first design on the west side of the home, we remove them to keep the temperature of the home more comfortable. So yes, that was a that was definitely a consideration. The front of the home will get the sun, but there's a large overhanging in the front, and so the whole entryway is covered. So that was definitely a consideration.

When asked about their family's plan for the possibility of losing power at their home, Participant B stated, "I do not know. I do not. I've never even thought about it to be honest." However, after taking a moment to consider the question, they offered a short-term plan of going to the movie theatre and a long-term plan of leaving to visit family in California. Many older Arizonians I interviewed described various adaptive measures for the heat, and could create heat safety plans even if never before considered. However, the professionals interviewed shared stories about their parents who were not prepared to the extent that the professional would prefer:

> [My dad] is 81 and lives with his wife [in Arizona], but my brother is not far from them. So, [my brother] has done a bit more of the critical thinking. And while we've had the conversations, are they prepared to the level that I want them to be? Not quite. But I think that between other family members in the area that they'll be sufficiently taken care of.

Conclusion

Older participants in the survey and interviews reported making modifications to their daily actives to avoid the most intense heat. Such as, running errands in the early morning, drawing shades to block direct sunlight, using a smart thermostat or having backup air conditioners (for higher income people), and making difficult choices about when to turn on the a/c and use electricity (for lower income people). Older participants were generally in support of making energy efficient updates to housing design and policy; such as temperature control units, such as heat pumps, being either standard or easily available to homeowners and renters, and the most readily accepted suggested for older residents I talked to was changing the building code to require all new homes be better insulated. Professionals interviewed stressed the importance of updating policy, design codes, and insurance protections to implement these changes. Also, interviewees spoke of the barriers to both heat and aging adaptations HOAs create. Professional key informants interviewed explained it is "when, not if" these areas of Arizona will lose power during days of high heat, and most older residents I talked to expressed no concern and stating "it hasn't happened yet." This limited awareness of future risks to self is where home design comes in. If we are relying primarily on people's perception of their own risk to save their lives, we will ultimately fail since people are inclined to stay home to stay safe.

CHAPTER V: DISCUSSION

In this discussion of findings, I present a deeper examination of pressing issues related to extreme heat and residential design considerations that contribute to the deaths of older people. The rise in fatalities of older adults in their homes during disasters, particularly extreme heat, pose a pressing concern. However, due to modern human migration patterns and the increasing threat of disasters, people will continue to move to, live, and age in places prone to extreme heat (Schwartz, 2020; Shah, 2020). Therefore, this research fills an important gap in our understanding by identifying harmful and helpful factors found within the homes of older people experiencing extreme heat.

In this chapter, I summarize findings of each research question then connect findings to theories, review contributions to theory through the lens of my PLACE conceptual framework (see Figure 2.1, Table 2.2), discuss broader implications of the research, reflect on limitations of this study, and close by proposing areas for further research.

Summary of Findings and Connections with Existing Research

Part I (Past): Archival Review for Research Question 1

In the archival review portion of this study, titled "Past," I addressed Research Question 1: *What can we learn from archival reports from the Medical Examiner's Office in Maricopa County about the relationship between the built environment of an older person's home and their death during days of extreme heat?*

Information found in Medical Examiner reports from Maricopa County that connected an older person's death with the built environment of their home varied depending on the Examiner who completed the report. Overall, there were two predominant clues present in the

reports. First, autopsy evidence of external or internal injuries reflecting a recent fall. Second, mention of recorded temperature within the home.

These findings support existing literature that also utilized coroner reports. For instance, when examining the cause of death during a season of unusually high heat during July of 2006 in California, researchers collaborated directly with the medical examiner's office to obtain information (such as address of decedents), which was not included in the final coroner report (Margolis et al., 2008). Their findings indicated the majority died indoors, were male, and 13% had a working air conditioner but it was not turned on (Margolis et al., 2008). All of which aligns with findings from my study.

Importantly, some reports in my study listed additional contributing factors to the deaths that were not connected to the physical home: a presence of medical complications, living alone, poor condition of teeth, and dehydration. Older individuals are not inherently vulnerable, but they are more likely to live with vulnerabilities that increase their need for help during storms, floods, heat waves, and other extreme events (Arigoni, 2023). Such vulnerabilities are due in part to limited mobility, lack of access to resources, tendency to live alone in certain cultures, reduced access to healthcare, and the presence of health conditions (e.g., heart or lung) that restrict physiological responses to environmental stressors such as extreme heat or air pollution (Cornell et al., 2012; Daddoust et al., 2018; IPCC, 2023; Kirk Smith et al., 2014).

Utilization of the PLACE conceptual framework was helpful when analyzing the archival data in order to ensure the emphasis remained on clues as to how the home environment contributed the death of the older person, as well as being helpful in uncovering limitations

when using this dataset. My dissertation research supports the understanding that people with existing medical conditions or disabilities are at a greater risk of dying during extreme heat (Greenberg, 2014; Molinsky & Forsyth, 2022). Specifically, within my archival sample, findings highlighted that people living alone, who were dehydrated, or were living with some form of heart disease faced the greatest risk of death. Most notably, people who had recently experienced a ground-level fall were well represented among the decedents, as evidenced in all cases where an autopsy was completed. Utilizing the PLACE framework also helped to uncover limitations when incorporating coroner reports as archival data. For instance, since PLACE requires emphasis on the home environment and potential decision-making related to risk perception, the following information was notably missing, which would have created a fuller picture of the decedent: address, income, education level, language spoken, social supports available. While coroner reports do not offer a complete story of the death, these documents were useful in building understanding of the connection of the home to an older person's death during days of extreme heat.

Part II (Present): Survey for Research Question 2

I created a digital survey available to all older Arizonians to answer Research Question 2: *What residential adaptations for both heat and aging are most commonly implemented by people over 65 living in Arizona?*

Results of this survey indicated that residential adaptations for extreme heat most commonly implemented by older Arizonians included a well-insulated home and reliance on air-conditioners. Residential age-friendly adaptations most commonly implemented by survey

participants included: ease of ingress and egress to the home, good interior lighting, and at least one step-free shower.

It is important to note that the study site of Arizona is unique in age-friendly home designs. Due in part to the local vernacular style being low ranch-style housing on flat land, which lends itself well to a step-free entry to the home. Also, Pima County Arizona was the first jurisdiction in the U.S. to enact a “visitability” requirement into the local building codes; meaning that since 2002, all newly constructed single-family houses must meet the new standard including one step-free entrance, wider interior doors, lever door handles, and a ground-floor bathroom (The Center for an Accessible Society, 2003). These factors, not commonly found elsewhere in the U.S., likely contribute to the high number of survey respondents reporting ease of entering and exiting their homes. This underscores the need to incorporate such age-friendly design features early and often in the planning stages of housing development.

Survey responses emphasized personal adaptations like energy-efficient appliances and external shading techniques, such as patio umbrellas or gardens. However, systemic issues such as increased urban heat in areas with dense concrete and insufficient greenery persist, which researchers have shown disproportionately affects economically disadvantaged communities (Keith et al., 2023). Survey respondents also reported installing or wanting better home insulation, and everyone surveyed relied on air conditioners to stay cool during days of high heat. Also, participants reported adapting their behaviors to run errands in the early morning so they could stay home during the heat of the day. These adaptations were influenced by various factors such as personal risk perception of the heat and specific needs of individuals. All of

these findings are supported in previous literature, which affirms older adults are unlikely to leave their dwelling and will readily modify their behaviors at home during periods of high heat including opening windows, turning on an air conditioner, turning on fans, changing clothes, and taking a shower (White-Newsome et al., 2011).

A growing body of literature points to the importance of communication approaches public health departments use in order to change behavioral responses of vulnerable people living with extreme heat. For instance, researchers in the United Kingdom encourage heat communication for older people to be structured given the person's contextual, behavioral, and individual considerations of self (McLoughlin et al., 2023). This suggestion supports previous research indicating that an older person is more likely to respond to a public health message if it is delivered by a trusted person. Löckenhoff (2017) found that older adults have a tendency to defer or delegate a decision, meaning confidants and family members play a key role in the decision-making process of older adults. Due to an "age-related emphasis on emotionally meaningful relationships," older adults are more likely than younger adults to be responsive to the wishes and actions of close others (Löckenhoff, 2017, p.143). All of this points to the person delivering the message may be more important than the message itself.

However, there is limited information available on how to change responses of decision-makers with control over local and national building codes to support inclusion of long-term lifesaving home designs that protect occupants from heat. Since we have established the design of the home itself connects to the health of its inhabitants (Maisel et al., 2022; Vu et al., 2019), and current housing does not meet the needs of older people (Greenhouse, 2012;

Molinsky & Forsyth, 2022), more research is needed into strategies for communicating risk to built environment decision-makers.

Extreme heat is increasingly deadly, especially for people with comorbidities such as heart conditions or diabetes. These findings are supported by the literature; scholars Daddoust et al. (2018) and Cornell et al. (2012) suggested that older people are more often victims of disasters due to factors such as physical limitations, social isolation, and lack of access to resources. Older adults living with vulnerabilities are more likely to live in housing that exacerbates health risks, and they may lack the finances for any needed retrofits (Adepoju et al., 2022; Brasher, 2020). Inadequate housing and the inability to evacuate to a shelter compound a person's heat risks. For instance, a systematic review of peer reviewed literature found that people using mobility aids and living in housing not well-suited to their aids, were at a higher risk of death during a heat wave (Vu et al., 2019). However, participants in this study reported actively adapting to the heat by modifying their homes with interior blinds, using a smart thermostat, or making financial decisions about when to turn on the air conditioner. These findings support previous research of Maisel et al. (2022), which indicated high levels of emergency planning success when involving populations being served. Therefore, it is crucial to tailor disaster preparedness interventions and support to meet the needs of vulnerable populations by working with them; thereby, ensuring that all community members have the necessary resources and support to safely navigate challenges posed by extreme weather conditions.

Lastly, a new theme of self-reliance emerged from this research. Participants reported a desire for self-reliance, not wanting to rely on external support from the medical establishment

or friends, and an inclination to help others before helping themselves. This finding aligns with previous research, and is especially prominent in women. Gerontologists in Canada collected personal narratives from 12 participants and found that they were motived to stay home without medical assistance, and were likely to "change their residential environment and their behavior by deploying the coping strategies and resources they have developed over time" (Narushima & Kawabata, 2020, p. 1). Meaning, residential adaptations varied based on life experiences, but women were not likely to reach out for help (Narushima & Kawabata, 2020). Since women live longer than men and are more likely to age alone (Aburto et al., 2020), more research into the intersection of climate-adaptive housing and feminist gerontology is warranted in order to further explore how self-reliance in late-life might impact our housing choices with respect to extreme weather.

Ultimately, findings from this research suggest that messages from local health departments could include how to keep pets and others in the home safe from extreme heat; thereby providing opportunities to help everyone in the house to stay safe from climate extremes.

Part III (Future): Interviews for Research Question 3

I conducted semi-structured, one-on-one interviews with professionals and older Arizonians to answer Research Question 3: *What are strategies to improve residential extreme heat resilience and enhance living conditions for people as we age in place with heat?*

Participants reported strategies to improve residential extreme heat resilience and enhance living conditions for aging in places with extreme heat. These strategies included proactive home design for both weatherization and aging, personal emergency planning that

included retrofitting homes for extreme weather in addition to creating evacuation plans, and legislative changes to promote policies that support adoption of residential building codes that incorporate climate-adaptive guidelines. However, barriers to living safely with extreme heat persist. Primary barriers identified within this study include: Available housing stock within the U.S. does not match our needs, electricity dependency becomes amplified with extreme heat, and barriers enacted by homeowners' associations. Therefore, we will now explore each of these barriers, along with possible solutions.

Our housing stock does not meet the needs of our population. In the U.S. today, we have a surplus of similarly designed single-family houses located in gated communities, which represents 50–80% of all new houses built within varying regions of the U.S. (W. Clarke & Freedman, 2019). However, 53% of households are either single people living alone or couples with no children, but the housing stock for smaller spaces (studio and one bedroom) equals only 12% (Broikios & Stanton, 2019). Esther Greenhouse, Environmental Gerontologist, describes a barrier for building age-adaptive homes, which is needed in this country, "We have enough information that we can be predicting a lot of scenarios, and we're not designing for them. So, we need to design [housing] with flexibility for older adults in mind." Patrick Marchman, from KS Sustainability, agrees and also encourages a return to vernacular architecture, "but we have to make sure climate adaptive plans can work ... for example, prioritizing heat pumps rather than large air conditioning systems." Connecting the idea of building housing to be adaptable to both aging populations and an increase in extreme weather, this research study points to a need for policy requiring local residential building regulations support the projected needs of a community: to specifically include aging

populations and climate change. As an important reminder, aging does not mean a city needs more nursing homes but instead will benefit from a variety of housing types of varying sizes and prices.

Electricity dependency becomes amplified with extreme heat, meaning, when faced with extreme heat people living with vulnerabilities often cannot survive without air conditioning. Wendy Reeve-Smith elaborates on health challenges of energy dependency, “if the power goes out for any reason, and you have triple digit temperatures, you create health problems for those individuals, especially if they are dependent upon oxygen or something else that requires electricity.” The average cost of U.S. electricity bills in the summer has increased by 51% from 2014 (Chernikoff & Lee, 2024). Since air conditioning is expensive to run, people are making difficult and life-threatening decisions between possible death due to heat or being evicted if they are not able to pay. Findings from this research point to the need to update building code to require more insulation for new construction and the expansion of programs such as residential weatherization, energy bill pay, and community solar.

Also, homeowners’ associations were found to be a persistent barrier to home adaptation. Currently, four out of every five new homes in the U.S. are governed by a homeowner’s association (HOA) and 58–63% of *all* single-family homes in the U.S. are now overseen by an HOA (W. Clarke et al., 2019; Community Associations Institute, 2023). Legal commentator Ross Guberman (2006) called HOAs “one of the most significant privatizations of local government functions in history...although structured as nonprofit organizations, HOAs operate as private governments” (para. 3). Since a developer-built communities are managed by an HOA, these managed ideals are difficult to change. For example, if a homeowner would like

to remove the non-native grassy lawn in their desert home and install a low-water native plant garden, an HOA can mandate they keep the grass to maintain "uniformity" within the community or be fined daily (McKenzie, 2011). These restrictions become a problem when the HOA can legally stop a homeowner from modifying their home for heat safety or aging-related needs. The following are examples from my interviews, in which an HOA has said no to: window air conditioner, planting shade trees, installing a shade canopy, installing a wheelchair ramp, installation of an electric vehicle charging station, and installing solar on roof or top of a carport. These decisions can be deadly if homeowners' associations are preventing many heat-adaptive and age-related exterior changes to homes. Natalie Enclade, executive director of BuildStrong America, summarizes the barrier this way:

> If you [as the homeowner] are wanting to modify your home to a research-backed fortified standard, the HOA will turn it down if it's not pretty. … And there's no way for potential buyers to know how [unsupportive] the HOA board is at any moment.

Currently HOAs have no governing body and homeowners have little recourse if they disagree with an HOA rule (W. Clarke & Freedman, 2019). The results of this research point to the need for restrictions to limit HOA control for health-related home modifications, also, an impartial governing body for HOA appeals is needed.

Overall, findings from this study indicate a reduced perception of personal risk, since older individuals did not routinely consider how their health could be impacted by extreme heat within their home. Older participants rely on air conditioners for comfort during extreme heat but reported financial challenges in paying for electricity; participants also had few plans to stay cool during a power outage. Financial challenges paying for electricity is frequently found within the literature. For instance, when conducting disaster planning research with

older adults in Connecticut, Rhoades et al. (2018) found older participants intentionally limited use of air conditioning due to financial constraints, while also staying home during days of high heat. Low financial resources are known predictors of climate vulnerability (Rhoades et al., 2018; Timalsina & Songwathana, 2020; Vu et al., 2019). Because of this, Danielle Arigoni, suggested a gap in climate research during our interview—understanding misappropriation of risk between present and future risk. For example, the daily risks of becoming homeless due to not being able to pay electricity bills supersede the risk of possibly dying at home with extreme heat, which explains the choice to not use a working air conditioner even though it could be lifesaving. She suggested that future research could dig into this topic further:

> Sometimes you prioritize financial risk over personal health risk. That hasn't necessarily translated into is what other risks that therefore expose you to, in terms of being able to or having to withstand being homeless; not just uncomfortable, but dangerous. So, I think maybe it is a misappropriation of risk; that's part of the of gap [in knowledge] as well.

Environmental sociologist Tierney (2019) supported this finding and explained that the perception of someone's personal risk varies based on whether it is a present or future risk. During my interviews with older Arizonians for this study, each participant expressed concern about leaving the house during the day due to the substantial cascading injuries if they might fall in a parking lot. Participants described news stories of severe burn victims filling hospital beds due to falling in parking lots while simply trying to walk from their car to their destination. Participants did not fear the actual fall, but rather feared burning their skin when hitting the pavement. However, while older participants were aware of the dangers of the heat, it was rare for participants in this study to acknowledge the possibility of their area losing power during extreme heat.

The experts I talked to said it is “when, not if” these areas of Arizona will lose power during days of high heat, and most older residents that I talked to expressed no concern about a power outage, stating that “it hasn’t happened yet.” This emphasizes the need to prioritize climate-adaptive housing, for both new construction and retrofitting existing housing. Ultimately, if we rely primarily on people’s perception of their own risks to save their lives, we will fail, because people are inclined to stay home to stay safe.

Lastly, an additional finding indicates that older adults living with factors that increase vulnerability to extreme heat (e.g., limited economic means) use cooling centers or other community resources less, thereby further exacerbating the risk of injury or death. This dissertation research supports previous inquiries into cooling shelters, indicating that older people are not likely to leave their homes during an extreme heat event, nor are participants likely to go to a cooling shelter if the power goes out (Sadiq, 2023; Yoon et al., 2022). Respondents in my study stated that they would be more likely to say home to “ride it out” or visit a friend with power than go to a cooling shelter. This finding matters since cooling shelters are commonly suggested as a solution for cities to provide relief to their community members (Gabbe et al., 2023). However, there is growing understanding that traditional cooling shelters—often located in an empty school or recreation building—are either underutilized or act as daytime shelters for people experiencing homelessness (Brasher, 2020; Gabbe et al., 2023). In fact, some counties are permanently closing their cooling shelters due to lack of visitors, and instead creating and distributing care packages, such as a backpack with necessities to help keep cool (Sadiq, 2023). Therefore, incorporating lived experience and preferences of a community’s most vulnerable older people will be essential in creating heat

preparedness long-term and short-term plans that meet the needs of those most at risk of death. Ultimately, the findings of this study have the potential to inform development of age-friendly and climate-adaptive housing policies that prioritize the needs and preferences of older community members. Importantly, understanding the end users' experiences through the survey and interviews enabled me to incorporate perspectives about needs and barriers directly from older adults, ultimately leading to the development of user-centered designs and policies for heat-adaptive and age-adaptive housing (see Appendices E and F).

Contributions to Theory

This dissertation served as a pilot study for my new conceptual framework titled PLACE: Preparing Living spaces for Aging with Climate Extremes (see Figure 2.1, Table 2.2). While many conceptual frameworks already exist in academic literature, there was a clear gap that did not adequately address the confluence of an aging population, housing, and climate extremes (Molinsky & Forsyth, 2022). The PLACE conceptual framework addresses these existing gaps and informed the entire methodology of this dissertation. The purpose of utilizing the PLACE conceptual framework was to maintain focus on the confluence of aging, housing, and climate extremes. For instance, I used the PLACE framework in this dissertation to:

- develop a thematic codebook for use when analyzing archival data,
- structure questions for a survey sent to older Arizonians,
- identify professionals who participated in key informant semi-structured interviews, and
- provide focus and structure when analyzing data.

In this section, I highlight contributions of my PLACE conceptual framework to the theoretical landscape.

There is growing support for centering the needs of climate vulnerable populations into disaster preparedness planning (Adepoju et al., 2022; Brasher, 2020). This dissertation provides a critically needed conceptual framework that centers the housing needs of older people in order to survive disasters. Exploring components of PLACE provided structural guidance to answer my research questions. For instance, I utilized PLACE to develop survey questions, which involved the integration of the framework's key theories, principles, and concepts. Additionally, the codebook of themes (see Table 3.7) used to analyze both archival transcripts and interview transcripts was created based upon component parts of PLACE. Analyzing the archival data and interview transcripts involved a combination of deductively and inductively coding the written reports following key themes within PLACE. According to Bernard (2011), using an analytic framework is a systematic approach to organizing and analyzing data, which involves identifying key themes and categories in the data and using these to develop a codebook for analysis. Incorporating the established PLACE framework as a guide to data collection—and also as an analytic framework—helped to identify patterns and relationships in the data that could inform further analysis aligned with the core research questions (Bernard, 2011).

Importantly, utilization of the PLACE conceptual framework enabled this research inquiry to remain focused on housing. The physical designs of our homes have a profound impact on older adults' behaviors and well-being (Molinsky & Forsyth, 2022). Key informants interviewed for this study supported the need for academic and applied emphasis on housing.

The primary findings from interviews in this study supported residential building codes continue to follow climate-adaptive best-practice. Requiring that new construction incorporates these residential building codes will thereby fortify homes to the climate risks in an area. Professionals interviewed were especially interested in policy changes for new construction in areas previously destroyed by a disaster, and older Arizonians were primarily interested in information to help retrofit existing homes. This proactive approach—centering housing as both a climate adaptation and healthy aging strategy—not only benefits immediate occupants but also contributes positively to the broader goals of sustainable urban development and inclusive housing policies.

Given the usefulness of PLACE to emphasize housing, it would be a disservice to move attention away from the design of dwellings to focus instead on, for example, infrastructure resilience of roads or the electric grid. Both housing and infrastructure are essential. However, the impacts of housing design are not well understood among climate adaptation professionals (Martín & Arena, 2019). Thus, climate and age adaptive impacts are at risk of being pushed aside to focus instead on neighborhood or regional systems of climate resilience, such as shade trees. Therefore, housing must be woven into our climate solutions and utilization of PLACE is a method to ensure success.

An area for expansion of the PLACE conceptual framework could be a more substantial emphasis on place-based solutions. Since climate adaptive housing materials and tools are quickly emerging due to the growing need to protect people and property from extreme weather, incorporating a formal process for considering the appropriateness of each solution would be helpful in order to offer professionals a guide to use when considering place-based

solutions. A possible example of which can be found at Colorado State University's Institute for the Built Environment via the resource titled *Becoming a Regenerative Practitioner: A Field Guide* (Plaut & Amedée, 2018). This guide offers practitioners of regenerative built environments, a belief that humans and their buildings should co-evolve with their surrounding landscape (Mang & Haggard, 2016), a process to think of each project as part of a whole system. In the case of the PLACE framework, the "process" potion of this guide could offer structure to help practitioners think through the place-based considerations for climate adaptive housing design inclusions (Plaut & Amedée, 2018). This process could be explored within future iterations of the PLACE conceptual framework.

Overall, I found PLACE to be useful throughout the research process, especially for designing the study, collecting data, and analyzing results. PLACE also offers opportunity for potential value to scholars whose research aim is to center the residential needs of our aging population within the context of climate change. Developing a novel framework for this research was necessary to ensure cohesive inclusion of the primary components of the inquiry. As a result, this project produced results that are consistent with the structure of PLACE: aging, housing, and climate extremes. In the next section, I emphasize the practical implications of this dissertation research.

Implications

The results of this dissertation underscore the importance of proactively addressing housing needs of older people in communities prone to extreme heat, as the trend of living and retiring in risk-prone areas continues. In this section, I summarize the potential applications of my findings from this dissertation.

Housing Design

Within this dissertation, the discussion of climate-adaptable housing encompasses a larger matter of residential universal design, simply defined as designing spaces for people of all human abilities throughout the life course (Dolph, 2021). In the context of heat adaptive and age-friendly housing, residential universal design considerations could include at least one home entry without any steps to encourage ease of exit to cooler locations if desired, as well as an automatic and intuitive backup electricity supply to ensure power for medically necessary equipment in the event of a power outage during a heat wave. Incorporating principles of universal design into homes has been shown to increase the personal independence and social connectedness of inhabitants (Pynoos et al., 2009). These outcomes of personal resilience are important contributing factors in disaster survival predictions (Timalsina & Songwathana, 2020).

In other words, the more personal resilience a person possesses, the more likely they are to survive a disaster. In social-ecological systems, resilience describes the capacity of living things to anticipate change and influence future pathways in the face of a disaster (Vazquez-Gonzales et al., 2021). If this goal of resilience is applied to housing, I argue that residential universal design would enhance personal resilience and should be adopted within climate-adaptive building models. The future of housing must accommodate all ages, abilities, and projected climatic changes. If we are fortunate, we will all be older adults continuing to live in this changing world.

Similar to principles of universal design, voluntary housing standards are available for developers to include energy efficiency or passive cooling in home design. These standards focus on creating buildings that maintain comfortable indoor temperatures without extensive

reliance on active heating and cooling systems (Borrallo-Jiménez et al., 2022; Liao & Tam, 2021; Ridley et al., 2013). Key features include high-performing insulation, airtight building envelopes, high-performance windows, and heat recovery ventilation systems (e.g., heat pump or mini-split) that help to affordably control indoor temperatures (Li et al., 2019). Survey results and interviews with older Arizonans from this dissertation research showed that their strongest interest was in improving an existing home's insulation and window seals (e.g., weatherization), as well as affordable and reliable indoor cooling. Furthermore, heat-adaptive housing standards encourage site considerations in new home design to minimize heat intake, including strategic placement of windows to avoid southern exposure (Liao & Tam, 2021). Site considerations were theoretically supported by participants, but many reported that this was out of their control to decide. Lastly, my interviews with professional key informants confirmed that residential adaptations are not limited to structural modifications; personal emergency planning is critical, including contingency locations in case of power outages and ensuring accessible facilities for mobility-restricted family members. All of which underscores the importance of proactively addressing housing design needs of aging populations at high risk for climate impacts.

While I was focused on new construction in my research, the need became clear for affordable suggestions to retro fit existing homes for aging and extreme heat. This was the impetus for a handout (see Appendix E), designed with data from this dissertation research for people aging in places with extreme heat. I have modeled this draft after FEMA's Protect Your Property series; some highlights include a merger of residential adaptations for heat and age-friendly designs for both the interior and exterior of a home; special considerations for pets and your neighbors; and resources for financial assistance in completing these adaptations.

Policy

The idea behind these policy suggestions is to advocate for housing-related changes at a national level; specifically for new housing and retrofitting options to be inclusive of our health needs with both extreme heat and aging. Appendix F offers a sample policy research brief connecting energy policy to needs of an aging population, as informed by this dissertation research. Below are the three policy takeaways from my study:

1. Institute federal requirements for municipalities to update local residential building codes to meet the projected climate and population aging needs for their region.
2. Continue/increase federal support for efforts to offset high electricity costs and enhance residential insulation, for both existing and new construction homes. Support should be linked to the specific needs of older people in the community.
3. The most promising way to adapt people's current homes to extreme heat is to prevent HOAs from restricting health-related changes to people's homes. For example, nationally, HOAs would no longer be allowed to prevent the installation of a window air conditioner or wheelchair ramps.

Policy takeaway 1 offers a suggestion for new construction to meet community needs for local climate and population aging projections. One possible avenue for implementation could be through the U.S. Federal Emergency Management Administration (FEMA). FEMA is a government entity charged with population and infrastructure safety connected with disaster events (Moore, 2018). Prior to FEMA's 2018 Disaster Recovery Reform Act (DRRA), there were no requirements communities needed to rebuild to current building codes after a disaster

event; meaning the only rebuilding requirements came from the insurance provider to build a comparable replacement for what was destroyed (Moore, 2018; Sack & Schwartz, 2018). However, since the DRRA was enacted, the federal government will now fill the financial gap between what insurance will cover and what is needed to build to modern hazard-resilient codes (FEMA-Building Resilient Infrastructure and Communities [FEMA-BRIC], 2022; Kristin Smith, 2023). In addition to post-disaster recovery, FEMA has many resources available for communities to implement climate mitigation through their newly developed BRIC program (Building Resilient Infrastructure and Communities; FEMA-BRIC, 2022). While BRIC is not without fault, noting a complicated application and grant matching requirements among the predominant barriers (Kristin Smith, 2023), policy suggestion 1 could compliment BRIC support. BRIC could not only act as an impetus for rebuilding and mitigating against local environmental hazards, but also to rebuild or mitigate for the local aging population. Meaning, communities would have federal funding and planning support for their local climate hazards as well as their increase in an older population.

A key consideration for this policy suggestion is simply that extreme heat is not currently considered a disaster event, and therefore not eligible for FEMA funding. However, a large group of organizations has recently filed a petition to FEMA requesting that extreme heat (and wildfire smoke) be added to the definition of a major disaster (Center for Biological Diversity, 2024). As explained within the petition,

> This simple but elegant amendment serves to unlock critical funds for state, Tribal, and local governments and communities to manage and mitigate extreme heat and wildfire smoke—both natural catastrophes predicted to worsen in duration, frequency, and severity due to the climate emergency. (Center for Biological Diversity, 2024, pg. 4)

Unlocking FEMA funds to build heat-resilient homes has the potential to dramatically change the survivability outcomes as we age in with heat.

Policy takeaway 2 addresses the direct costs to cool a home and supports continuation of existing programs and services. Many municipalities have established programs to provide financial assistance to pay people's electricity bills, or complete residential weatherization. These programs are essential, as Miller et al. (2017) found that thermal efficiency of housing designed for older people impacts the internal temperatures experienced by older occupants; the decision to use an air conditioner to cool a home is often dictated by the person's finances, rather than their physical health. Since older adults are more likely to live on fixed incomes (Casey & Yamada, 2002; Guvenen et al., 2022), this takeaway highlights the need for energy policies to be linked to the specific needs of older people who are more likely to suffer due to climate stressors.

Policy takeaway 3 focuses on reducing barriers for retrofitting existing homes. As previously discussed, homeowners' associations (HOAs) across the country present barriers for people needing to modify their homes for health and safety. In a recent example of how policy suggestion 3 could work at a local-level, a new law was recently passed within the state of Arizona requiring owners of mobile home parks to allow residents the ability to install shade sails and/or window air conditioners (Faller, 2024). This was a profound victory, since previously residents were prohibited from modifying their mobile homes with these heat-adaptive updates (Arizona State University, 2021). Owners of mobile home communities act as a governing body over the residents, similar to HOA governing boards, and their decisions intended to control the visual cohesion of the community have direct health connections for residents (Harlan et al.,

2013; McKenzie, 2011). Placing legal restrictions on the power of HOAs could enable more people to modify their homes with potentially lifesaving updates.

These policy takeaways are also supported by the PLACE conceptual framework. For instance, the theory of environmental press, a key component of PLACE, is often used to explain how the built environment, including design and layout of neighborhoods, buildings, and infrastructure, can influence the behavior and well-being of individuals (Kendig, 2003). But individuals have little to no control over the design of our built environments, which is a critical component of our lives and impacts energy efficiency, accessibility, and health outcomes as we age (Molinsky & Forsyth, 2022). Climate vulnerability problems for older adults arise from poor design of our built environment (Greenhouse, 2012; Klinenberg, 2002; Lawton, 1977), and the design of our homes directly contributes to climate vulnerability of older adults (Molinsky & Forsyth, 2022). Therefore, residential building codes and policy should reflect an age-friendly response from our dwellings, thereby providing less environmental press as we age. In the context of climate vulnerability for an older age demographic, it means the design and characteristics of residential dwellings can impact the ability of older adults to adapt and cope with the impacts of climate change. Ultimately, if we do not prioritize accessible housing in addition to climate-adaptive housing, we have built U.S. homes that add undue environmental press to our aging bodies, thus directly contributing to people's inability to survive disasters and perpetuating existing problems.

Northern Cities

While the study site chosen for this dissertation was Arizona, translating findings to northern U.S. communities is important for long-range disaster planning. Ultimately, heat is a

threat that will impact everyone and will only amplify as climate change worsens (Harlan et al., 2013; Porter, 2020). Over the next 30 years, 63% of the U.S. population will endure at least three consecutive days of 100-plus degree heat, on average, every year (EPA, 2024b). Cities that have historically experienced mild summers are ill prepared for increased heat (Randazzo et al., 2020), with many homes, schools, and public buildings lacking air conditioning (Porter, 2020). For instance, the state of Minnesota is getting warmer and wetter (Wu et al., 2019), has a growing aging population (Hauser, 2023), and is known as a potential destination to successfully receive an influx of people moving due to a changing climate in their origin location (Steuteville, 2022). As northern states work to understand the challenges ahead and consider solutions, findings of this study suggest that northern cities should be updating their building codes now to require air conditioning in all new construction homes, improve weatherization throughout the home, and offer energy efficient appliances to reduce overall energy consumption. Especially important is the need for more age-friendly housing designs at multiple price-points, which can be accomplished through zoning updates allowing the building of diverse types of housing. Examples of such needed housing include condominiums or smaller single-family and attached townhomes. This research can help decision-makers to center the needs of older people.

New Construction vs. Retrofitting

While this research study was originally focused on understanding adaptive design and policies for new construction only, the need for suggestions to retrofit existing homes for aging and extreme heat became clear during the process of surveying and interviewing older Arizonians. Retrofitting an existing home, for either climate changes or accessibility, is often

prohibitively expensive and involves a different web of decision dependencies and cost considerations (Hill & Martinez-Diaz, 2019). Additionally, homeowners are burdened with the cost of retrofitting, not developers, whose design choices have placed inhabitants in precarious positions to date. On the other hand, new construction offers an opportunity to integrate climate-adaptive and age-friendly features from the ground up, potentially reducing long-term costs for occupants. The housing policy and retrofitting suggestions (see Appendix E) resulting from this research enhance opportunities to adapt existing housing and offer solutions to the way new homes are designed and built. Thus, avoiding the need for homeowners to bear the burden of costly retrofits, which ultimately enables more housing choices as we age. In essence, while retrofitting presents a necessary path for immediate adaptation, this research suggests that new construction offers a strategic avenue to embed resilience and accessibility into the very fabric of our housing infrastructure, promoting a more adaptive and inclusive future. In the next section, I synthesize limitations encountered within this research project and point to value added despite limitations.

Limitations

Limitations are inherent to any research project. I acknowledge that the dataset obtained for each method was limited by broadening the inquiry to a mixed-methods study rather than focusing on one methodology, as well as by not closely partnering with a local Arizona organization. While triangulation of data is useful in gaining a broad breadth of data, it can also limit the depth of information received. For instance, in an effort to constrain the archival dataset to a manageable size, I restricted data collection to Medical Examiner reports for deaths occurring on only the three hottest days in 2022. Expanding the archival dataset to

include many additional reports—perhaps an entire month or one summer season—could have provided further understanding and insights. Additionally, survey limitations included difficulty recruiting people over age 85 who are often underrepresented in surveys (Folta, 2019), participant unfamiliarity with my university, and offering only a digital survey (i.e., inability to capture feedback from older adults who do not actively use computers). Further, self-selection bias may have played a factor, potentially causing only older adults who were interested in this topic to take the survey. Implications of these limitations were most acutely felt within the small number of usable survey responses. Due to the small dataset, I was not able to extrapolate the results in order to generalize about the broader Arizona population.

Despite these limitations, the findings are valuable and facilitated noteworthy insights into connections between the physical home and the death of an older person during days of extreme heat. Specifically, my prolonged engagement with the data provided the opportunity for deep and iterative analysis, which enabled me to identify key findings with confidence. Validity and reliability of findings was enhanced through triangulation of data, which is particularly helpful when compiling data across different methods (Bernard, 2011). Triangulation is a research method used to enhance the validity and reliability of findings by using multiple methods to collect and analyze data; simply put, triangulation is a method of compiling data gathered from multiple sources (Bernard, 2011). Triangulation was useful for this dissertation, as similar results and considerations were highlighted within the archival reports and interviews and in the survey and interviews. In the following section, I offer suggestions for expansion of this study, as well as directions for future research.

Future Research

In this section I offer three new research questions, which I believe could build upon this dissertation research and expand our understanding into aging, heat, and housing. Below each question is a brief discussion of potential usefulness of a new study and suggested methods. Lastly, an additional section considers a broader array of future research considerations.

Future Research Question 1

The first future research question I suggest is: *How do un-housed older adults perceive risks associated with extreme heat?*

While surveying unhoused people was outside the scope of this research, an expanded dataset of surveys and interviews, specifically highlighting voices of un-housed older adults, could offer additional insights into risk perception. Methods to fill this gap include partnering with local outreach organizations, building trust with potential participants, and co-creating participatory research. Since I used a small dataset in this study, results cannot be expanded to infer findings to the broader population. However, this study can be used as a pilot for expansion. Therefore, future research should include collaboration with an organization that holds local name recognition for older participants, which could be a non-profit, local university, or public health department. By partnering with a locally known organization, direct outreach to un-housed older adults could substantially build on our understanding of risk perception of people facing significant heat vulnerability.

Future Research Question 2

The second future research question I suggest is: *Can the climate-adaptive housing component of the PLACE conceptual framework be expanded if PLACE is utilized to research a different climate extreme*?

While the PLACE conceptual framework could be helpful in highlighting any given climate extreme, for this study, extreme heat was chosen. Future research can expand the Preparing Living spaces for Aging with Climate Extremes (PLACE) Framework (see Figure 2.1, Table 2.2) into research on other hazards such as wildfires or inland flooding. Currently, the framework is limited since testing was completed for only one hazard in one location—extreme heat in Arizona. Workshopping handouts and additional disaster preparedness planning with focus groups would also help solidify the PLACE framework, as well as repeating research attempts with PLACE can inform growth of the framework by stretching its capabilities and uncovering gaps in knowledge. Lastly, when preparing the PLACE conceptual framework for publication, expanding upon the risk perception portion with other elements of disaster communication could expand our understanding of the complexity of risk perception.

Future Research Question 3

The third future research question I recommend is: *What insights can be found when user testing with older adults is administered with heat-adaptive housing designs?*

To support heat-adaptive housing that meets the needs of older adults, it is important to gain an in depth understanding of older adults' experience of housing adapted for heat and aging. Combining grounded theory with post occupancy evaluations offers a potential research methodology capable of illuminating the older adult experience in this regard. Grounded theory

is a method in which researchers work with the ultimate goal of constructing an original theory by collecting data, analyzing data, coding data, and then creating a new theory based on the data collected (Birks et al., 2019). Post occupancy evaluations (POEs) are methods used to understand the performance of a building after it is constructed and occupied (Carnemolla et al., 2021), residential POEs focus on the performance of human dwellings rather than a broader array of built structures. Ultimately, this future research study could assess the built environment needs of older adults living in heat-adaptive houses, using a conceptual methodology shaped when integrating POEs and grounded theory. Understanding design considerations of heat vulnerability and aging will help to bridge the gap between significant research and effective real-world applications, and should ideally be done with end users in their homes—where life and death occur.

Additional Future Research Considerations

The handout I created for the general public (see Appendix E) was built using results from the study. However, it has not yet been vetted by older adults who live in areas with extreme heat. Therefore, a next phase of this research would workshop the guide with a group of older people. This workshopping could be completed through a partnership with senior centers in different states and comparing results based on the type of heat (i.e., dry vs. humid heat) each location experiences.

In addition to the two deliverables, policy research brief (see Appendix F) and handout (see Appendix E), an expansion of this study could involve the creation of a guide for practitioners. This guide could provide instruction on how to assess for risk factors of extreme heat in the homes of older adults, and offer suggestion for modifications to help mitigate the

risk. Before beginning a guide, a market research study will be helpful to understand the practitioner need and interest in this type of tool.

Lastly, while this study focused on design and policy considerations for housing, future research could further explore barriers and strategies to overcome them. A primary barrier that emerged from this study emphasized the possible harm caused by restrictions enacted by homeowners' associations, which may limit people's ability to adapt their home to extreme heat or aging. However, not addressed in this study, which was situated in Arizona but of notable concern in other parts of the country, are challenges imposed by home insurance providers. For instance, in preparation for the 2024 hurricane season, property insurance providers serving the state of Florida are rapidly increasing monthly payments or dropping policyholders located in high-risk areas of the state altogether (Edinger, 2024). Also, nationwide property insurers are pulling out of entire states due to increased climate risks to property. Notably, American National Insurance will no longer be insuring properties in the following states: Washington, California, Colorado, South Dakota, Minnesota, Oklahoma, Louisiana, and South Carolina (Mohammed, 2024). In the wake of these insurance vacuums, homeowners are struggling to understand their options while also contending with climate risk. Therefore, next steps for this study could expand into locations of the U.S. experiencing struggles with a sudden change in insurance coverage due to the housing risk posed our changing climate. This exploration could provide insight into decision-making considerations of older residents who face multi-faceted vulnerabilities of aging, extreme weather, and unavailable property insurance.

Conclusion

In an effort to promote U.S. housing policies that ensure newly constructed homes are adaptable to both climate change and our aging population, my dissertation research focused on how older adults' climate vulnerability to extreme heat is connected to residential built environment designs, which may have the potential to save lives of older adults. According to the World Health Organization (2023), "everyone, everywhere" (para. 24) is at risk of climate-amplified disaster events; meaning, disasters generally transcend geographic regions and cultural contexts. However, older individuals face heightened health and adaptation challenges to climate threats due in part to physical changes and limited resources (Filiberto et al., 2023). Tragically, many older disaster victims are found in and around their homes (Keller, 2015; Kelman, 2020; University of Chicago, 2002).

Results from this dissertation research indicate the urgent need for updated housing designs and policies that reflect our aging population and warming climate. Key findings from this dissertation study include:

- Older participants in this study were actively adapting to the heat.
- Older participants and professional key informants were in favor of changing building codes to make homes more energy efficient.
- Perception of personal risk varied based on whether it was an acute or future risk.

Overall, participants in my study reported modifying to their daily actives to avoid the most intense heat. For example, running errands in the early morning, drawing shades to block direct sunlight, using a smart thermostat or having backup air conditioners (for higher income

people), and making difficult choices about when to turn on the AC and use electricity (for lower income people).

Participants expressed support for energy efficient updates to housing design and policy, such as heat pumps or portable air conditioners being either standard or easily available to homeowners and renters. The most readily accepted suggestion from participants was support for changing local building codes to require all new homes be better insulated.

Perception of one's own risk to the heat varied amongst participants. There was an expressed concern among interview participants about leaving the house at all during the day due to the substantial cascading injuries if they might fall in a parking lot—many participants talked about news stories of severe burn victims filling the hospital last summer when they fell in parking lots, simply trying to walk from their car to their destination. However, while everyone was aware of the dangers of the heat, it was rare for someone in my study to acknowledge the possibility of their area losing power during extreme heat. The experts I talked to said it is "when, not if" these areas of Arizona will lose power during days of high heat, and most older residents I talked to expressed no concern and stated "it hasn't happened yet." This highlights the primary implication from this research—an urgent need to update home design and policy. If we are relying primarily on people's perceptions of their own risks to save their lives, we will ultimately fail since people are inclined to stay home to stay safe.

In addition to these key findings, I have summarized specific housing design recommendations for both heat and aging, while connecting each with a corresponding policy suggestion (see Table 5.1).

Table 5.1

Suggested Home Design Updates for Heat and Aging and New Policies Supporting These Updates

Suggested Home Design Updates	New Policies Supporting This Update
Heat	
Enhanced insulation to reduce heat gain and loss: ceiling, walls, around windows, and around doors.	Building codes requiring higher quality residential insulation.
Installation of exterior shade to prevent sun from reaching the home.	City or county program to supply and install residential shade sails; or tax incentives for homeowner installation.
Routine maintenance on air conditioners.	City or county program to complete free or low-cost routine maintenance on air conditioners.
Aging	
At least one no-step entry into each home.	Requirements for building codes to be responsive of population aging needs; ideally by incorporating universal design features in new housing construction.
Wider doorways and hallways to accommodate wheeled mobility devices.	
Varied height storage in kitchen and bathrooms.	
All on main level of home: kitchen, laundry, at least one bedroom and full bathroom.	

An additional overarching policy change I recommend involves restrictions on health-related restrictions enacted by homeowners' associations (HOA). As reviewed in Chapter II, HOAs have substantial legal control over residents and findings from this study indicate that people who live in HOAs would not be able to complete many of the heat-adaptive changes to their homes highlighted in Table 5.1. To address this barrier, I suggest a state-by-state legal change requiring HOAs to allow residents the ability to adapt their homes for heat or aging without

penalty. For example, an HOA would no longer be allowed to deny a person installing a window air conditioner or wheelchair ramp. Alternatively, residents of HOAs should have a clear legal path—through an established 3rd party such as a state mediator—to quickly appeal a decision that would directly affect a resident's health and safety.

Contributions

This dissertation research contributes to the larger scope of knowledge in three ways. First, through inclusion of my PLACE conceptual framework, this dissertation has introduced a new resource to center our residential built environment needs as we age with climate extremes. This framework focuses on the age group most likely to die in disasters (over age 65), in the location they are most likely to be found (in and around the home). Additionally, this mixed-methods study contributes to an emerging body of work exploring homes, climate change, and vulnerable populations. While the majority of current housing designs do not consider the needs of an aging population, nor consider needed changes due to a warming climate, there is growing support for centering voices of climate-vulnerable populations in disaster preparedness planning (Adepoju et al., 2022; Brasher, 2020). Within this dissertation, the needs of local older adults were included within the survey and one-on-one interviews. Interview participants shared an interest in and curiosity about this research, exemplified by this comment from Participant B:

> I think [this research] sounds really, really interesting. What you're putting together here, it makes a lot of sense if you think about it, and most of us don't think about that kind of stuff. We assume that the people that take care of that, are thinking all about it, like what you're doing. And so, I find it really kind of interesting that you're making me think about this. Some of the decisions that we made [when designing the new home] that maybe I didn't even realize that is important to what you're doing right now, but we did it. I'm glad you're trying to gather this information to figure out how you can get people to live more comfortably in the heat and preserve their health.

Finally, creation of the handout (see Appendix E) and policy research brief (see Appendix F) are tangible take-aways that can be easily shared in order to guide future home construction and retrofits for people aging in places with extreme heat. Findings from this dissertation point to the importance of our physical homes in human survivability with extreme heat; based on the insights gathered from each part of this study, I integrated the information to culminate in development of the handout and policy research brief.

Although older people represent the vast majority of climate-amplified disaster victims, our trend of living and retiring in areas prone to climatic risk continues unabated (Greenberg, 2014; Lehner, 2019). As the Baby Boomer generation reaches retirement age, and 10,000 people are turning age 65 in the U.S. daily (Cisneros et al., 2012), it is essential to consider the needs of older adults when building new climate-adaptive housing. In a forward-looking document from the U.S. Census Bureau, authors Vespa et al. (2020) offered population projections up to the year 2060, emphasizing a rapidly aging U.S. population. For instance, 2030 marks a milestone as the year when all Baby Boomers will be over age 65 (Vespa et al., 2020). The authors provided further elaboration on our aging society, stating that "the number of people 85 years and older is expected to nearly double by 2035 (from 6.5 million to 11.8 million) and nearly triple by 2060 to 19 million people" (Vespa et al., 2020, p. 3). Therefore, without a more specific focus on the built environmental needs of all occupants of all income levels, we will perpetuate the creation of housing that disables more people in places of risk.

These projections pose significant consequences for the broader domain of U.S. housing. Survey results from AARP were consistent with my study results, indicating that older adults have strong preferences to remain in their homes and communities of choice, rather

than move to institutional nursing care (Binette & Farago, 2021). Yet, the lack of accessible housing in the U.S. severely limits the choices available as we age (Scheckler et al., 2022). Due to the lack of accessible housing options for new construction, and financial difficulty common with retrofitting for age or a changing climate (Scheckler et al., 2022), the majority of the current housing stock in the U.S. places older adults at risk of injury or death during a disaster event. Writer and researcher on disability and climate change, Julia Watts Belser (2019) at Georgetown University, reminded us that:

> If we persist in framing disability and climate change as a problem of physical vulnerability, we miss the underlying realities of structural violence: how ableism, racism, class inequality, and other forms of oppression work together to compound and intensify risk. (p. 1)

Essentially, vulnerability to climate change is not the results of a person living with disabilities. Rather, climate vulnerability is caused by design and policy decisions that alienate people with disabilities within their own homes. Since we are all aging on our changing planet, building age-friendly climate-adaptive housing will benefit everyone, eventually.

References

AARP. (2021). *AARP HomeFit Guide*. https://www.aarp.org/livable-communities/housing/info-2020/homefit-guide-download.html

Abatzoglou, J. T., & Williams, A. P. (2016). Impact of anthropogenic climate change on wildfire across western US forests. *Proceedings of the National Academy of Sciences*, *113*(42), 11770–11775. https://doi.org/10.1073/pnas.1607171113

Absolon, K. E. (2011). *Kaandossiwin: How we come to know Indigenous research methodologies*. Fernwood Publishing.

Abt Associates. (2023). *HUD Community Resilience Toolkit*. U.S. Department of Housing and Urban Development. https://www.hudexchange.info/resource/5981/community-resilience-toolkit/

Aburto, J. M., Villavicencio, F., Basellini, U., Kjærgaard, S., & Vaupel, J. W. (2020). Dynamics of life expectancy and life span equality. *Proceedings of the National Academy of Sciences*, *117*(10), 5250–5259. https://doi.org/10.1073/pnas.1915884117

Adams R. M., Evans, C. M., Peek, L. (2021, April). *Broader ethical considerations for hazards and disaster researchers* [Training module]. CONVERGE Natural Hazards Center at University of Colorado Boulder. https://converge.colorado.edu/resources/training-modules

Adepoju, O. E., Herrera, L., Chae, M., & Han, D. (2022). Optimizing disaster preparedness planning for minority older adults: One size does not fit all. *International Journal of Environmental Research and Public Health*, *20*(1), 401. https://doi.org/10.3390/ijerph20010401

Adger, W. N., & Kelly, P. M. (1999). Social vulnerability to climate change and the architecture of entitlements. *Mitigation and Adaptation Strategies for Global Change*, *4*(3), 253–266. https://doi.org/10.1023/A:1009601904210

Akbari, H., Gartland, L., & Konopacki, S. (1998). Measured energy savings of light colored roofs: Results from three California demonstration sites (Report No. LBNL-41907). *Lawrence Berkeley National Library*. https://escholarship.org/uc/item/9dj295gj

Aleksić, J., Kosanović, S., Tomanović, D., Grbić, M., & Murgul, V. (2016). Housing and climate change-related disasters: A study on architectural typology and practice. *Procedia Engineering*, *165*, 869–875. https://doi.org/10.1016/j.proeng.2016.11.786

Alexandri, E., & Jones, P. (2008). Temperature decreases in an urban cnayon due to green walls and green roofs in diverse climates. *Building & Environment*, *43*(4), 480–493. https://doi.org/10.1016/j.buildenv.2006.10.055

Allen, J. S. (2015). *Home: How human habitat made us human.* Basic Books.

America Counts Staff. (2019, December 10). *2020 Census Will Help Policymakers Prepare for the Incoming Wave of Aging Boomers*. United States Census Bureau. https://www.census.gov/library/stories/2019/12/by-2030-all-baby-boomers-will-be-age-65-or-older.html

American Red Cross. (n.d.). *Extreme heat safety*. https://www.redcross.org/get-help/how-to-prepare-for-emergencies/types-of-emergencies/extreme-heat-safety.html

Anthoney, S. F. (2011). *Students in context: Effects of psychological needs and environmental press on academic and life satisfaction* (Publication No. 3462989) [Doctoral dissertation, Iowa State University]. ProQuest Dissertations & Theses Global. https://www.proquest.com/docview/894983320/abstract/838DA6111DB0463DPQ/1

Applewhite, A. (2016). *This chair rocks: A manifesto against ageism.* Celadon Books.

Applied Technology Institute. (2016). *Critical assessment of lifeline systems performance: Understanding societal needs in disaster recovery* (Report No. NIST GCR 16-917-39). U.S. Department of Commerce, National Institute of Standards and Technology. http://doi.org/10.6028/NIST.GCR.16-917-39

Arigoni, D. (2023). *Climate resilience for an aging nation*. Island Press.

Arizona State University. (2021, February 18). *How the deadliest hazard kills mobile home residents* [ArcGIS StoryMap]. ASU Knowledge Exchange for Resilience. https://storymaps.arcgis.com/stories/84e07969829945cb9968151a5c1b2b76

Ash, K. D., Egnoto, M. J., Strader, S. M., Ashley, W. S., Roueche, D. B., Klockow-McClain, K. E., Caplen, D., & Dickerson, M. (2020). Structural forces: Perception and vulnerability factors for tornado sheltering within mobile and manufactured housing in Alabama and Mississippi. *Weather, Climate, and Society*, *12*, 453–472. https://doi.org/10.1175/WCAS-D-19-0088.1

Asseng, S., Spänkuch, D., Hernandez-Ochoa, I. M., & Laporta, J. (2021). The upper temperature thresholds of life. *The Lancet Planetary Health*, *5*(9), e378–e385. https://doi.org/10.1016/S2542-5196(21)00079-6

Associated Press. (2022, October 25). Deadliest summer for heat-related deaths in Arizona's biggest county. *The Guardian*. https://www.theguardian.com/us-news/2022/oct/25/arizona-heat-related-deaths-summer-maricopa-county

Augello, J. (n.d.). *ADA and accessibility: What's the difference*? National Association of Homebuilders. https://www.nahb.org/advocacy/legal-issues/accessibility/ada-and-accessibility-whats-the-difference

AZFamily Digital News Staff. (2023, May 25). *4 heat-related deaths reported in Maricopa County so far this year*. Arizona's Family. https://www.azfamily.com/2023/05/26/4-heat-related-deaths-reported-maricopa-county-so-far-this-year/

Babaizadeh, H., Haghighi, N., Asadi, S., Broun, R., & Riley, D. (2015). Life cycle assessment of exterior window shadings in residential buildings in different climate zones. *Building and Environment*, *90*, 168–177. https://doi.org/10.1016/j.buildenv.2015.03.038

Bagenstos, S. R. (2020). The ADA Amendments Act and the projects of the American disability rights movement. *University of the District of Columbia Law Review*, *23*, 139.

Batchelor, M. (2024, April). *2023 Heat related deaths report*. Maricopa County Department of Public Health Division of Epidemiology and Informatics. https://www.maricopa.gov/ArchiveCenter/ViewFile/Item/5820

Bear, J. (2015, June 5). 'We're all alive': Tornado-rattled residents near Berthoud begin clean- up. *Loveland Reporter-Herald*. https://www.reporterherald.com/ci_28256115/berthoudtornadoes-destroy-3-damage-12-homes

Behera, J. K. (2021). Role of social capital in disaster risk management: A theoretical perspective in special reference to Odisha, India. *International Journal of Environmental Science and Technology*, *20*, 3385–3394. https://doi.org/10.1007/s13762-021-03735-y

Belser, J. W. (2019, September 20). *Disabled people cannot be "expected losses" in the climate crisis* [Op-ed]. Truthout. https://truthout.org/articles/disabled-people-cannot-be-expected-losses-in-the-climate-crisis/

Benford, R., Barr, S., Kain, N., & Ratajcyzk, E. (2019). *Colorado lifelong homes: A review of barriers and solutions for aging in place* [White paper]. Colorado State University Institute for the Built Environment. https://ibe.colostate.edu/wp-content/uploads/2019/04/LifeLongHomeWhitepaper_2019_FINAL_corrected.pdf

Bernard, H. R. (2011). *Research methods in anthropology: Qualitative and quantitative approaches* (5th ed.). AltaMira Press.

Bernardin-Haldemann, V. (1988). Ecology and aging: A critical review. *Canadian Journal on Aging*, *7*(4), 458–471. https://eric.ed.gov/?id=EJ390144

Binette, J., & Farago, F. (2021). *2021 Home and Community Preference Survey: A national survey of adults age 18-plus.* AARP Research. https://doi.org/10.26419/res.00479.001

Birks, M., Hoare, K., & Mills, J. (2019). Grounded theory: The FAQs. *International Journal of Qualitative Methods*, *18*. https://doi.org/10.1177/1609406919882535

Black-Plumeau, L. (2015, July 22). *Less than one percent of U.S. housing is wheel chair accessible*. Vermont Housing Finance Agency. https://www.vhfa.org/news/blog/less-one-percent-us-housing-wheel-chair-accessible

Blackwell, M. S. A. (2022). Blueprint for phosphorus efficiency. *Nature Sustainability*, *6*, 128–129. https://doi.org/10.1038/s41893-022-01001-8

Bolli, R., Jr., & Asada, H. H. (2023). A data-driven approach to positioning grab bars in the sagittal plane for elderly persons. *National Science Foundation National Robotics Initiative*. https://doi.org/10.48550/arXiv.2306.05343

Borrallo-Jiménez, M., LopezDeAsiain, M., Esquivias, P. M., & Delgado-Trujillo, D. (2022). Comparative study between the passive house standard in warm climates and nearly zero energy buildings under Spanish Technical Building Code in a dwelling design in Seville, Spain. *Energy and Buildings*, *254*, Article 111570. https://doi.org/10.1016/j.enbuild.2021.111570

Borunda, A. (2024, June 11). *Here's why an Arizona medical examiner is working to track heat-related deaths.* NPR. https://www.npr.org/2024/05/30/nx-s1-4854224/death-heat-arizona-climate-change-medical-examiner

Brasher, K. (2020). *An age-friendly approach to disaster recovery*. Central Hume Primary Care Partnership. https://extranet.who.int/agefriendlyworld/wp-content/uploads/2020/05/AgeFriendlyApproachToDisasterRecovery.pdf

Broikos, C., & Stanton, M. (Eds.). (2019). *Making room: Housing for a changing America*. AARP. https://www.gacities.com/GMASite/media/PDF/AARP-making-room.pdf

Browne, K. E., & Even, T. (2018). The 'Culture of Disaster' student immersion project: First-Hand research to learn about disaster recovery after a Colorado flood. *International Journal of Mass Emergencies and Disasters*, *36*(3), 264–286. https://doi.org/10.1177/028072701803600305

Browne, K. E., O'Connell, C., & Yoder, L. M. (2018). Journey through the Groan Zone with academics and practitioners: Bridging conflict and difference to strengthen disaster risk reduction and recovery work. *International Journal of Disaster Risk Science*, *9*(3), 421–428. https://doi.org/10.1007/s13753-018-0180-y

Brunkard, J., Namulanda, G., & Ratard, R. (2008). Hurricane Katrina deaths, Louisiana, 2005. *Disaster Medicine and Public Health Preparedness*, *2*(4), 215–223. https://doi.org/10.1097/DMP.0b013e31818aaf55

Burgdorf, R. L., Jr. (1991). The Americans with Disabilities Act: Analysis and implications of a second-generation Civil Rights statute. *Harvard Civil Rights-Civil Liberties Law Review*, *26*, 413.

Burgess, K., & Foster, E. (2019). *Scorched: Extreme heat and real estate*. Urban Land Institute. https://developingresilience.uli.org/themes/extreme-heat/

Burlotos, A., Dresser, C., & Shandas, V. (2023). Portland's response to the Western North American heatwave: A brief report. *Disaster Medicine and Public Health Preparedness*, *17*, Article e522. https://doi.org/10.1017/dmp.2023.184

Caplan, Z. (2023, May 25). *U.S. older population grew from 2010 to 2020 at fastest rate since 1880 to 1890*. United States Census Bureau. https://www.census.gov/library/stories/2023/05/2020-census-united-states-older-population-grew.html

Carnemolla, P., Debono, D., Hourihan, F., Hor, S., Robertson, H., & Travaglia, J. (2021). The influence of the built environment in enacting a household model of residential aged care for people living with a mental health condition: A qualitative post-occupancy evaluation. *Health & Place*, *71*, Article 102624. https://doi.org/10.1016/j.healthplace.2021.102624

Carney, G. M., & Gray, M. (2015). Unmasking the 'elderly mystique': Why it is time to make the personal political in ageing research. *Journal of Aging Studies*, 35, 123–134. https://doi.org/10.1016/j.jaging.2015.08.007

Casey, B., & Yamada, A. (2002). Getting older, getting poorer? A study of the earnings, pensions, assets and living arrangements of older people in nine countries. *OECD Labour Market and Social Policy Occasional Papers*, *60*. https://doi.org/10.1787/345816633534

The Center for an Accessible Society. (2003, December 23). *Nation's first "visibility" law withstands court challenge*. http://www.accessiblesociety.org/topics/housing/pimacoruling.html

Center for Biological Diversity. (2024, June 17). *Before the Federal Emergency Management Agency: Petition for rulemaking, pursuant to the Administrative Procedure Act, to include extreme heat and wildfire smoke as major disasters under the Stafford Act*. https://www.biologicaldiversity.org/programs/energy-justice/pdfs/EMBARGOED_FEMA-Petition-on-Heat-and-Wildfire-Smoke.pdf

Center for Climate and Energy Solutions. (2019, April). *What is climate resilience and why does it matter*? https://www.c2es.org/wp-content/uploads/2019/04/what-is-climate-resilience.pdf

Center for Inclusive Design and Environmental Access. (2010). *Inclusive housing, a pattern book: Design for diversity and equality*. W. W. Norton & Company.

Centers for Disease Control and Prevention. (2017). *Check for safety*: *A home fall prevention checklist for older adults*. https://www.cdc.gov/steadi/pdf/steadi-brochure-checkforsafety-508.pdf

Centers for Disease Control and Prevention. (2022, July 15). *Disability impacts all of us* [Fact sheet]. https://www.cdc.gov/ncbddd/disabilityandhealth/infographic-disability-impacts-all.html

Centers for Disease Control and Prevention. (2024, February 19). *Preventing heat-related illness*. https://www.cdc.gov/extreme-heat/prevention/?CDC_AAref_Val=https://www.cdc.gov/disasters/extremeheat/heattips.html

Chan, E. Y. Y. (2020). *Disaster public health and older people.* Routledge.

Cheitlin, M. D. (2003). Cardiovascular physiology—Changes with aging. *The American Journal of Geriatric Cardiology*, *12*(1), 9–13. https://doi.org/10.1111/j.1076-7460.2003.01751.x

Chen, Y., Li, S., & He, R. (2022). Can social media data be freely used? Participants' ethical perceptions toward using their social media data in research. *Social Science Information*, *61*(2–3), 297–317. https://doi.org/10.1177/05390184221101972

Chernikoff, S. & Lee, M. (2024, July 10). The cost of staying cool: How extreme heat is costing Americans more than ever. *USA Today*. https://www.usatoday.com/story/news/nation/2024/07/10/extreme-heat-cost-climate-change/74341171007/

Chun, E., & Evans, A. (2021). *Leveraging multigenerational workforce strategies in higher education*. Routledge. https://doi.org/10.4324/9781003150381-6

Cisneros, H., Dyer-Chamberlain, M., & Hickie, J. (Eds.). (2012). *Independent for life: Homes and neighborhoods for an aging America*. University of Texas Press.

Clark, W. A. (2021). *Advanced introduction to housing studies.* Edward Elgar Publishing Limited.

Clark, W. A., & Lisowski, W. (2017). Prospect theory and the decision to move or stay. *Proceedings of the National Academy of Sciences of the United States of America*, *114*(36), E7432–E7440.

Clarke, R. (1973). *Ellen Swallow: The woman who founded ecology*. Follett Publishing.

Clarke, W., & Freedman, M. (2019). The rise and effects of homeowners associations. *Journal of Urban Economics*, *112*, 1–15. https://doi.org/10.1016/j.jue.2019.05.001

Clemson, L., Stark, S., Pighills, A. C., Torgerson, D. J., Sherrington, C., & Lamb, S. E. (2019). Environmental interventions for preventing falls in older people living in the community. *The Cochrane Database of Systematic Reviews*. https://doi.org/10.1002/14651858.CD013258

Climate Mapping for Resilience and Adaptation. (n.d.). *Climate mapping for resilience and adaptation*. https://resilience.climate.gov/

Community Associations Institute (2023). *2023 U.S. national and state statistical review*. Foundation for Community and Association Research. https://foundation.caionline.org/wp-content/uploads/2024/01/2023StatsReviewDigital-002.pdf

Connell, B. R., Jones, M., Mace, R. L., Mueller, J., Mullick, A., Ostroff, E., Sanford, J., Steinfeld, E., Story, M. & Vanderheiden, G. (1997). *The principles of universal design*. N.C. State University, The Center for Universal Design. https://web.stanford.edu/class/engr110/2007/PUD.pdf

CoreLogic. (2022, February 17). *CoreLogic climate change catastrophe report estimates 1 in 10 U.S. residential properties impacted by natural disasters in 2021*. Business Wire. https://www.businesswire.com/news/home/20220217005368/en/CoreLogic-Climate-Change-Catastrophe-Report-Estimates-1-in-10-U.S.-Residential-Properties-Impacted-by-Natural-Disasters-in-2021

Cornell, V. J., Cusack, L., & Arbon, P. (2012). Older people and disaster preparedness: A literature review. *Australian Journal of Emergency Management*, *27*(3), 49–53. https://www.humanitarianlibrary.org/sites/default/files/2019/09/45.pdf

Costanza-Chock, S. (2020). *Design Justice: Community-Led practices to build the worlds we need*. MIT Press. https://doi.org/10.7551/mitpress/12255.001.0001

Crimmins, M., Guido, Z., & McMahan, B. (2022, August). *Guide to Southwest U.S. station climate summaries*. University of Arizona Cooperative Extension.

Cvitkovich, M. Y., & Wister, A. V. (2002). Bringing in the life course: A modification to Lawton's ecological model of aging. *Hallym International Journal of Aging*, *4*(1), 15–29.

Dabaieh, M. (2011). *A future for the past of desert vernacular architecture: Testing a novel conservation model and applied methodology in the town of Balat in Egypt* [Doctoral dissertation, Lund University]. Research Portal at Lund University. https://portal.research.lu.se/en/publications/a-future-for-the-past-of-desert-vernacular-architecture

Daddoust, L., Khankeh, H., Ebadi, A., Sahaf, R., Nakhaei, M., & Asgary, A. (2018). The social vulnerability of older people to natural disasters: An integrative review. *Health in Emergencies and Disasters Quarterly*, *4*(1), 5–14. https://doi.org/10.32598/hdq.4.1.5

Daniels, C., & Simpson, M. (2021). *City for the future: Resilient, equitable and regenerative* [Research document 051121]. Center for Climate Preparedness and Community Resilience. https://communityresilience-center.org/wp-content/uploads/2024/02/City_for_Future-Resilient-Equitable-and-Regenerative-2021.pdf

Dare, R. (2021). A system dynamics model to facilitate the development of policy for urban heat island mitigation. *Urban Science*, *5*(1), Article 19. https://doi.org/10.3390/urbansci5010019

Das, S., Ghosh, A., Hazra, S., Ghosh, T., Safra de Campos, R., & Samanta, S. (2020). Linking IPCC AR4 & AR5 frameworks for assessing vulnerability and risk to climate change in the Indian Bengal Delta. *Progress in Disaster Science*, *7*, Article 100110. https://doi.org/10.1016/j.pdisas.2020.100110

DeCastellarnau, A. (2017). A classification of response scale characteristics that affect data quality: A literature review. *Quality & Quantity*, *52*(4), 1523–1559. https://doi.org/10.1007/s11135-017-0533-4

de Leeuw, E. D. (2011, May 10–12). *Improving data quality when surveying children and adolescents: Cognitive and social development and its role in questionnaire construction and pretesting* [Paper presentation]. Annual Meeting of the Academy of Finland: Research Programs, Public Health Challenges, and Health and Welfare of Children and Young People, Naantali, Finland. https://www.aka.fi/globalassets/tietysti1.fi/awanhat/documents/tiedostot/lapset/presentations-of-the-annual-seminar-10-12-may-2011/surveying-children-and-adolescents_de-leeuw.pdf

Deleuze, G., & Guattari, F. (1987). *A thousand plateaus: Capitalism and schizophrenia* (B. Massumi, Trans.). University of Minnesota Press. (Original work published 1980)

Department of Economic and Social Affairs. (2011). *Current status of the social situation, well-being, participation in development and rights of older persons worldwide.* United Nations. https://www.un.org/esa/socdev/ageing/documents/publications/current-status-older-persons.pdf

Doeske, N. D., Pielke, R. A., Sr., & Bliss, O. A. (2003, January). *Climate of Colorado*. Colorado Climate Center at Colorado State University. https://climate.colostate.edu/climate_long.html

Dolph, E. (2021). The developing definition of universal design. *Journal of Accessibility and Design for All*, *11*(2), 178–194. https://doi.org/10.17411/jacces.v11i2.263

Dominelli, L. (2012). *Green social work: From environmental crises to environmental justice*. Polity Press.

Economic and Social Commission for Asia and the Pacific. (2022, June 1). *Climate change and population ageing in the Asia-Pacific region: Status, challenges and opportunities* [Policy brief]. United Nations. https://www.unescap.org/kp/2022/climate-change-and-population-ageing-asia-pacific-region-status-challenges-and

Edinger, M. (2024, July 23). *Why so many insurance companies are dropping Florida homeowners*. FOX 35 Orlando. https://www.fox35orlando.com/news/why-so-many-insurance-companies-dropping-florida-homeowners

Edwards, N., Dulai, J., & Rahman, A. (2019). A scoping review of epidemiological, ergonomic, and longitudinal cohort studies examining the links between stair and bathroom falls and the built environment. *International Journal of Environmental Research and Public Health*, *16*(9). Article 1598. https://doi.org/10.3390/ijerph16091598

Ellard, C. (2015). *Places of the heart: The psychogeography of everyday life.* Bellevue Literary Press.

Environmental Protection Agency. (2024a, April 17). *Reduce urban heat island effect.* https://www.epa.gov/green-infrastructure/reduce-urban-heat-island-effect

Environmental Protection Agency. (2024b, June 27). *Climate change indicators: Heat waves*. https://www.epa.gov/climate-indicators/climate-change-indicators-heat-waves

Environmental Protection Agency & Centers for Disease Control and Prevention. (2016). *Climate change and extreme heat: What you can do to prepare*. https://www.epa.gov/sites/default/files/2016-10/documents/extreme-heat-guidebook.pdf

Epstein, G., Vogt, J. M., Mincey, S. K., Cox, M., & Fischer, B. (2013). Missing ecology: Integrating ecological perspectives with the social-ecological system framework. *International Journal of the Commons*, *7*(2), 432–453. https://www.jstor.org/stable/26523137

Eskinasi, M. (2014). *Towards housing system dynamics: Projects on embedding system dynamics in housing policy research* [Doctoral dissertation, Radboud University]. Eburon Academic Publishers. https://hdl.handle.net/2066/129859

Faller, M. B. (2024, April 11*). ASU team's research leads to new law protecting mobile-home dwellers*. ASU News. https://news.asu.edu/20240411-environment-and-sustainability-asu-teams-research-leads-new-law-protecting-mobilehome

Faurie, C., Varghese, B. M., Liu, J., & Bi, P. (2022). Association between high temperature and heatwaves with heat-related illnesses: A systematic review and meta-analysis. *Science of the Total Environment*, *852*, Article 158332. https://doi.org/10.1016/j.scitotenv.2022.158332

Federal Emergency Management Agency. (2020, November). *Building codes save: A nationwide study.* U.S. Department of Homeland Security. https://www.fema.gov/sites/default/files/2020-11/fema_building-codes-save_study.pdf

Federal Emergency Management Agency. (2022). *Mitigation assistance: Building resilient infrastructure and communities* (Policy FP-104-008-05). https://www.fema.gov/sites/default/files/documents/fema_bric-policy-fp-008-05_program_policy.pdf

Federal Emergency Management Agency & AARP. (2022, May 18). *Guide to expanding mitigation: Making the connection to older adults.* https://www.fema.gov/sites/default/files/documents/fema_mitigation-guide_older-adults.pdf

Ferreira, A. F., Zimmermann, H., Santos, R., & von Wehrden, H. (2018). A social-ecological systems framework as a tool for understanding the effectiveness of biosphere reserve management. *Sustainability*, *10*(10), Article 3608. https://doi.org/10.3390/su10103608

Ferrucci, L., Cooper, R., Shardell, M., Simonsick, E. M., Schrack, J. A., & Kuh, D. (2016). Age-Related change in mobility: Perspectives from life course epidemiology and geroscience. *The Journals of Gerontology: Series A*, *71*(9), 1184–1194. https://doi.org/10.1093/gerona/glw043

Filiberto, D., Wells, N., Wethington, E., Pillemer, K., & Wysocki, M. (2023). *Climate change, vulnerability and health effects: Implications for the older population* [Working paper]. https://www.researchgate.net/publication/265265398

Fineman, M. A. (2010). The vulnerable subject and the responsive state. *Emory Law Journal*, *60*, Article 251. https://scholarlycommons.law.emory.edu/elj/vol60/iss2/1/

Fineman, M. A. (2019, August 26). Understanding vulnerability theory. *Vulnerability and the Human Condition, Emory University Scholar Blogs*. https://scholarblogs.emory.edu/vulnerability/2019/08/26/understanding-vulnerability-theory/

Flavelle, C. (2023, July 18). As climate shocks multiply, designers seek holy grail: Disaster-Proof homes. *The New York Times*. https://www.nytimes.com/2023/07/16/climate/climate-geodesic-dome-house.html

Flavelle, C., & Healy, J. (2023, June 1). Arizona limits construction around Phoenix as its water supply dwindles. *The New York Times*. https://www.nytimes.com/2023/06/01/climate/arizona-phoenix-permits-housing-water.html

Fleming, W., King, B., Robinson, K., Wade, E., Erickson, B., Delie, J., de Ycaza, R., Trimbach, D., Spalding, A., & Biedenweg, K. (2022). Is there no "I" in team? Potential bias in key informant interviews when asking individuals to represent a collective perspective. *PLOS ONE*, *17*(1), Article e0261452. https://doi.org/10.1371/journal.pone.0261452

Florida Department of Law Enforcement. (n.d.). *Medical Examiners Commission*. Retrieved May 14, 2023, from https://www.fdle.state.fl.us/MEC

Florido, A. (2018, October 18). *Why stay during a hurricane? because it's not as simple as "get out.*" NPR. https://www.npr.org/2018/10/18/658258370/why-stay-during-a-hurricane-because-its-not-as-simple-as-get-out

Folta, S. C. (2019). *Recruitment and retention of older adults in research studies* [Online course]. Tufts University Clinical and Translational Science Institute. https://ilearn.tuftsctsi.org/product?catalog=IUPR101_2018_Online

FrameWorks Institute. (2017, April 7). *Framing strategies to advance aging and address aging as policy issues.* https://www.frameworksinstitute.org/wp-content/uploads/2020/05/aging_frame_brief.pdf

Franits, L. E. (2005). Nothing about us without us: Searching for the narrative of disability. *American Journal of Occupational Therapy*, *59*(5), 577–579. https://doi.org/10.5014/ajot.59.5.577

Franklin, J. (2023, September 28). *Some don't evacuate, despite repeated hurricane warnings, because they can't*. NPR. https://www.npr.org/2022/09/28/1125448849/why-people-dont-evacuate-hurricane-ian-florida

Fraser, E. D., & Stringer, L. C. (2009). Explaining agricultural collapse: Macro-Forces, micro-crises and the emergence of land use vulnerability in southern Romania. *Global Environmental Change*, *19*(1), 45–53. https://doi.org/10.1016/j.gloenvcha.2008.11.001

Gabbe, C. J., Chang, J. S., Kamson, M., & Seo, E. (2023). Reducing heat risk for people experiencing unsheltered homelessness. *International journal of disaster risk reduction*, *96*, Article 103904. https://doi.org/10.1016/j.ijdrr.2023.103904

Gallego, K. (2023, April 27). *Towards a more resilient Phoenix: How one desert city is tackling extreme heat challenges.* International Institute for Sustainable Development. https://sdg.iisd.org:443/commentary/guest-articles/towards-a-more-resilient-phoenix-how-one-desert-city-is-tackling-extreme-heat-challenges/

Galtung, J. (1969). Violence, peace, and peace research. *Journal of Peace Research*, *6*(3), 167–191. https://doi.org/10.1177/002234336900600301

Gibberd, J. T. (2020). Climate change in the built environment: Addressing future climates in buildings. In S. Mostafa & P. Rahnamayiezekavat (Eds.), *Claiming identity through redefined teaching in construction programs* (pp. 100–121). IGI Global. https://doi.org/10.4018/978-1-5225-8452-0.ch006

Gilmore, R. W. (2008). Forgotten places and the seeds of grassroot planning. In C. R. Hale (Ed.), *Engaging contradictions: Theory, politics, and methods of activist scholarship* (pp. 31–61). University of California Press.

Gilmore, R. W. (2010). Fatal couplings of power and difference: Notes on racism and geography. *The Professional Geographer*, *54*(1), 15–24. https://doi.org/10.1111/0033-0124.00310

Golder, S., Ahmed, S., Norman, G., & Booth, A. (2017). Attitudes toward the ethics of research using social media: A systematic review. *Journal of Medical Internet Research*, *19*(6), Article e195. https://doi.org/10.2196/jmir.7082

Goldhagen, S. W. (2017). *Welcome to your world: How the built environment shapes our lives.* Harper Collins.

Gonzalez, J. (2024, May 3). *The 10 best places to retire in Oregon*. New Home Source. Retrieved February 2021, from https://www.newhomesource.com/learn/best-places-retire-oregon/

Goodell, J. (2023). *The heat will kill you first: Life and death on a scorched planet.* Little, Brown and Company.

Gourevitch, J. D., Kousky, C., Liao, Y., Nolte, C., Pollack, A. B., Porter, J. R., & Weill, J. A. (2023). Unpriced climate risk and the potential consequences of overvaluation in US housing markets. *Nature Climate Change*, *13*(3), 250–257. https://doi.org/10.1038/s41558-023-01594-8

Granneman, S. (2006, May 30). *The tyranny of HOAs*. GranneBlog. https://blog.granneman.com/2006/05/30/the-tyranny-of-hoas/

Grech, E., Longbottom, E., Yee, J., Hastings, R., Aitkenhead, A., Cason, A., Obrecht, K., & Currie, J. (2022). Scoping review of the application of the Behavioural Model for Vulnerable Populations to people experiencing homelessness. *Journal of Social Distress and Homelessness*, *33*(1), 50–64. https://doi.org/10.1080/10530789.2022.2130590

Greenberg, M. R. (2014). *Protecting seniors against environmental disasters: From hazards and vulnerability to prevention and resilience.* Routledge.

Greenhouse, E. (2012). The home and environment for aging. In H. Cisneros, M. Dyer-Chamberlain, & J. Hickie (Eds.), *Independent for life: Homes and neighborhoods for an aging America* (pp. 87–98). University of Texas Press. https://www.jstor.org/stable/10.7560/737914.12

Guvenen, F., Kaplan, G., Song, J., & Weidner, J. (2022). Lifetime earnings in the United States over six decades. *American Economic Journal: Applied Economics*, *14*(4), 446–479. https://doi.org/10.1257/app.20190489

Hall, A., McLennan, J., Marques, M. D., & Bearman, C. (2022). Conceptualizing and measuring householder bushfire (wildfire) risk perception: The householder bushfire risk perception scale (HBRPS-4). *International Journal of Disaster Risk Reduction*, *67*, Article 102667. https://doi.org/10.1016/j.ijdrr.2021.102667

Hamstead, Z. A. (2023). Critical heat studies: Deconstructing heat studies for climate justice. *Planning Theory & Practice*, *24*(2), 153–172. https://doi.org/10.1080/14649357.2023.2201604

Harlan, S. L., Declet-Barreto, J. H., Stefanov, W. L., & Petitti, D. B. (2013). Neighborhood effects on heat deaths: Social and environmental predictors of vulnerability in Maricopa County, Arizona. *Environmental Health Perspectives*, *121*(2), 197–204. https://doi.org/10.1289/ehp.1104625

Hauser, T. (2023, August 24). *Minnesota policymakers plan for a rapidly aging population*. KSTP.com Eyewitness News. https://kstp.com/kstp-news/top-news/minnesota-policymakers-plan-for-a-rapidly-aging-population/

Heidari, A., Taghipour, M., & Yarmahmoodi, Z. (2021). The effect of fixed external shading devices on daylighting and thermal comfort in residential building. *Journal of Daylighting*, *8*(2), 165–180. https://dx.doi.org/10.15627/jd.2021.15

Hill, A. C., & Martinez-Diaz, L. (2019). *Building a resilient tomorrow: How to prepare for the coming climate disruption.* Oxford University Press.

Insurance Institute for Business and Home Safety. (2021, November). *Suburban wildfire adaptation roadmaps: A path to coexisting with wildfires*. https://ibhs.org/wp-content/uploads/member_docs/ibhs-suburban-wildfire-adaptation-roadmaps.pdf

Intergovernmental Panel on Climate Change. (2007). Climate change 2007: Impacts, adaptation and vulnerability. In M. Parry, O. Osvaldo, J. Palutikof, P. van der Linden, & C. Hanson (Eds.), *Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press.

Intergovernmental Panel on Climate Change. (2019). Summary for policymakers. In H.-O. Pörtner, D. C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K.

Mintenbeck, A. Alegría, M. Nicolai, A. Okem, B. Rama, N. M. Weyer (Eds.), *IPCC special report on the ocean and cryosphere in a changing climate*. Cambridge University Press. https://doi.org/10.1017/9781009157964.001

Intergovernmental Panel on Climate Change. (2023). Summary for policymakers. In H.-O. Pörtner, D. C. Roberts, E. S. Poloczanska, K. Mintenbeck, A. Algería, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, & B. Rama (Eds.), *Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press. https://doi.org/10.1017/9781009325844.001

Israel, T. (2003). *Some place like home: Using design psychology to create ideal places*. Wiley.

Iverson, S. A., Gettel, A., Bezold, C. P., Goodin, K., McKinney, B., Sunenshine, R., & Berisha, V. (2020). Heat-Associated mortality in a hot climate: Maricopa County, Arizona, 2006–2016. *Public Health Reports*, *135*(5), 631–639. https://doi.org/10.1177/0033354920938006

Jackson, C. (2021, November 12). What does it take to build a disaster-proof house? *The New York Times*. https://www.nytimes.com/2021/11/12/realestate/disaster-proof-housing.html

Jacobs, J. (1961). *The death and life of great American cities.* Random House.

Janssen, M. A., & Ostrom, E. (2006). Empirically based, agent-based models. *Ecology and Society*, *11*(2), Article 37. http://www.ecologyandsociety.org/vol11/iss2/art37/

Jones, B., Dunn, G., & Balk, D. (2021). Extreme heat related mortality: Spatial patterns and determinants in the United States, 1979–2011. *Spatial Demography*, *9*, 107–129. https://doi.org/10.1007/s40980-021-00079-6

Jones, H. (2019). Property, territory, and colonialism: An international legal history of enclosure. *Legal Studies*, *39*(2), 187–203. https://doi.org/10.1017/lst.2018.22

Kahneman, D., & Tversky, A. (1972). Subjective probability: A judgement of representativeness. *Cognitive Psychology*, *3*(3), 430–454. https://doi.org/10.1016/0010-0285(72)90016-3

Kahneman, D., & Tversky, A. (1973). On the psychology of prediction. *Psychological Review*, *80*(4), 237–251. https://doi.org/10.1037/h0034747

Kailembo, A., Quiñonez, C., Lopez Mitnik, G. V., Weintraub, J. A., Stewart Williams, J., Preet, R., Iafolla, T., & Dye, B. A. (2018). Income and wealth as correlates of socioeconomic disparity in dentist visits among adults aged 20 years and over in the United States, 2011–2014. *BMC Oral Health*, *18*(1), Article 147. https://doi.org/10.1186/s12903-018-0613-4

Kain, N., Donovan, C. J., & Yee-Melichar, D. (2014). Naturally occurring retirement communities. In D. Yee-Meilchar, C. M. Flores, & E. P. Cabigao (Eds.), *Long-term care administration and management: Effective practices and quality programs in eldercare* (pp. 53–68). Springer. https://doi.org/10.1891/9780826195685.0003

Kamin, D. (2023, September 20). As the climate changes, pressure is growing to make buildings more efficient. *The New York Times*. https://www.nytimes.com/2023/09/20/realestate/building-construction-emissions-climate-change.html

Kaup, M. L., Poey, J. L., Corneilson, L., & Doll, G. (2020). Environmental attributes of person-centered care. *Journal of Aging and Environment*, *34*(1), 48–69. https://doi.org/10.1080/02763893.2019.1627266

Kaysen, R. (2023, September 29). Worried about living in a flood zone? Try a house that floats. *The New York Times*. https://www.nytimes.com/2023/09/29/realestate/floating-houses-floods-climate-change.html

Keglovits, M., Clemson, L., Hu, Y.-L., Nguyen, A., Neff, A. J., Mandelbaum, C., Hudson, M., Williams, R., Silianoff, T., & Stark, S. (2020). A scoping review of fall hazards in the homes of older adults and development of a framework for assessment and intervention. *Australian Occupational Therapy Journal*, *67*(5), 470–478. https://doi.org/10.1111/1440-1630.12682

Keith, L., Meerow, S., Jensen, L., Trego, S., Schmidt, E. L., & Berke, P. (2023). Evaluating urban heat mitigation across networks of plans. *Journal of Planning Education and Research*.

Keller, R. C. (2015). *Fatal isolation: The devastating Paris heat wave of 2003*. University of Chicago Press.

Kelman, I (2020). *Disaster by choice: How our actions turn natural hazards into catastrophes.* Oxford University Press.

Kendig, H. (2003). Directions in Environmental Gerontology: A Multidisciplinary Field. *The Gerontologist*, *43*(5), 611–614. https://doi.org/10.1093/geront/43.5.611

Kenny, G. P., Poirier, M. P., Metsios, G. S., Boulay, P., Dervis, S., Friesen, B. J., Malcolm, J., Sigal, R. J., Seely, A. J. E., & Flouris, A. D. (2017). Hyperthermia and cardiovascular strain during an extreme heat exposure in young versus older adults. *Temperature*, *4*(1), 79–88. https://doi.org/10.1080/23328940.2016.1230171

Ketcham, C. J. & Darby, A. (2022, August 24). *Universal design in the classroom: Quick tips to try*. Elon University Center for Engaged Learning. https://www.centerforengagedlearning.org/universal-design-in-the-classroom-quick-tips-to-try/

Khatana, S. A. M., Werner, R. M., & Groeneveld, P. W. (2022). Association of extreme heat with all-cause mortality in the contiguous US, 2008–2017. *JAMA Network Open*, *5*(5), Article e2212957. https://doi.org/10.1001/jamanetworkopen.2022.12957

Kim, Y. J., Park, C., Lee, D. K., & Park, T. Y. (2023). Connecting public health with urban planning: Allocating walkable cooling shelters considering older people. *Landscape and Ecological Engineering*, *19*(2), 257–269. https://doi.org/10.1007/s11355-023-00543-z

Kinnane, O., Grey, T., & Dyer, M. (2016). Adaptable housing design for climate change adaptation. *Engineering Sustainability*, *170*(5), 249–267. https://doi.org/10.1680/jensu.15.00029

Klein, P. R. (2009). The ADA Amendments Act of 2008: The pendulum swings back. *Case Western Reserve Law Review*, *60*(2), Article 7. https://scholarlycommons.law.case.edu/caselrev/vol60/iss2/7

Klinenberg, E. (2002). *Heat wave: A social autopsy of disaster in Chicago*. University Of Chicago Press.

Klinenberg, E. (2018). *Palaces for the people: How social infrastructure can help fight inequality, polarization, and the decline of civic life*. Crown Publishing.

Koh, C. H., & Kraniotis, D. (2020). A review of material properties and performance of straw bale as building material. *Construction and Building Materials*, *259*, Article 120385. https://hdl.handle.net/10642/9342

Kolbert, E. (2021). *Under a white sky: The nature of the future.* Crown.

Kreuter, F., Barkay, N., Bilinski, A., Bradford, A., Chiu, S., Eliat, R., Fan, J., Galili, T., Haimovich, D., Kim, B., LaRocca, S., Li, Y., Morris, K., Presser, S., Salomon, J. A., Sarig, T., Stewart, K., Stuart, E. A., & Tibshirani, R. (2020). Partnering with Facebook on university-based rapid turn-around global survey. *Survey Research Methods*, *14*(2), 159–163. https://d-nb.info/122827150X/34

Kuthy, R. A., Strayer, M. S., & Caswell, R. J. (1996). Determinants of dental user groups among an elderly, low-income population. *Health Services Research*, *30*(6), 809. 809–825. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1070094/

Kyle, G. T., Theodori, G. L., Absher, J. D., & Jun, J. (2010). The influence of home and community attachment on firewise behavior. *Society & Natural Resources*, *23*(11), 1075–1092. https://doi.org/10.1080/08941920902724974

Lapan, S. D., & Quartaroli, M. T. (2009). *Research essentials: An introduction to designs and practices*. John Wiley & Sons.

Lau, G. W. C., Yu, M.-L., Brown, T., & Locke, C. (2018). Clients' perspectives of the effectiveness of home modification recommendations by occupational therapists. *Occupational Therapy in Health Care*, *32*(3), 230–250. https://doi.org/10.1080/07380577.2018.1491085

Lawton, M. P. (1977). An ecological theory of aging applied to elderly housing. *Environments and Aging*, *31*(1), 8–10. https://doi.org/10.2307/1424527

Lawton, M. P., & Nahemow, L. (1973). Ecology and the aging process. In C. Eisdorfer & M. P. Lawton (Eds.), *The psychology of adult development and aging* (pp. 619–674). American Psychological Association. https://doi.org/10.1037/10044-020

Lee, S. B., Oh, J. H., Park, J. H., Choi, S. P., & Wee, J. H. (2018). Differences in youngest-old, middle-old, and oldest-old patients who visit the emergency department. *Clinical and Experimental Emergency Medicine*, *5*(4), 249–255. https://doi.org/10.15441/ceem.17.261

Lehner, J. (2019, July 18). More on migration to Oregon. *Oregon Office of Economic Analysis*. https://oregoneconomicanalysis.com/2019/07/18/more-on-migration-to-oregon/

Leone, C. M. (2023). *Hot, hot, heat: Evaluating Phoenix, Arizona cooling centers through a project management perspective* [Master's thesis, Oregon State University]. https://ir.library.oregonstate.edu/concern/graduate_thesis_or_dissertations/j6731b91s

Levenson, M. (2023, May 23). Heat wave and blackout would send half of Phoenix to E.R., study says. *The New York Times*. https://www.nytimes.com/2023/05/23/climate/blackout-heat-wave-danger.html

Lewis, M. (2018). *The fifth risk: Undoing democracy.* W. W. Norton & Company.

Li, Y., Kubicki, S., Guerriero, A., & Rezgui, Y. (2019). Review of building energy performance certification schemes towards future improvement. *Renewable and Sustainable Energy Reviews*, *113*, Article 109244. https://doi.org/10.1016/j.rser.2019.109244

Liao, Z., & Tam, C. (2021). A review of housing certification standards with a focus on energy efficiency. *IOP Conference Series: Earth and Environmental Science*, *China*, *787*, Article 012168. https://doi.org/10.1088/1755-1315/787/1/012168

Liljas, A. E. M., Walters, K., Jovicic, A., Iliffe, S., Manthorpe, J., Goodman, C., & Kharicha, K. (2019). Engaging 'hard to reach' groups in health promotion: The views of older people and professionals from a qualitative study in England. *BMC Public Health*, *19*, Article 629. https://doi.org/10.1186/s12889-019-6911-1

Linebaugh, P. (2014). *Stop, thief! The commons, enclosures, and resistance.* PM Press.

Linneberg, M. S., & Korsgaard, S. (2019). Coding qualitative data: A synthesis guiding the novice. *Qualitative Research Journal*, *19*(3), 259–270. https://doi.org/10.1108/QRJ-12-2018-0012

Little, D. (2012, November 15). Assemblage theory. Understanding Society. https://understandingsociety.blogspot.com/2012/11/assemblage-theory.html

Löckenhoff, C. E. (2017). Aging and decision-making: A conceptual framework for future research- a mini-review. *Gerontology*, *64*(2), 140–148. https://doi.org/10.1159/000485247

Loftus, G. R., & Masson, M. E. (1994). Using confidence intervals in within-subject designs. *Psychonomic Bulletin & Review*, *1*(4), 476–490. https://doi.org/10.3758/BF03210951

Luber, G., & McGeehin, M. (2008). Climate change and extreme heat events. *American Journal of Preventive Medicine*, *35*(5), 429–435. https://doi.org/10.1016/j.amepre.2008.08.021

Maisel, J. L., Perez, B., & Macy, K. (2022). Increasing adaptive capacity of vulnerable populations through inclusive design. In N. B. Rajkovich & S. H. Holmes, *Climate adaptation and resilience across scales: From buildings to cities* (pp. 125–140). Routledge. https://doi.org/10.4324/9781003030720-8

Maixner, A. H., & Morin, K. (2001). Confidentiality of health information postmortem. *Archives of Pathology & Laboratory Medicine*, *125*(9), 1189–1192. https://doi.org/10.5858/2001-125-1189-COHIP

Mang, P., & Haggard, B. (2016). *Regenerative development and design: A framework for evolving sustainability*. Wiley.

Mankin, J. S., Simpson, I., Hoell, A., Fu, R., Lisonbee, J., Sheffield, A., & Barrie, D. (2021). *NOAA drought task force report on the 2020–2021 Southwestern U.S. drought*. NOAA Drought Task Force, MAPP, and NIDIS. https://www.drought.gov/sites/default/files/2021-09/NOAA-Drought-Task-Force-IV-Southwest-Drought-Report-9-23-21.pdf

Margolis, H. G., Gershunov, A., Kim, T., English, P., & Trent, R. (2008). 2006 California heat wave high death toll: Insights gained from coroner's reports and meteorological characteristics of event. *Epidemiology*, *19*(6), S363–S364. https://journals.lww.com/epidem/fulltext/2008/11001/2006_california_heat_wave_high_death_toll_.1000.aspx

Maricopa County. (n.d.). *Medical examiner*. Maricopa County, AZ. Retrieved May 14, 2023, from https://www.maricopa.gov/468/Medical-Examiner

Martín, C. (2022). exploring climate change in U.S. housing policy. *Housing Policy Debate*, *32*(1), 1–13. https://doi.org/10.1080/10511482.2022.2012030

Martín, C., & Arena, O. (2019). *Catalyst brief: What would it take to make sure all families can live in a physically secure home and a stable community that's prepared for the effects of global climate change?* Urban Institute. https://next50.urban.org/sites/default/files/2019-04/Next50-climate-adaptation.pdf

Matthews, T. (2018). Humid heat and climate change. *Progress in Physical Geography: Earth and Environment*, *42*(3), 391–405. https://doi.org/10.1177/0309133318776490

McKenzie, E. (1996). *Privatopia: Homeowner Associations and the Rise of Residential Private Government*. Yale University Press.

McKenzie, E. (2011) *Beyond Privatopia: Rethinking Residential Private Government.* The Urban Institute Press.

McLeod, J., & O'Connor, K. (2020). Ethics, archives and data sharing in qualitative research. *Educational Philosophy and Theory*, *53*(5), 523–535. https://doi.org/10.1080/00131857.2020.1805310

McLoughlin, N., Howarth, C., & Shreedhar, G. (2023). Changing behavioral responses to heat risk in a warming world: How can communication approaches be improved? *WIREs Climate Change*, *14*(2), Article e819. https://doi.org/10.1002/wcc.819

McWhirter, S. (2023, October 10). *HOAs could not block rooftop solar, home EV charging—Even clothes lines—Under new bill*. Michigan Live News. https://www.mlive.com/public-interest/2023/10/hoas-could-not-block-rooftop-solar-home-ev-charging-even-clothes-lines-under-new-bill.html

Meadows, D. H. (2008). *Thinking in systems: A primer*. Chelsea Green Publishing.

Meadows, D. H., Meadows, D. L., Randers, J., & Behrens, W. W., III. (1972). *Limits to growth*. Universe Books.

Mehryar, S. (2022, September 12). *What is the difference between climate change adaptation and resilience?* Grantham Research Institute on Climate Change and the Environment. https://www.lse.ac.uk/granthaminstitute/explainers/what-is-the-difference-between-climate-change-adaptation-and-resilience/

Meldrum, J. R., Brenkert-Smith, H., Champ, P. A., Gomez, J., Byerly, H., Falk, L., & Barth, C. M. (2021). Would you like to know more? The effect of personalized wildfire risk information and social comparisons on information-seeking behavior in the wildland–urban interface. *Natural Hazards*, *106*, 2139–2161. https://doi.org/10.1007/s11069-021-04534-x

Middel, A., Selover, N., Hagen, B., & Chhetri, N. (2016). Impact of shade on outdoor thermal comfort—a seasonal field study in Tempe, Arizona. *International Journal of Biometeorology*, *60*, 1849–1861. https://doi.org/10.1007/s00484-016-1172-5

Middel, A., Turner, V. K., Schneider, F. A., Zhang, Y., & Stiller, M. (2020). Solar reflective pavements—A policy panacea to heat mitigation? *Environmental Research Letters*, *15*(6), Article 064016. https://doi.org/10.1088/1748-9326/ab87d4

Miller, W., Vine, D., & Amin, Z. (2017). Energy efficiency of housing for older citizens: Does it matter? *Energy Policy*, *101*, 216–224. https://doi.org/10.1016/j.enpol.2016.11.050

Mohammed, O. (2024, March 4). Map shows 9 states where homeowners are losing their insurance. *Newsweek*. https://www.newsweek.com/map-shows-9-states-where-homeowners-are-losing-their-insurance-1875252

Molinsky, J., & Forsyth, A. (2022). Climate Change, Aging, and Well-being: How Residential Setting Matters. *Housing Policy Debate*, *33*(5), 1029–1054. https://doi.org/10.1080/10511482.2022.2109711

Moore, R. (2018, October 10). Disaster recovery reform act is a smart move ... Mostly. *NRDC Expert Blog*. https://www.nrdc.org/bio/rob-moore/disaster-recovery-reform-act-smart-movemostly

Morgan, N. (2021, June 8). *Police release image of Almeda fire victim*. https://www.mailtribune.com/crime-courts-and-emergencies/2021/06/08/new-information-released-about-third-almeda-fire-fatality/

Msuha, B. & Mdendemi, T. (2019). Hypothesis testing for the association between categorical variables: Empirical application of chi square test. *Mathematical Theory and Modeling*, *9*(2), 9–17. https://doi.org/10.7176/MTM/9-2-02

Narushima, M., & Kawabata, M. (2020). “Fiercely independent”: Experiences of aging in the right place of older women living alone with physical limitations. *Journal of Aging Studies*, *54*, Article 100875. https://doi.org/10.1016/j.jaging.2020.100875

National Academy of Sciences. (2020). *Climate change: Evidence and causes: Update 2020*. The National Academies Press. https://doi.org/10.17226/25733

New Hampshire Department of Justice. (n.d.). *Office of the Chief Medical Examiner.* Retrieved May 14, 2023, from, https://www.doj.nh.gov/medical-examiner/

Newman, S. M., Carroll, M. S., Jakes, P. J., & Paveglio, T. B. (2013). Land development patterns and adaptive capacity for wildfire: Three examples from Florida. *Journal of Forestry*, *111*(3), 167–174. https://doi.org/10.5849/jof.12-066

Northeast ADA Center (n.d.). *About housing accessibility*. Americans With Disabilities Act National Network. https://northeastada.org/resource/about-housing-accessibility

Office of Policy Development and Research. (2022). *Resiliency at work*. U.S. Department of Housing & Urban Development. https://www.huduser.gov/portal/periodicals/em/Summer22/highlight3.html

Oppenheimer, J., Badruzzaman, M., McGuckin, R., & Jacangelo, J. G. (2014). Urban water-cycle energy use and greenhouse gas emissions. *Journal-American Water Works Association*, *106*(2), E86–E97. https://doi.org/10.5942/jawwa.2014.106.0017

Padden, P. (2023, March 25). Colorado's housing boom meets the water crisis. *Colorado Springs Gazette*. https://gazette.com/denver-gazette/colorado-s-housing-boom-meets-the-water-crisis/article_6f62177e-aee1-11ed-90d9-fbe1e676d0fa.html

Park, J. H., & Choi, J. M. (2022). The effect of residential environment satisfaction on depression in the elderly: Focusing on the mediating effect of stress. *Frontiers in Public Health*, *10*, Article 1038516. https://doi.org/10.3389/fpubh.2022.1038516

Partelow, S. (2018). A review of the social-ecological systems framework: Applications, methods, modifications, and challenges. *Ecology and Society*, *23*(4). Article 36. https://www.jstor.org/stable/26796887

Paton, D. (2019). Disaster risk reduction: Psychological perspectives on preparedness. *Australian Journal of Psychology*, *71*(4), 327–341. https://doi.org/10.1111/ajpy.12237

Pichlhöfer, A., Korjenic, A., Sulejmanovski, A., & Streit, E. (2023). Influence of facade greening with ivy on thermal performance of masonry walls. *Sustainability*, *15*(12), Article 9546. https://doi.org/10.3390/su15129546

Pilgeram, R. (2021). *Pushed out: Contested development and rural gentrification in the US West.* University of Washington Press.

Plaut, J. M. & Amedée, E. (2018). *Becoming a regenerative practitioner: A field guide.* Colorado State University, Institute for the Built Environment. https://ibe.colostate.edu/wp-content/uploads/2018/07/Regenerative-Practitioner-Field-Guide_2018_pages.pdf

Porter, L., Rickards, L., Verlie, B., Bosomworth, K., Moloney, S., Lay, B., Latham, I., & Pellow, D. (2020). Climate justice in a climate changed world. *Planning Theory & Practice*, *21*(2), 293–321. https://doi.org/10.1080/14649357.2020.1748959

Pynoos, J., Caraviello, R., & Cicero, C. (2009). Lifelong housing: The anchor in aging-friendly communities. *Generations*, *33*(2), 26–32.

Ramakrishna, S. (2024, August 1). *States with the most tech-savvy seniors*. Seniorly Resource Center. https://www.seniorly.com/resource-center/seniorly-news/states-with-the-most-tech-savvy-seniors

Rampin, R., Rampin, V., & DeMott, S. (2021). Taguette: Open source qualitative data analysis. *Journal of Open Source Software*, *6*(68), Article 3522. https://doi.org/10.21105/joss.03522

Randazzo, T., De Cian, E., & Mistry, M. N. (2020). Air conditioning and electricity expenditure: The role of climate in temperate countries. *Economic Modelling*, *90*, 273–287. https://doi.org/10.1016/j.econmod.2020.05.001

Raymond, C., Matthews, T., & Horton, R. M. (2020). The emergence of heat and humidity too severe for human tolerance. *Science Advances*, *6*(19), Article eaaw1838. https://doi.org/10.1126/sciadv.aaw1838

Rhoades, J. L., Gruber, J. S., & Horton, B. (2018). Developing an in-depth understanding of elderly adult's vulnerability to climate change. *The Gerontologist*, *58*(3), 567–577. https://doi.org/10.1093/geront/gnw167

Ridley, I., Clarke, A., Bere, J., Altamirano, H., Lewis, S., Durdev, M., & Farr, A. (2013). The monitored performance of the first new London dwelling certified to the Passive House standard. *Energy and Buildings*, *63*, 67–78. https://doi.org/10.1016/j.enbuild.2013.03.052

Ritchie, K. (2023, January 23). *You've heard of first responders. Now meet Maricopa County's last responders* [Radio broadcast]. KJZZ Phoenix. https://kjzz.org/content/1836843/youve-heard-first-responders-now-meet-maricopa-countys-last-responders

Rossman, G. B., & Rallis, S. F. (2017). *An Introduction to qualitative research: Learning in the field* (4th ed.). SAGE Publications, Inc. https://doi.org/10.4135/9781071802694

Roth, R. E. (2013). Interactive maps: What we know and what we need to know. *Journal of Spatial Information Science*, (6), 59–115. http://dx.doi.org/10.5311/JOSIS.2013.6.105

Rothstein, R. (2017). *The color of law: A forgotten history of how our government segregated America*. Liveright publishing.

Sack, K., & Schwartz, J. (2018, October 8). As storms keep coming, FEMA spends billions in 'cycle' of damage and repair. *The New York Times*. https://www.nytimes.com/2018/10/08/us/fema-disaster-recovery-climate-change.html

Sadiq, S. (2023, July 31). *No cooling centers for unhoused people in the gorge this summer* [Radio broadcast]. Oregon Public Broadcasting. https://www.opb.org/article/2023/07/24/columbia-river-gorge-summer-heat-cooling/

Saldaña, J. (2016). *The coding manual for qualitative researchers* (3rd ed.). SAGE Publications, Inc.

Sampson, N. R., Gronlund, C. J., Buxton, M. A., Catalano, L., White-Newsome, J. L., Conlon, K. C., O'Neill, M. S., McCormick, S., & Parker, E. A. (2013). Staying cool in a changing climate: Reaching vulnerable populations during heat events. *Global Environmental Change*, *23*(2), 475–484. https://doi.org/10.1016/j.gloenvcha.2012.12.011

Sanford, J. A. (2016). Design for all users. In R. H. Hunter, L. A. Anderson, & B. L. Belza (Eds.), *Community wayfinding: Pathways to understanding* (pp. 81–101). Springer. https://doi.org/10.1007/978-3-319-31072-5_5

Sanford, J. A., & Hernandez, S. C. (2017). Universal design, design for aging in place, and habilitative design in residential environments. In D. Kopec (Ed.), *Health and well-being for interior architecture* (pp. 137–148). Routledge.

Sattar, S., Kenis, C., Haase, K., Burhenn, P., Stolz-Baskett, P., Milisen, K., Ayala, A. P., & Puts, M. T. E. (2020). Falls in older patients with cancer: Nursing and Allied Health Group of International Society of Geriatric Oncology review paper. *Journal of Geriatric Oncology*, *11*(1), 1–7. https://doi.org/10.1016/j.jgo.2019.03.020

Schaechter, J., Duran, I., De Marchena, J., Lemard, G., & Villar, M. E. (2003). Are "accidental" gun deaths as rare as they seem? A comparison of medical examiner manner of death coding with an intent-based classification approach. *Pediatrics*, *111*(4), 741–744. https://doi.org/10.1542/peds.111.4.741

Scharlach, A. E. & Lehning, A. J. (2016) *Creating aging-friendly communities*. Oxford University Press.

Scheckler, S., Molinsky, J., & Airgood-Obrycki, W. L. (2022). *How well does the housing stock meet accessibility needs? An analysis of the 2019 American Housing Survey*. Joint Center for Housing Studies of Harvard University. https://www.jchs.harvard.edu/sites/default/files/research/files/harvard_jchs_housing_stock_accessibility_scheckler_2022_0.pdf

Schmidt, R., III., Eguchi, T., Austin, S., & Gibb, A. (2010). What is the meaning of adaptability in the building industry? *Engineering and Physical Sciences Research Council, Innovative Manufacturing and Construction Research Center at Loughborough University.* http://adaptablefutures.com/wp-content/uploads/2011/11/Schmidt-et-al.-2010b.pdf

Schroeder, K., Noll, J. G., Henry, K. A., Suglia, S. F., & Sarwer, D. B. (2021). Trauma-informed neighborhoods: Making the built environment trauma-informed. *Preventive Medicine Reports*, *23*, Article 101501. https://doi.org/10.1016/j.pmedr.2021.101501

Schwartz, J. (2020). Surrendering to rising seas: Coastal communities struggling to adapt to rising seas are beginning to do what was once unthinkable: Retreat. *Scientific American*, *319*(2). https://www.scientificamerican.com/article/surrendering-to-rising-seas/

Shah, S. (2020). *The next great migration: The beauty and terror of life on the move.* Bloomsbury.

Shashua-Bar, L., & Hoffman, M. E. (2003). Geometry and orientation aspects in passive cooling of canyon streets with trees. *Energy and buildings*, *35*(1), 61–68. https://doi.org/10.1016/S0378-7788(02)00080-4

Shaw, L., Kiegaldie, D., & Farlie, M. K. (2020). Education interventions for health professionals on falls prevention in health care settings: A 10-year scoping review. *BMC Geriatrics*, *20*(1), Article 460. https://doi.org/10.1186/s12877-020-01819-x

Shor, E., van de Rijt, A., & Fotouhi, B. (2019). A large-scale test of gender bias in the media. *Sociological Science*, *6*(20), 526–550. https://doi.org/10.15195/v6.a20

Sidorowicz, J. (2024, June 24). *Yes, new Florida law places limits on reasons HOAs can fine you*. Tampa Bay News. https://www.wtsp.com/article/news/verify/florida-law-hoas-homeowners-association-limits-fines/67-1084aefb-e6ce-42e3-affe-783b0a20bbde

Slack, T., & Jensen, L. (2020). The changing demography of rural and small-town America. *Population Research and Policy Review*, *39*, 775–783. https://doi.org/10.1007/s11113-020-09608-5

Smith, K. [Kristin]. (2023, September 5). *FEMA's BRIC program continues to fund innovative risk reduction – But community capacity limits access*. Headwaters Economics. https://headwaterseconomics.org/headwaters/femas-bric-program-continues-to-fund-innovative-risk-reduction-but-community-capacity-limits-access/

Smith, K. R. [Kirk], Woodward, A., Campbell-Lendrum, D., Chadee, D. D., Honda, Y., Liu, Q., Olwoch, J. M., Revich, B., & Sauerborn, R. (2014). Human health: Impacts, adaptation, and co-benefits. In C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, & L. L. White (Eds.), *Climate change 2014:*

Impacts, adaptation, and vulnerability. Part A: Global and sectoral aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (pp. 709–754). Cambridge University Press. https://www.ipcc.ch/site/assets/uploads/2018/02/WGIIAR5-Chap11_FINAL.pdf

Smith, M. K., Robles, F., Fawcett, E., & Sasani, A. (2022, October 7). Many of Hurricane Ian's victims were older adults who drowned. *The New York Times*. https://www.nytimes.com/2022/10/07/us/hurricane-ian-victims-drowned.html

Smith, M. L., Ory, M. G., & Larsen, R. (2010). Older women in a state-wide, evidence-based falls prevention program: Who enrolls and what benefits are obtained? *Women's Health Issues*, *20*(6), 427–434. https://doi.org/10.1016/j.whi.2010.07.003

Smith, S. K., & House, M. (2006). Snowbirds, sunbirds, and stayers: Seasonal migration of elderly adults in Florida. *The Journals of Gerontology: Series B*, *61*(5), S232–S239. https://doi.org/10.1093/geronb/61.5.S232

Sorooshnia, E., Rashidi, M., Rahnamayiezekavat, P. R., Rezaei, F., & Samali, B. (2023). Optimum external shading system for counterbalancing glare probability and daylight illumin'nce in Sydney's residential buildings. *Engineering, Construction and Architectural Management*, *30*(1), 296–320. https://doi.org/10.1108/ECAM-03-2021-0191

Stanton, M. (2022) *Disaster Resilience Toolkit: A guide for how local leaders can reduce risks and better protect older adults.* AARP. https://www.aarp.org/livable-communities/tool-kits-resources/info-2022/aarp-disaster-resilience-tool-kit-download.html

Stark, S., Keglovits, M., Somerville, E., Hu, Y.-L., Barker, A., Sykora, D., & Yan, Y. (2021). Home hazard removal to reduce falls among community-dwelling older adults: A randomized clinical trial. *JAMA Network Open*, *4*(8), Article e2122044. https://doi.org/10.1001/jamanetworkopen.2021.22044

Stern, M. J. (2018). *Social science theory for environmental sustainability: A practical guide*. Oxford University Press.

Steuteville, R. (2022, April 6). *What cities will receive climate migrants?* Congress for New Urbanism. https://www.cnu.org/publicsquare/2022/04/06/what-cities-will-receive-climate-migrants

Strahan, K., & Watson, S. J. (2019). The protective action decision model: When householders choose their protective response to wildfire. *Journal of Risk Research*, *22*(12), 1602–1623. https://doi.org/10.1080/13669877.2018.1501597

Subotić, J. (2021). Ethics of archival research on political violence. *Journal of Peace Research*, *58*(3), 342–354. https://doi.org/10.1177/0022343319898735

Swallow, P. C. (2014). *The remarkable life and career of Ellen Swallow Richards: Pioneer in science and technology.* Wiley-TMS.

Syphard, A. D., Bar Massada, A., Butsic, V., & Keeley, J. E. (2013). Land use planning and wildfire: Development policies influence future probability of housing loss. *PloS One*, *8*(8), Article e71708. https://doi.org/10.1371/journal.pone.0071708

Terpstra, T., & Lindell, M. K. (2013). Citizens' perceptions of flood hazard adjustments: An application of the protective action decision model. *Environment and Behavior*, *45*(8), 993–1018. https://eric.ed.gov/?id=EJ1019223

Tierney, K. (2019). *Disasters: A sociological approach.* Polity Press.

Timalsina, R., & Songwathana, P. (2020). Factors enhancing resilience among older adults experiencing disaster: A systematic review. *Australasian Emergency Care*, *23*(1), 11–22. https://doi.org/10.1016/j.auec.2019.12.007

Thaler, R. H., & Sunstein, C. R. (2008). *Nudge: Improving decision about health, wealth, and happiness.* Yale University Press. https://doi.org/10.1017/S1474747209990175

Thompson, B. (2019). *Designing for disaster: Domestic architecture in the era of climate change*. Schiffer.

Tippett, K. (Host). (2023, March 30). *Ruth Wilson Gilmore: "Where life is precious, life is precious*" [Audio podcast episode]. In *On Being*. The On Being Project. https://onbeing.org/programs/ruth-wilson-gilmore-where-life-is-precious-life-is-precious/

Tullis, R. S. (2021). Placemaking: Programming urbanism for human engagement. In K. Menezes, P. Oliveira-Smith, & A. V. Woodworth (Eds.), *Programming for health and wellbeing in architecture*. Routledge.

Tversky, A., & Kahneman, D. (1974). Judgement under uncertainty: Heuristics and biases. *Science*, *185*(4157), 1124–1131. https://www.cs.tufts.edu/comp/150AIH/pdf/TverskyKa74.pdf

United States Access Board. (2014, February). *Using the ADA standards*. https://www.access-board.gov/files/ada/guides/using-ADAstandards.pdf

United States Department of Energy. (n.d.). *Home cooling systems*. https://www.energy.gov/energysaver/home-cooling-systems

United States Department of Homeland Security. (2024, July 30). *Extreme heat*. https://www.ready.gov/heat

University of Arkansas Community Design Center. (2017). *Houses for aging socially: Developing third place ecologies*. ORO Editions.

University of Chicago Press. (2002). *Dying alone: An interview with Eric Klinenberg*. https://press.uchicago.edu/Misc/Chicago/443213in.html

Vasudevan, A., McFarlane, C., & Jeffrey, A. (2008). Spaces of enclosure. *Geoforum*, *39*(5), 1641–1646. https://doi.org/10.1016/j.geoforum.2008.03.001

Vázquez-Gonzáles, C., Ávila-Foucat, V. S., Ortiz-Lozano, L., Moreno-Casasola, P., & Grandos- Barba, A. (2021). Analytical framework for assessing the social-ecological system trajectory considering the resilience-vulnerability dynamic interaction in the context of disasters. *International Journal of Disaster Risk Reduction*, *59*(1), Article 102232. https://doi.org/10.1016/j.ijdrr.2021.102232

Vespa, J., Medina, L., & Armstrong, D. M. (2020). Demographic turning points for the United States: Population projections for 2020 to 2060 (Report No. P25-1144). *Current Population Reports*. U.S. Census Bureau. https://www.census.gov/library/publications/2020/demo/p25-1144.html

Vu, A., Rutherford, S., & Phung, D. (2019). Heat health prevention measures and adaptation in older populations—A systematic review. *International Journal of Environmental Research and Public Health*, *16*(22), Article 4370. https://doi.org/10.3390/ijerph16224370

Webb, H., Jirotka, M., Stahl, B. C., Housley, W., Edwards, A., Williams, M., Procter, R., Rana, O. & Burnap, P. (2017, June 25–28). *The ethical challenges of publishing Twitter data for research dissemination* [Paper presentation]. Proceedings of the 2017 ACM on Web Science Conference, Troy, New York, USA. https://doi.org/10.1145/3091478.3091489

Wellecke, C., D'Cruz, K., Winkler, D., Douglas, J., Goodwin, I., Davis, E., & Mulherin, P. (2022). Accessible design features and home modifications to improve physical housing accessibility: A mixed-methods survey of occupational therapists. *Disability and Health Journal*, *15*(3), Article 101281. https://doi.org/10.1016/j.dhjo.2022.101281

White-Newsome, J. L., Sánchez, B. N., Parker, E. A., Dvonch, J. T., Zhang, Z., & O'Neill, M. S. (2011). Assessing heat-adaptive behaviors among older, urban-dwelling adults. *Maturitas*, *70*(1), 85–91. https://doi.org/10.1016/j.maturitas.2011.06.015

Whitman, S., Good, G., Donoghue, E. R., Benbow, N., Shou, W., & Mou, S. (1997). Mortality in Chicago attributed to the July 1995 heat wave. *American Journal of Public Health*, *87*(9), 1515–1518. https://doi.org/10.2105/ajph.87.9.1515

Wieck, G., Dianati, K., Eckert, A., & Arquitt, S. (2020, July 21). *Searching for system leverage*: *Group model building for shared understanding of adequate housing in Kenya* [Conference presentation]. 38th International Conference of the System Dynamics Society, Bergen, Norway. https://proceedings.systemdynamics.org/2020/papers/P1157.pdf

Williams, D., Edwards, W. S., Giambo, P., & Kena, G. (2018). *Cost effective mail survey design* [Paper presentation]. Proceedings of the 2018 Federal Committee on Statistical Methodology (FCSM) Research Conference, Washington, DC, USA. https://nces.ed.gov/FCSM/pdf/F4_Williams_2018FCSM.pdf

Williams, M. L., Burnap, P., & Sloan, L. (2017). Towards an ethical framework for publishing Twitter data in social research: Taking into account users' views, online context and algorithmic estimation. *Sociology*, *51*(6), 1149–1168. https://doi.org/10.1177/0038038517708140

Williamson, T. (2013). Understanding enclosure. *Landscapes*, *1*(1), 56–79. https://doi.org/10.1179/lan.2000.1.1.56

Winchester, S. (2021). *Land: How the hunger for ownership shaped the modern world*. Harper.

Wisner, B., & Kelman, I. (2015). Community resilience to disasters. In J. D. Wright (Ed.), *International encyclopedia of social and behavioural sciences* (2nd ed.; pp. 354–360). Elsevier.

World Health Organization. (2023, July 28). *"It's not easy to live in this situation" – Extreme heat in Italy hits the elderly hard* [News release]. https://www.who.int/europe/news/item/28-07-2023-it-s-not-easy-to-live-in-this-situation----extreme-heat-in-italy-hits-the-elderly-hard

Wu, S., Markus, M., Lorenz, D., Angel, J. R., & Grady, K. (2019). A comparative analysis of the historical accuracy of the point precipitation frequency estimates of four data sets and their projections for the Northeastern United States. *Water*, *11*(6), Article 1279. https://doi.org/10.3390/w11061279

Yoon, S., Woo, S., Kim, J., Hwang, S. W., & Kweon, S. J. (2022). The location routing problem for cooling shelters during heat waves. *Urban Climate*, *44*, Article 101138. https://doi.org/10.1016/j.uclim.2022.101138

Ysseldyk, R., Haslam, S. A., & Haslam, C. (2013). Abide with me: Religious group identification among older adults promotes health and well-being by maintaining multiple group memberships. *Aging & Mental Health*, *17*(7), 869–879. https://doi.org/10.1080/13607863.2013.799120

Zerkel, E. (2023, August 16). *Little warning, few escape routes, phones knocked out: The chilling similarities between the Maui and Paradise fires*. CNN. https://www.cnn.com/2023/08/16/us/camp-fire-2018-maui-fire-climate/index.html

Zhou, Q., She, L. Y., Xiao, Y., Shan, B., Huo, J. S., Ma, J., & Yang, R. Z. (2011). Fire-Resistance simulation and test of prefabricated bamboo house. Journal of Building Structure, 32, 60–66.

APPENDIX A: SUPPLEMENTAL INFORMATION

Avoiding Ageist Language

It is common for researchers and practitioners within an interdisciplinary paradigm, such as environmental studies, to work with vulnerable populations. It is also therefore common for researchers to unknowingly use ageist language when describing populations outside of the median, such as the oldest and youngest generations (Applewhite, 2016; Chun & Evans, 2021). However, this is not an issue to be ashamed of or shy away from, as gerontologists for decades have been exploring the "elderly mystique," explaining that our modern American societal view of aging is masked by a set of false beliefs about what it means to get old (Carney & Gray, 2015). In other words, ageism is woven into the fabric of our society. Therefore, it is essential to acknowledge the importance of our words and to work toward change; to this end, I will briefly introduce intentional steps I took in this dissertation to avoid ageist language.

When reflecting on themes from the dissertations of scholars following Indigenous paradigms, Absolon (2011) noted that respect is paramount, and wrote that, "Respect is a wholistic value and can be enacted at all levels of re-search" (p. 65). In a continual reorientation toward showing respect for older adult populations whom I am serving today, and for the older person I will be in the future, I am actively working to eliminate unconscious ageism from my language. Emerging research encourages scholars and practitioners in the field of aging to reframe aging to reduce ageist language and unconscious bias (FrameWorks Institute, 2017). For instance, use of disaster language to describe aging (i.e., the "silver tsunami" or the "grey wave") is discouraged, as natural aging is not a disaster. Additionally, when planning for future

in-migration of older adults to receiving communities, or planning for those choosing to age in place in areas prone to disasters, city planners should avoid language that could cause resources to seem finite (i.e., “pool of resources” or “economic pie”) as this will subtly cue the general public to hoard resources and instill a sense of fatalism (FrameWorks Institute, 2017).

As a scholar, I am making a conscious effort to avoid “us vs. them” language. For instance, instead of using “as they age” to describe a population, I use “as we are aging.” This reframe of aging now includes the fact that we are all aging and avoids othering a population group. Ultimately, I believe an increasing number of aging Americans builds momentum for collective responsibility to solve problems at the policy-level, which I make an intentional effort to center through my language within this dissertation.

Glossary

Since this dissertation involves the incorporation of novel ideas, it is beneficial to provide a glossary of terms to offer a shared understanding. Therefore, for the purpose of clarity and consistency, certain terms will be used with specific meaning. Below is a list of definitions for key concepts I have throughout this dissertation:

- Built environment adaption: “The capacity of a building to accommodate effectively the evolving demands on its context, thus maximizing value through life” (Schmidt et al., 2010, p. 235).
- Climate adaptation: “Adjustment in natural or human systems in anticipation of or response to a changing environment in a way that effectively uses beneficial opportunities or reduces negative effects” (Department of Defense [DOD], 2016).
- Climate-adaptive lifelong housing: “housing built to adapt effectively to the evolving demands on its context imposed on it by climate change and the changing needs of occupants” (I coined and defined this term during my doctoral Qualifying Exam).
- Climate change: “Any change in climate over time, weather due to natural variability or as a result of human activity” (DoD, 2017).
- Climate resilience: “is the capacity to absorb stresses and maintain function in the face of external stresses imposed upon it by climate change and adapt, reorganize, and evolve into more desirable configurations that improve the

sustainability of the system, leaving it better prepared for future climate change impacts" (Center for Climate and Energy Solutions, 2019, p. 2).

- Climate vulnerability: "The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes" (IPCC, 2007, p. 6).
- Lifelong housing: is housing built to enable "the ability to live in one's own home and community safely, independently, and comfortably, regardless of age, income or ability level" (Benford et al., 2019, p. 3).
- Older adults: "65 and older, classified into three groups: youngest-old, ages 65 to 74 years; middle-old, 75 to 84 years; and oldest-old, ≥ 85 years" (Lee et al., 2018, p. 249).

Table A1

Glossary

Term	Definition
Choice Architecture	Organization of the context in which people make decisions; there is no such thing as a "neutral design" (Thaler & Sunstein, 2009).
Decision-Making	The uniquely human process of making a decision.
Disaster	Disasters are social events, not merely physical. Disasters occur when geophysical forces meet vulnerable human communities. The severity of a disaster is measured by the magnitude of social impacts, not by the magnitude of physical forces (Tierney, 2019).
Older Adult	The term "older adult" can vary widely based on context. For purposes of this dissertation, "older adult" will be used to describe people 60 years of age and older. The age range of 60 years and older was chosen to match the population served by my community partner, the Aging and Disability Services Department within the Rogue Valley Council of Governments.
Post-Disaster	The time immediately after a disaster, and extending into the recovery phase.
Post-Disaster Recovery	Post-disaster recovery includes all activities related to the community overcoming the disaster and thriving; examples include recovering from trauma, reestablishing economic activity, and regaining a sense of community (Tierney, 2019).
Younger Adult	For the purposes of this dissertation, "younger adult" refers to people under 60 years of age.

Seven Principles of Universal Design

Connell, B. R., Jones, M., Mace, R. L., Mueller, J., Mullick, A., Ostroff, E., Sanford, J., Steinfeld, E., Story, M. & Vanderheiden, G. (1997). *The principles of universal design*. N.C. State University, The Center for Universal Design. https://web.stanford.edu/class/engr110/2007/PUD.pdf

Information below is copied directly from the source.

Principle 1: Equitable Use

The design is useful and marketable to people with diverse abilities.

- GUIDELINES:
    - Provide the same means of use for all users: identical whenever possible, equivalent when not.
    - Avoid segregating or stigmatizing any users.
    - Provisions for privacy, security, and safety should be equally available to all users.
    - Make the design appealing to all users.

Principle 2: Flexibility in Use

The design accommodates a wide range of individual preferences and abilities.

- GUIDELINES:
    - Provide choice in methods of use.
    - Accommodate right- or left-handed access and use.
    - Facilitate the user's accuracy and precision.
    - Provide adaptability to the user's pace.

Principle 3: Simple and Intuitive

Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.

- GUIDELINES:
  - Eliminate unnecessary complexity.
  - Be consistent with user expectations and intuition.
  - Accommodate a wide range of literacy and language skills.
  - Arrange information consistent with its importance.
  - Provide effective prompting and feedback during and after task completion.

Principle 4: Perceptible Information

The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.

- GUIDELINES:
  - Use different modes (pictorial, verbal, tactile) for redundant presentation of essential information.
  - Provide adequate contrast between essential information and its surroundings.
  - Maximize "legibility" of essential information.
  - Differentiate elements in ways that can be described (i.e., make it easy to give instructions or directions).

- Provide compatibility with a variety of techniques or devices used by people with sensory limitations.

Principle 5: Tolerance for Error

The design minimizes hazards and the adverse consequences of accidental or unintended actions.

- GUIDELINES:
  - Arrange elements to minimize hazards and errors: most used elements, most accessible; hazardous elements eliminated, isolated, or shielded.
  - Provide warnings of hazards and errors.
  - Provide fail-safe features.
  - Discourage unconscious action in tasks that require vigilance.

Principle 6: Low Physical Effort

The design can be used efficiently and comfortably and with minimal fatigue.

- GUIDELINES:
  - Allow user to maintain a neutral body position.
  - Use reasonable operating forces.
  - Minimize repetitive actions.
  - Minimize sustained physical effort

Principle 7: Size and Space for Approach and Use

Appropriate size and space are provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility.

- GUIDELINES:
    - Provide a clear line of sight to important home elements for any seated or standing user.
    - Make reach to all components comfortable for any seated or standing user.
    - Accommodate variations in hand and grip size.
    - Provide adequate space for the use of assistive devices or personal assistance.

Appendix A References

Applewhite, A. (2016). *This chair rocks: A manifesto against ageism.* Celadon Books.

Absolon, K. E. (2011). *Kaandossiwin: How we come to know Indigenous research methodologies*. Fernwood Publishing.

Benford, R., Barr, S., Kain, N., & Ratajcyzk, E. (2019). *Colorado lifelong homes: A review of barriers and solutions for aging in place* [White paper]. Colorado State University Institute for the Built Environment. https://ibe.colostate.edu/wp-content/uploads/2019/04/LifeLongHomeWhitepaper_2019_FINAL_corrected.pdf

Carney, G. M., & Gray, M. (2015). Unmasking the 'elderly mystique': Why it is time to make the personal political in ageing research. *Journal of Aging Studies*, 35, 123–134. https://doi.org/10.1016/j.jaging.2015.08.007

Center for Climate and Energy Solutions. (2019, April). *What is climate resilience and why does it matter*? https://www.c2es.org/wp-content/uploads/2019/04/what-is-climate-resilience.pdf

Chun, E., & Evans, A. (2021). *Leveraging multigenerational workforce strategies in higher education*. Routledge. https://doi.org/10.4324/9781003150381-6

FrameWorks Institute. (2017, April 7). *Framing strategies to advance aging and address aging as policy issues.* https://www.frameworksinstitute.org/wp-content/uploads/2020/05/aging_frame_brief.pdf

Intergovernmental Panel on Climate Change. (2007). Climate change 2007: Impacts, adaptation and vulnerability. In M. Parry, O. Osvaldo, J. Palutikof, P. van der Linden, & C. Hanson (Eds.), *Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press.

Lee, S. B., Oh, J. H., Park, J. H., Choi, S. P., & Wee, J. H. (2018). Differences in youngest-old, middle-old, and oldest-old patients who visit the emergency department. *Clinical and Experimental Emergency Medicine*, *5*(4), 249–255. https://doi.org/10.15441/ceem.17.261

Schmidt, R., III., Eguchi, T., Austin, S., & Gibb, A. (2010). What is the meaning of adaptability in the building industry? *Engineering and Physical Sciences Research Council, Innovative Manufacturing and Construction Research Center at Loughborough University.* http://adaptablefutures.com/wp-content/uploads/2011/11/Schmidt-et-al.-2010b.pdf

Thaler, R. H., & Sunstein, C. R. (2008). *Nudge: Improving decision about health, wealth, and happiness.* Yale University Press. https://doi.org/10.1017/S1474747209990175

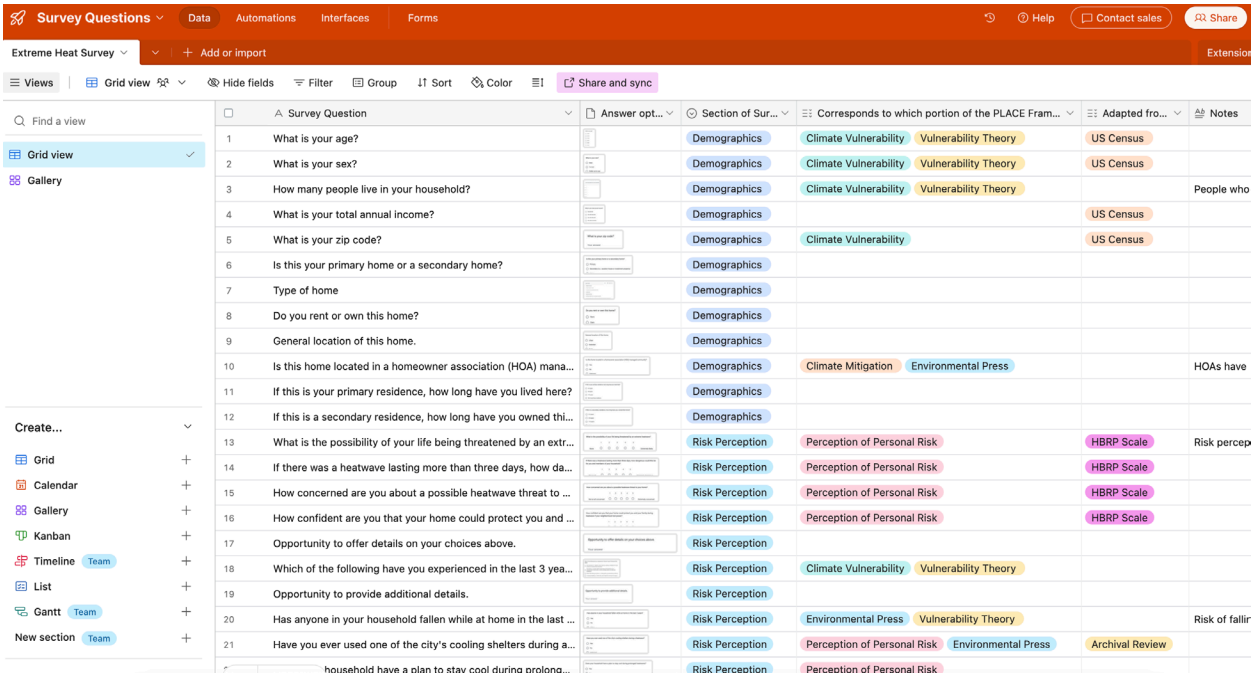
Tierney, K. (2019). *Disasters: A sociological approach.* Polity Press.

United States Department of Defense. (2016, January 14). Climate change adaptation and resilience (DOD Directive 4715.21). https://dod.defense.gov/Portals/1/Documents/pubs/471521p.pdf

United States Department of Defense. (2024 July, 22). *Natural resources management* (DOD Instruction 4715.03). https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodi/471503p.pdf?ver=2017-10-05-073238-040

APPENDIX B: SUPPLEMENTAL INFORMATION FOR PART II, SURVEY

Airtable

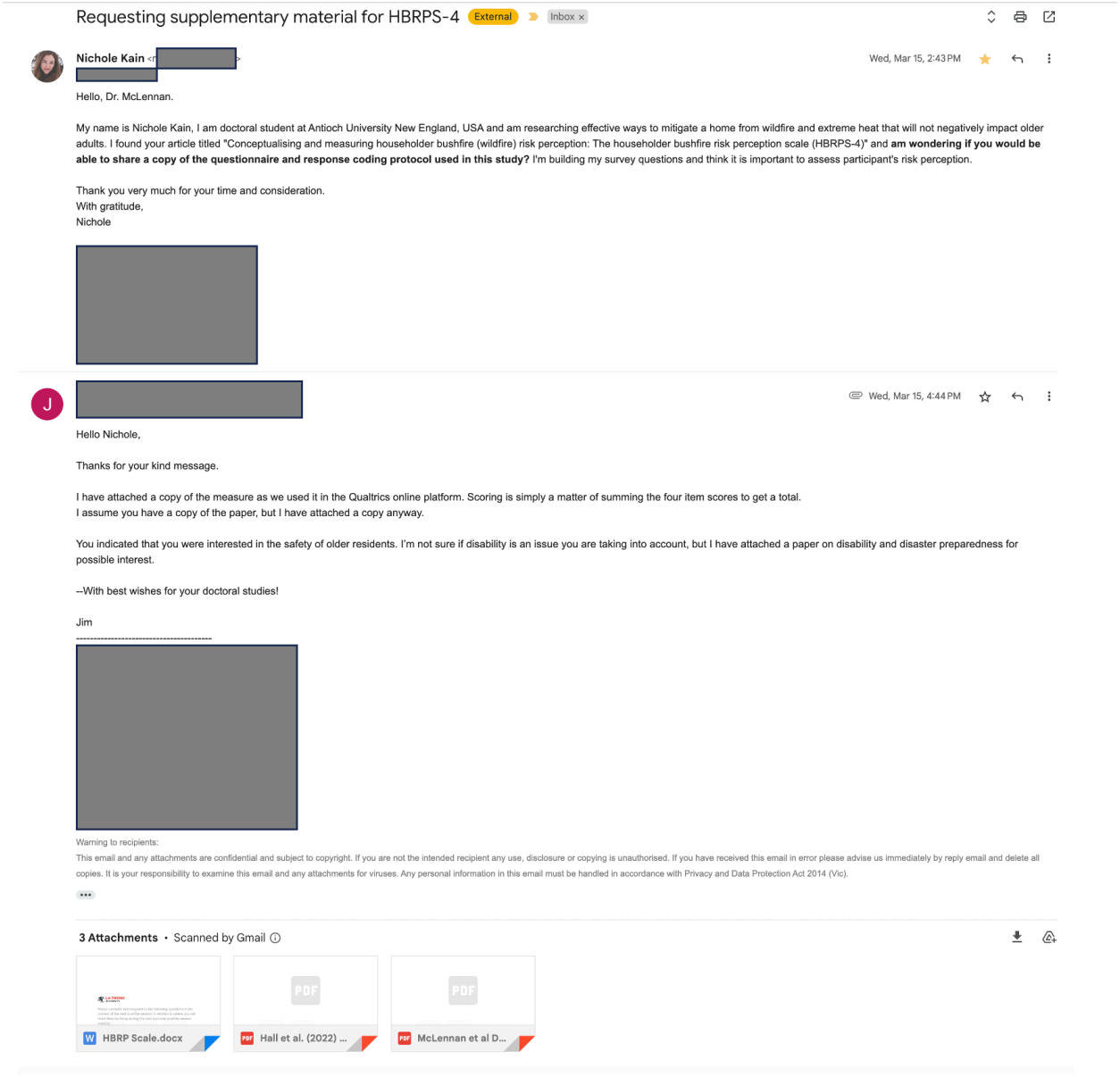


	Survey Question	Answer opt...	Section of Sur...	Corresponds to which portion of the PLACE Fram...	Adapted fro...	Notes
1	What is your age?		Demographics	Climate Vulnerability, Vulnerability Theory	US Census	
2	What is your sex?		Demographics	Climate Vulnerability, Vulnerability Theory	US Census	
3	How many people live in your household?		Demographics	Climate Vulnerability, Vulnerability Theory		People who
4	What is your total annual income?		Demographics		US Census	
5	What is your zip code?		Demographics	Climate Vulnerability	US Census	
6	Is this your primary home or a secondary home?		Demographics			
7	Type of home		Demographics			
8	Do you rent or own this home?		Demographics			
9	General location of this home.		Demographics			
10	Is this home located in a homeowner association (HOA) mana...		Demographics	Climate Mitigation, Environmental Press		HOAs have
11	If this is your primary residence, how long have you lived here?		Demographics			
12	If this is a secondary residence, how long have you owned thi...		Demographics			
13	What is the possibility of your life being threatened by an extr...		Risk Perception	Perception of Personal Risk	HBRP Scale	Risk percep
14	If there was a heatwave lasting more than three days, how da...		Risk Perception	Perception of Personal Risk	HBRP Scale	
15	How concerned are you about a possible heatwave threat to ...		Risk Perception	Perception of Personal Risk	HBRP Scale	
16	How confident are you that your home could protect you and ...		Risk Perception	Perception of Personal Risk	HBRP Scale	
17	Opportunity to offer details on your choices above.		Risk Perception			
18	Which of the following have you experienced in the last 3 yea...		Risk Perception	Climate Vulnerability, Vulnerability Theory		
19	Opportunity to provide additional details.		Risk Perception			
20	Has anyone in your household fallen while at home in the last ...		Risk Perception	Environmental Press, Vulnerability Theory		Risk of fallir
21	Have you ever used one of the city's cooling shelters during a...		Risk Perception	Perception of Personal Risk, Environmental Press	Archival Review	
	household have a plan to stay cool during prolong...		Risk Perception	Perception of Personal Risk		

This table has been used to organize survey questions and connect source information for each question. View Airtable with the following link:

https://airtable.com/appyZwyrDrWe9s6MY/shrIplg4gH3y5IKNs

Permission to Use HBRPS-4



Requesting supplementary material for HBRPS-4 External Inbox ×

Nichole Kain <[redacted]> Wed, Mar 15, 2:43 PM

Hello, Dr. McLennan.

My name is Nichole Kain, I am doctoral student at Antioch University New England, USA and am researching effective ways to mitigate a home from wildfire and extreme heat that will not negatively impact older adults. I found your article titled "Conceptualising and measuring householder bushfire (wildfire) risk perception: The householder bushfire risk perception scale (HBRPS-4)" and **am wondering if you would be able to share a copy of the questionnaire and response coding protocol used in this study?** I'm building my survey questions and think it is important to assess participant's risk perception.

Thank you very much for your time and consideration.
With gratitude,
Nichole

[redacted]

J [redacted] Wed, Mar 15, 4:44 PM

Hello Nichole,

Thanks for your kind message.

I have attached a copy of the measure as we used it in the Qualtrics online platform. Scoring is simply a matter of summing the four item scores to get a total.
I assume you have a copy of the paper, but I have attached a copy anyway.

You indicated that you were interested in the safety of older residents. I'm not sure if disability is an issue you are taking into account, but I have attached a paper on disability and disaster preparedness for possible interest.

--With best wishes for your doctoral studies!

Jim

[redacted]

Warning to recipients:
This email and any attachments are confidential and subject to copyright. If you are not the intended recipient any use, disclosure or copying is unauthorised. If you have received this email in error please advise us immediately by reply email and delete all copies. It is your responsibility to examine this email and any attachments for viruses. Any personal information in this email must be handled in accordance with Privacy and Data Protection Act 2014 (Vic).

3 Attachments • Scanned by Gmail

HBRP Scale.docx | Hall et al. (2022) ... | McLennan et al D...

Permission to Use Modified HBRPS-4

Nichole Kain [redacted]
to Jim

Dec 19, 2023, 10:50 AM (22 hours ago)

Hi, Jim -

I'm writing to follow up with you about the HBRP scale. Thank you again for sending me these resources.
I have narrowed my focus for the dissertation research from wildfire + extreme heat, to only extreme heat. With that in mind, I still am interested in understanding older participants' personal perception of risk.
Therefore, I'm writing to request permission to use questions I created, which are inspired by the HBRPS-4, for use as part of my larger survey.
Here are my proposed survey questions, and the corresponding HBRPS-4 question:

Survey question	HBRPS-4 question
In your opinion, how likely is it that your life will be threatened by an extreme heat wave next season?	What do you think your home's brushfire risk level will be next brushfire season?
If there was a heat wave in your city lasting more than three days, how dangerous could this be for you?	What is the possibility of your home being threatened by a brushfire?
If there was a heat wave in your city lasting more than three days, how dangerous could this be for members of your household?	If there was a brushfire close to your home, how dangerous could this be for you and the members of your household?
How confident are you that your home could protect you during a heat wave if your neighborhood lost power?	How concerned are you about a possible threat to your home?

The survey questions are inspired by the HBRPS-4, but reflect issues connected with extreme heat rather than brushfires.
Because of these modifications to the questions, and since risk perception is part of a much larger survey about adaptive strategies older residents are implementing in their homes, I don't plan on scoring as you previously described with HBRPS-4 -- but simply using descriptive statistics. I also have a couple of open narrative questions for participants to elaborate further about perception of risk if desired.

Thank you for considering this request to offer permission for me to use survey questions that have been inspired by the HBRPS-4 for use in my dissertation research.

With gratitude,
Nichole
[redacted]

Jim [redacted]
to me

Dec 19, 2023, 3:38 PM (17 hours ago)

Dear Nicole,

Permission is freely given to use the modified items of the HBRPS-4 for the purpose of your research as you propose.

For possible interest, I have attached a paper about heat stress from some work a team of us did. In Table 1 of the paper there is an error: in the Heat Stress Symptoms section, the number are displaced up one line and a numeral was omitted (this happened AFTER we proofread the material!!!): the correct value for "Feeling thirsty" is 52% and the values all drop down one line, so the value for "Sunburn" is 19%.

With best wishes for you research!

Jim

[redacted]

One attachment • Scanned by Gmail

Survey Consent and Questions in English and Spanish

Please use this link to view the table in detail, which includes: all survey questions, examples of how the answer options will be displayed to participant, corresponding section of survey for each question, corresponding PLACE framework component, checklist adapted from (if applicable), and notes.

Informed Consent:

The purpose of this survey is to gather your opinions and experience with extreme heat at home. Your feedback will help us understand how our homes can better protect people during extreme heat.
To take this survey, you should be age 65 or older and live in Arizona, or age 65 or older and own a home in Arizona.

Filling out the survey is voluntary; you may end at any time. Results will be anonymous, and may be used for future projects. There are no known risks from participating.

The survey will take about 15 minutes to complete. This project has been approved by the Institutional Review Board at Antioch University; if you have any questions about your rights as a participant, please contact IRB Chair,
By clicking the arrow below, you have read this form and agree to participate in the study.

Thank you!

---

1. Before we begin, let's make sure you are eligible to take the survey.
    a. Are you age 65 or older?
    b. Do you either currently live in Arizona or own a home in Arizona?

---

2. We will begin the survey with some background information about your home.

What is your zip cod_____

3. Is this your primary home or a secondary home?

Primary

Secondary (i.e., vacation house or investment property)

4. What type of home is this?

Single-family house

Attached: duplex or tri-plex

Townhouse: 4 attached units or more

Condominium

Manufactured home

Small and mobile (i.e., tiny house or house boat)

Accessory dwelling unit (i.e., smaller unit, which shares property with larger single-family house)

Other _____

5. Do you rent or own this home?

Rent

Own

What year was you_____

6. Is this home located in a homeowner association (HOA) managed community?

Yes

No

Unknown

7. If this is your primary residence, how long have you lived there?

0-3 years

4-9 years

10+ years

If over 10, approximately how long?

_____

8. If this is a secondary property, how long have you owned this home?

9. Including yourself, how many people live in the home?

More than 5

N/A, this is a secondary property'

Next, let's explore the risk posed by extreme heat in your home.

10. In your opinion, how likely is it that your life will being threatened by an extreme heat wave next season?
11. If there was a heat wave in your city lasting more than three days, how dangerous could this be for you?
12. If there was a heat wave in your city lasting more than three days, how dangerous could this be for members of your household?
13. How confident are you that your home could protect you during a heat wave if your neighborhood lost power?

14. Which of the following have you experienced in the past year? (Choose all that apply.)

Heat exhaustion (i.e., headache, nausea, dizziness, weakness, irritability, Ivy sweating...caused by heat)

Heat stroke (i.e., confusion, slurred speech, loss of consciousness, It and dry skin...caused by heat)

Extreme heat altering your plans (i.e., not being able to go outside or to an event when you would like)

A temporary disability (i.e., broken ankle, cancer treatments, recovery from surgery...)

Permanent disability (i.e., stroke, paralysis, progression a chronic disease...)

15. Have you fallen while at home during the past year?
    a. What caused this fall to happen?

16. Have you ever used one of the city's cooling shelters during a heat wave?
    a. Why have you not used one the city's cooling shelters during a heat wave?

17. Does your household have a plan to stay cool during prolonged heat waves?
    a. Briefly, what is your household's plan to stay cool during prolonged heat waves?

18. What is your preferred method of staying cool in the summer?

In order to better protect people as we age in places with extreme heat, it is important to understand what adaptive features already exist in many homes.

19. Please answer the following questions about heat-adaptable features of your home.

	Yes	No	Unknown	Not applicable
Does your home have any type of air conditioning unit?				
If you have an air conditioner, are the filters changed at least once a month?				
Do you relay on an electric fan for cooling?				
Are there trees providing shade to the south-facing side of your home?				
Are there multiple windows you can open to achieve a cross breeze in your home?				
Do you have access to a hot tub at your home?				
Do you have access to a pool at your home?				
Does your home have adequate insulation, so that the cool air stays inside?				
Does your home have a cool roof (material used to reflect heat)?				
Does your home have a green roof (contained green space where plants are grown)?				
Does your home use energy efficient appliances?				

20. What type of air conditioning units(s) do you have in your home? (Choose all that apply.)

Central air

Window unit(s)

Ducted mini-split

Ductless mini-split

Evaporative cooler (swamp cooler)

Radiant cooling

Other _____’_____

Now we'll talk about some barriers to staying cool in your home during high heat.

21. How difficult is it to operate your air conditioning unit?

22. How often do you delay turning on your air conditioner because of the high energy cost to cool your home?
23. How difficult is it to open your windows to achieve a cross breeze?

24. If you live in an HOA managed community, do the HOA rules impact your ability to protect yourself from extreme heat while in your home? (i.e., not allowing window air conditioning units, or not allowing planting of shade trees)

Yes. The HOA has rules preventing me from fully protecting myself during extreme heat.

No. The HOA has no barriers and supports any changes I need to make to my home.

I do not live in an HOA.

Other _____

25. If you live in an HOA, what more could your HOA do to help residents stay cool on the most extreme heat days?

26. In your opinion, what the biggest challenge to staying cool in your home?

In order to better protect people as we age in places with extreme heat, it is important to understand what adaptive features already exist in many homes.

27. Please answer these questions about age-adaptable design features in your home.

	Yes	No	Unknown	Not Applicable
Is there at least one step-free entrance to the home?				
Does the most commonly used entrance to the home open out?				
Are there steps to enter the front door?				
Is the home's address number clearly visible?				
Are the exterior walkways and entrances well lighted?				
Are the exterior walkways safe and free of tripping hazards?				
Are the exterior door thresholds flat and easy to see?				
Is the entrance door easy to lock, unlock, open and close?				
Do all of the exterior doors have a secure lock that won't accidentally lock someone out?				
Do the gutters of the home require yearly maintenance to remove debris?				

28. Please answer these additional questions about age-adaptable design features in your home.

	Yes (1)	No (2)	Unknown (3)	Not Applicable (4)
Is there a bedroom, full bathroom, and kitchen on the main level?				
Does the kitchen have a work surface that can be used while seated?				
Are the kitchen cabinets and shelves easy to reach and use?				
Do the cabinets and drawers have easy-to-grasp, D-shaped handles?				
Does the kitchen have a lever, touch, or sensor-style faucet?				
Is there lighting above the sink, stove and other work areas?				
Does the stove or cooktop have controls near the front of the device?				
Does one shower in the home at a step-free entry?				
Are the bathroom cabinets and shelves easy to reach and use?				
Are the toilets a comfortable height”				
Is there "blocking" (e.g., a wood stud or other surface) behind the bathroom walls so grab or assist bars can be securely installed in the bathroom, shower, and toilet areas?				
Does one shower in the home at a step-free entry?				
Are the bathroom cabinets and shelves easy to reach and use?				
Are the toilets a comfortable height?				
Are the hallways well lighted? (i.e., Can people see what is in front of them on the floor?)				
Are the doorway” and hallways at least 32" wide?				
Are the staircases well lighted?				
Are there switches at both the top and bottom of the stairs to control stairway light fixture?				

Are there secure handrails on both sides of the stairs?				

As we wrap up, let's talk about solutions to help people age in places with extreme heat.

What age-adaptable home upgrades do you think should come standard on homes built in your city? _____

In your opinion, what features should come standard in all homes to help people stay cool? _____

What more could your city do to help people stay cool in the summer? _____

29. How strongly would you support requiring new homes in your state to be built with standards supporting both living with extreme heat and age-friendly designs?

Your experience matters.
If you are willing to speak directly with the researcher to share your opinions about living with extreme heat, please include your email or phone number and the
res_____

In this final section, please answer the following demographic questions to help us better understand the survey participants.

---

30. Approximately how many months out of the year do you live in Arizona?

If you do not live in Arizona full time, in what other cities do you reside?
_____

---

31. If you currently live full time in Arizona, are you considering moving away because of the heat?

Yes

No

Unsure

Yes, but not because of the heat. _____

---

32. If you moved out of Arizona, where would you want to live?

---

33. What is your age?

---

34. What is your sex?

Female

Male

Prefer not to say

35. What is your total household income?

Thank you for participating in this survey, your responses will help shape the future of housing. Please share this link with someone else over age 65 in Arizona.

Survey in Spanish:

El objetivo de esta encuesta es recopilar sus opiniones y experiencias con el calor extremo en el hogar. Sus comentarios nos ayudarán a comprender cómo pueden nuestras casas proteger mejor a las personas en caso de calor extremo.
Para participar en esta encuesta, debe tener 65 años o más y vivir en Arizona, o tener 65 años o más y ser propietario de una vivienda en Arizona.

La encuesta es voluntaria y puede terminarla en cualquier momento. Los resultados serán anónimos y podrían usarse en futuros proyectos. No existen riesgos conocidos por participar.

La encuesta se completa en aproximadamente 15 minutos. Este proyecto ha sido aprobado por la Junta de Revisión Institucional de la Universidad de Antioquía; si tiene alguna pregunta sobre sus derechos como participante, póngase en contacto con el presidente de la Junta.
Al hacer clic en la flecha de abajo, indica que ha leído este formulario y acepta participar en el estudio.

¡Gracias!

36. Antes de empezar, asegurémonos de que cumple los requisitos para participar en la encuesta.
    a. ¿Tiene 65 años o más?
    b. ¿Vive actualmente en Arizona o es propietario de una vivienda en Arizona?

---

37. Comenzaremos la encuesta con información general sobre su vivienda.

¿Cuál es su _____

---

38. ¿Es su vivienda principal o secundaria?

Principal

Secundaria (es decir, casa de vacaciones o propiedad de inversión)

---

39. ¿Qué tipo de vivienda es?

Vivienda unifamiliar

Adosado: dúplex o tríplex

Casa adosada: 4 unidades adosadas o más

Condominio

Casa prefabricada

Pequeña y móvil (por ejemplo, una casa pequeña o una casa-barco)

Unidad de vivienda complementaria (es decir, unidad más pequeña que comparte la propiedad con una casa unifamiliar más grande)

Otro _____

---

40. ¿Alquila o es propietario de esta vivienda?

Alquilo

Propia

¿En qué _____

---

41. ¿La vivienda está situada en una comunidad gestionada por una asociación de propietarios (HOA, por sus siglas en inglés)?

Sí

No

No lo sé

---

42. Si ésta es su residencia principal, ¿desde cuándo vive en ella?

0-3 años

4-9 años

Más de 10 años

Si son más de 10 años, ¿durante cuánto tiempo aproximadamente?

_____

43. Si es una propiedad secundaria, ¿cuánto tiempo hace que es propietario de esta vivienda?

44. Incluido usted, ¿cuántas personas viven en el hogar?

Más de 5

N/C, es una propiedad secundaria

A continuación, analicemos el riesgo que representa el calor extremo en su hogar.

45. En su opinión, ¿qué probabilidad hay de que su vida se vea amenazada por una ola de calor extremo la próxima temporada?

46. Si en su ciudad hubiera una ola de calor que durara más de tres días, ¿qué peligro representaría para usted?

47. Si en su ciudad hubiera una ola de calor que durara más de tres días, ¿qué peligro representaría para los miembros de su hogar?

48. ¿Qué tan seguro está de que su casa podría protegerlo durante una ola de calor si su vecindario se quedara sin electricidad?

---

49. ¿Cuál de las siguientes situaciones ha experimentado en el último año? (Seleccione solo lo que corresponda).

Agotamiento por calor (p. ej., dolor de cabeza, náuseas, mareos, debilidad, irritabilidad, sudoración intensa... causados por el calor).

Golpe de calor (p. ej., confusión, dificultad para hablar, pérdida de conciencia, piel caliente y seca... causados por el calor)

El calor extremo alteró sus planes (p. ej., no pudo salir al exterior o asistir a un evento cuando quería)

Una incapacidad temporal (p. ej., un tobillo roto, tratamientos contra el cáncer, recuperación de una operación...)

Incapacidad permanente (p. ej., derrame cerebral, parálisis, progresión de una enfermedad crónica...)

---

50. ¿Se ha caído en su casa durante el último año?
    a. ¿Cuál fue la causa de la caída?

---

51. ¿Ha usado alguna vez uno de los refugios de enfriamiento de la ciudad durante una ola de calor?
    a. ¿Por qué no ha usado uno de los refugios de enfriamiento de la ciudad durante una ola de calor?

---

52. ¿Su hogar cuenta con un plan para mantenerse fresco durante las olas de calor prolongadas?
    a. Describa brevemente, ¿cuál es el plan de su hogar para mantenerse fresco durante las olas de calor prolongadas?

53. ¿Cuál es su método preferido para mantenerse fresco en verano?

Para proteger mejor a las personas mayores en lugares con calor extremo, es importante comprender qué características de adaptación ya existen en muchos hogares.

54. Responda a las siguientes preguntas sobre las funciones de su vivienda para adaptarse al calor.

	Sí	No	No lo sé	No corresponde
¿Su casa tiene algún tipo de aparato de aire acondicionado?				
Si tiene aire acondicionado, ¿se cambian los filtros al menos una vez al mes?				
¿Usa un ventilador eléctrico para refrescarse?				
225onsideboles de sombra en el lado orientado al sur de su casa?				
¿Hay varias ventanas que puede abrir para que corra una brisa cruzada en su casa?				
¿Tiene acceso a un jacuzzi en su casa?				
¿Tiene acceso a una alberca en su casa?				
¿Su casa tiene un aislamiento adecuado para que el aire frío permanezca adentro?				
¿Su casa tiene un techo térmico (material usado para reflejar el calor)?				
¿Su casa tiene un techo de vegetación (espacio verde delimitado en el que se cultivan plantas)?				
¿Usa 225onsidedomésticos de bajo consumo en su casa?				

55. ¿Qué tipo de aparatos de aire acondicionado tiene en su casa? (Seleccione solo los que correspondan).

Aire acondicionado central

Aire acondicionado de ventana

Minisplit con conductos

Minisplit sin conductos

Enfriador evaporativo (aparato de aire lavado)

Enfriamiento radiante

Otro _____

Ahora hablaremos de algunas barreras para mantenerse fresco en su casa cuando hace mucho calor.

56. ¿Le parece difícil manejar su aparato de aire acondicionado?

57. ¿Con qué frecuencia retrasa encender el aire acondicionado debido al alto costo de energía para enfriar su casa?

58. ¿Le resulta difícil abrir las ventanas para tener una brisa cruzada?

59. Si vive en una comunidad gestionada por una HOA, ¿las normas de la HOA afectan su capacidad para protegerse del calor extremo mientras está en su casa? (Por ejemplo, no permiten aparatos de aire acondicionado de ventana, o no permiten plantar árboles de sombra).

Sí. La HOA tiene reglas que me impiden protegerme bien durante el calor extremo.

No. La HOA no pone barreras y apoya cualquier cambio que necesite hacer en mi casa.

No vivo en una HOA.

Otro _____

60. Si vive en una HOA, ¿qué más podría hacer la HOA para ayudar a los residentes a mantenerse frescos en los días de calor más extremo?

61. En su opinión, ¿cuál es el mayor desafío para mantener fresco su hogar?

Para proteger mejor a las personas mayores en lugares con calor extremo, es importante comprender qué características de adaptación ya existen en muchos hogares.

62. Responda a estas preguntas sobre las funciones de diseño adaptables a la edad en su hogar.

	Sí	No	No lo sé	No corresponde
¿Hay al menos una e227onsiderin escalones a la vivienda?				
¿Se abre ha227onsidera la entrada a la vivienda que más se usa?				
¿Hay es227onsids para entrar en la puerta principal?				
¿Está bien visible el número de la dirección de la casa?				
¿Están bie227onsidereos los pasillos exteriores y las entradas?				
227onsidereos los pasillos exteriores y están libres de peligros de tropiezo?				
¿Lo227onsidere de las puertas exteriores son planos y fáciles de ver?				
227onsiders canalones de la vivienda r227onsidren un mantenimiento anual para eliminar los residuos?				

63. Responda estas preguntas adicionales sobre las funciones de diseño adaptables a la edad en su hogar.

	Sí (1)	No (2)	No lo sé (3)	No corresponde (4)
¿229onsiderrecámara, un baño completo y una cocina en la planta principal?				
¿Dispone la cocina de una superficie de trabajo que se pueda usar estando sentado?				
¿Los gabinetes y estantes de la cocina son fáciles de alcanzar y de usar?				
¿Los gabinetes y cajones tienen asas en forma de D fáciles de agarrar?				
¿La cocina tiene una llave de palanca, táctil o con sensor?				
¿Hay iluminación sobre el lavabo, la estufa y otras áreas de trabajo?				
¿La estufa o placa de cocción tiene controles cerca de la parte frontal del aparato?				
¿Una regadera del hogar tiene una entrada sin escalones?				
¿Los gabinetes y estantes del baño son fáciles de alcanzar y usar?				
¿Los inodoros tienen una altur“ cómoda”				
¿Hay algún "bloqueo" (por ejemplo, un travesaño de madera u otra superficie) detrás de las paredes del baño par229onsidr instalar de forma segura barras de agarre o de asistencia en las áreas del baño, la regadera y el inodoro?				
¿Una regadera del hogar tiene una entrada sin escalones?				
¿Los gabinetes y estantes del baño son fáciles de alcanzar y usar?				
¿Los inodoros tienen una altura cómoda?				
¿Están bien iluminados los pasil229onsideredecir, ¿puede la gente ver lo que tienen delante en el suelo?).				
¿Las puertas y los pa229onsid tiene” una anchura mínima de 32" (81.2 cm)?				
¿Están bien iluminadas las escaleras?				

¿Hay interruptores en la parte de arriba y de abajo de la escalera para controlar la iluminación de la escalera?				
¿Hay barandales seguros a ambos lados de la escalera?				

Para terminar, hablemos de soluciones para ayudar a las personas mayores a vivir en lugares con calor extremo.

¿Qué mejoras para viviendas adaptadas a la edad cree que deberían incluirse por norma en las viviendas construida_____

En su opinión, ¿qué funciones deberían incluirse por norma en todos los hogares para ayudar a las personas a mantenerse frescas en co_____

64. ¿Qué más podría hacer su ayuntamiento para ayudar a los residentes a mantenerse
frescos?_____

65. ¿Hasta qué punto apoyaría pedir que las nuevas viviendas de su estado se construyan con normas que apoyen la vida con calor extremo y los diseños adaptados a las personas mayores?

Su experiencia es importante.
Si desea hablar directamente con el investigador para compartir sus opiniones sobre la vida con

calor extremo, incluya su correo electrónico o número de teléfono y el investigador podrá pone_____

En esta sección final, responda las siguientes preguntas demográficas para ayudarnos a comprender mejor a los participantes en la encuesta.

---

66. Aproximadamente, ¿cuántos meses al año vive en Arizona?

Si no vive en Arizona todo el tiempo, _____

---

67. Si actualmente vive a tiempo completo en Arizona, ¿está considerando la posibilidad de mudarse a causa del calor?

Sí

No

No estoy seguro

Sí, pero no por el calor.

_____

---

68. Si se mudara fuera de Arizona, ¿dónde le gustaría vivir?

---

69. ¿Cuál es su edad?

---

70. ¿Cuál es su sexo?

Mujer

Hombre

Prefiero no responder

---

71. ¿Cuáles son los ingresos totales de su hogar?

Gracias por participar en esta encuesta, sus respuestas ayudarán a dar forma al futuro de la vivienda. Por favor, comparta este enlace con alguien más mayor de 65 años en Arizona.

Press Release Template for Survey

FOR IMMEDIATE RELEASE
Home Matters:
A Digital Survey to Explore Age-Adaptable, Climate-Resilient Housing for Older Adults

[City, State] – As our population ages and faces the ever-growing threat of climate change, one doctoral researcher is on a mission to ensure that older adults can live safely and comfortably in their homes, no matter the conditions. The Home and Place Project invites older adults (aged 65 and above) in Arizona to participate in a groundbreaking digital survey aimed at understanding the connections between climate-adaptive and age-friendly housing design.

The problem is clear: older adults are disproportionately affected by climate-related disasters, such as extreme heat. With 10,000 people in the U.S. turning 65 daily and an increasing number choosing to retire in arid and mountainous regions, it is critical to adapt our housing designs to cater to the changing needs of an aging population while also addressing climate concerns.

To help inform housing policies that benefit both older adults and the environment, I intend to explore effective ways to mitigate homes against extreme heat without negatively affecting older community residents. By analyzing which residential strategies are most commonly implemented by older people living in high-risk areas, the research will seek to seamlessly incorporate age-adaptable design decisions into climate-resilient housing types.
If you are aged 65 or older and live in (or own a home in) Arizona, we invite you to participate in this important study. The digital survey will be hosted on www.HomeAndPlaceProject.com during July and August 2023. Your input will help shape the future of age-friendly and climate-adaptive housing in the U.S.

To learn more about the doctoral researcher and the project, visit www.HomeAndPlaceProject.com. Home matters – and your voice matters in ensuring a safe, comfortable, and sustainable living environment for all.

About this project: Home and Place Project is a research initiative focused on creating a better understanding of the connection between age-friendly and climate-adaptive housing designs. By working with older adults and studying their experiences and perspectives, we aim to inform housing policies that support both our aging population and the environment. For more information, visit www.HomeAndPlaceProject.com.

Contact: Nichole Kain | XXX-XXX-XXXX | XXX@XXXXX.XXX | www.HomeAndPlaceProject.com

Survey Poster

Hung in coffee shops (etc.) around the Phoenix metro area.

Survey Email Template: Senior Centers

Subject: Seeking Your Help to Share a Digital Survey for Older Adults in [State]

Dear [Senior Center Director/Coordinator's Name],

I hope this email finds you well. My name is Nichole Kain, and I am a doctoral student researcher working on a project that focuses on understanding the connection between age-friendly housing and climate resilience, especially in areas at high risk of extreme heat. I believe the insights from this research can help inform better housing policies for older adults in the United States, ensuring safe and comfortable living environments.

I am reaching out to kindly request your assistance in sharing a digital survey with your senior center members. Participants for this survey are people aged 65 and above who live in (or own a home in) Arizona. The digital survey will be available from July 1, 2023, to August 31, 2023, and can be accessed at www.HomeAndPlaceProject.com.

If you could kindly share the survey information with your members through email newsletters, social media, or any other communication channels you use, I would be extremely grateful. To make it easy for you, I have provided a brief description of the survey that you can share: "Home Matters: Help shape the future of age-friendly and climate-resilient housing by participating in a digital survey for older adults aged 65 and above living in (or owning a home in) Arizona. Share your thoughts and experiences on home design for extreme heat. Visit www.HomeAndPlaceProject.com to participate and learn more about the project."

Your support in sharing this survey can have a lasting impact on the future of housing for older adults and their ability to safely navigate the challenges of climate change. If you have any questions or require more information, please feel free to contact me directly at XXX@XXXXX.XXX or XXX-XXX-XXXX.

Thank you for considering this request and for your ongoing commitment to supporting the well-being of older adults in your community.

Warm regards,
Nichole Kain, Doctoral Researcher
XXXXX@XXXXX.XXX
XXX-XXX-XXXX

Marketing Plan for Survey Distribution

Marketing Plan: Survey Outreach
Objective: To promote and increase awareness about the survey among the target audience, which comprises older adults residing in Arizona, and encourage their participation.

Marketing Channels:

- Direct recruitment
- Flyers
- Task Rabbit (for flyer distribution)
- Local Community Centers and Senior Centers
- Email Campaign
- Partnerships with Local NGOs
- Local Media

Weekly Breakdown:
Week 1:

1. **Direct Recruitment**
   Email people known to researcher who either would fit demographic or who may know someone in the desired demographic, ask to share survey. Monitor initial performance.
2. **Initial Flyer Distribution**
   Begin the distribution of the already designed flyers through Task Rabbit in two major cities in Arizona (Phoenix and Tucson).
3. **Initiate Contact with Community Centers**
   Send out emails to community centers and senior centers in Arizona, introducing the survey and requesting their support in promoting it.
4. **Engagement on social media**
   Actively engage with any early responses or queries on Facebook regarding the survey. Encourage shares and likes to increase visibility.

Week 2:

5. **Engage with Local Community Centers and Senior Centers**
   Follow up with community centers and senior centers via phone call or visit, and provide them with flyers to distribute to their members.
6. **Monitor Facebook Ads**

Track the performance of Facebook Ads and make necessary adjustments to targeting.

7. **Partnerships with Local NGOs**
   Begin reaching out to local NGOs working with older adults to explore partnerships for promoting the survey.

Week 3:

8. **Press Release Distribution**

Send press releases to local media outlets, including newspapers and TV stations.

9. **Email Reminder**

Send a reminder email to community and senior centers.

10. **Update social media**

    Post an update on the Facebook page to create continued awareness about the survey.

Week 4/5:

11. **Final Push via social media**

Create urgency by highlighting that the survey is closing soon.

12. **Thank You Emails**

    Send thank you emails to all the community centers, senior centers, and NGOs that helped promote the survey.

13. **Final Review of Facebook Ads**

    Do a final review and assessment of the Facebook ads campaign.

Final Day:

14. **Close the Survey**

Officially close the survey for responses at 11:59pm on August 31st.

15. **Acknowledgement Post**

    Publish a thank you post on the Facebook page for all participants and supporting organizations.

APPENDIX C: SUPPLEMENTAL INFORMATION FOR PART III, KEY INFORMANT INTERVIEWS

English Consent Form: Key Informant Interviews

Title of Study: Climate-Adaptive and Lifelong Housing
Researcher: Nichole Kain, Antioch University New England

This voluntary 1-hour interview will be conducted and recorded with Zoom. Your insights will help make homes safer for older adults living with extreme heat. Ultimately, the goal of this project is to inform policy and practice, ensuring that homes can better support the needs of older adults while also being adaptable to the changing climate conditions. There are few, if any, risks to participating. You will be able to choose how you will be identified in the study, and results will be stored securely and used only for research purposes.

For more information about the study, please visit www.HomeAndPlaceProject.com.

This interview is part of my dissertation research at Antioch University New England in the Environmental Studies program. The information may be used for future research without additional consent. You may end the interview at any time. If you have any questions, please contact me at: XXX@XXX@.XXX

This project has been approved by the Institutional Review Board at Antioch University. If you have any questions about your rights as a research participant, please contact the IRB Chair, Kevin Lyness XXXX@XXXXX.XXX or the School of the Environment Dean, Ben Pryor XXX@XXXXX.XXX.

By signing or typing your name below, you confirm to have read and understood the information provided and you agree to participate.
Please print a copy of this page for your records. Thank you for your participation!

Participant's Name: _____
Participant's Signature: _____
Date: _____
Please provide your preferred method of attribution for the write-up (e.g., NAME, TITLE, ORGANIZATION, Leader in BLANK Industry, or ANONYMOUS):

Spanish Consent Form: Key Informant interviews

Título del estudio: Vivienda adaptada al clima y para toda la vida

Investigador: Nichole Kain, Antioch University New England

Esta entrevista voluntaria de 1 hora se realizará y grabará con Zoom. Sus conocimientos ayudarán a que los hogares sean más seguros para los adultos mayores que viven en condiciones de calor extremo. En última insta239onsider objetivo de este proyecto es inf239onsidere políticas y las prácticas, garantizando que los 239onsies puedan satisfacer mejor las necesidades de los adultos mayores y al mismo tiempo ser adaptables a las condiciones climáticas cambiantes. Hay pocos riesgos, si es que hay alguno, al participar. Podrá elegir cómo239onsididentificará en el estudio y los resultado239onsidlmacenarán de forma segura y se utilizarán únicamente con fines de investigación.

Para obtener239onsidformación sobre el estudio, visite www.HomeAndPlaceProject.com.

Esta entrevista es parte de mi investigación de tesis en la Universidad de Antioch, Nueva Inglaterra, en el programa de Estudios Ambientales. La información puede utilizarse para futuras investigaciones sin consen239onsidereadicional. Puede finalizar la entrevista en cualquier momento. Si tiene alguna pregunta, comuníquese conmigo XXXX@XXXXX.XXX

Este proyecto ha sido aprobado por la Junta de Revisión Institucional de la Universidad de Antioch. Si tiene alguna pregunta sobre sus derechos como participante de la investig239onsidereuníquese con el presidente del IRB, Kevin Lyness XXXX@XXXX.XXX o con el decano de la Escuela de Medio Ambiente, Ben Pryor XXX@XXXXX.XXXX onsidereirmar o escribir su nombre a continuación, confirma haber leído y comprendido la información proporcionada y acepta participar.
Imprima una copia de esta página para sus registros. ¡Gracias por su participación!

Nombre del participante: _____
Firma del participante: _____
Fecha: _____
Proporcione su método de atribución preferido para el artículo (por ejemplo, NOMBRE, TÍTULO, ORGANIZACIÓN, Líder en la industria en BLANCO o ANÓNIMO):

English Email Template: Key Informant Recruiting

Subject: Invitation to Participate as a Key Informant in Climate-Adaptive and Age-Friendly Housing Research

Dear [Recipient's Name],

I hope you're well. I'm Nichole Kain, a doctoral student researching how homes can better support older adults during extremely hot weather. Your expertise in [Recipient's Profession] caught my attention, and I believe your insights would be helpful for this project.

My research has received IRB approval, for more information please can visit my website at www.HomeAndPlaceProject.com. If you're interested in participating, we can set up a 60-minute Zoom chat. You can even choose a time that works best for you on my online calendar [insert Calendly link].

If this sparks your interest, or if you have any questions, please reach out. I'd greatly value your perspective. Thank you for considering this.

Looking forward to potentially connecting with you.

Best regards,
Nichole Kain
Doctoral Student Researcher
Antioch University New England
XXX-XXX-XXXX

Spanish Email Template: Key Informant Recruiting

Asunto: Invitación a participar como informante clave en la investigación sobre viviendas adaptadas al clima y adaptadas a las personas mayores

Estimado [Nombre del destinatario],

Espero que estés bien. Soy Nichole Kain, una estudiante de doctorado que investiga cómo 241onsiogares pueden ayudar mejor a los adultos mayores durante un clima extremadamente caluroso. Su experiencia en [Profesión del destinatario] me llamó la atención y creo que sus conocimiento241onsider útiles para este proyecto.

Mi investigación recibió la aprobación del IRB; para obten241onsideinformación, puede visitar mi sitio web en www.HomeAndPlaceProject.com. Si está 241onsideado en participar, podemos programar un chat de Zoom de 60 minutos. Incluso pue241onsilegir el horario que mejor te convenga e241onsiderendario en línea [insertar enlace de Calendly].

Si esto despierta su interés o si tiene alguna pregunta, comuníquese con nosotros. Valoraría mucho tu241onsidererva. Gracias por considerar ésto.

Esperamos poder conectarnos con usted.

Atentamente,
Nichole Kain
Investigadora estudiante de doctorado
Antioch University New England
XXX-XXX-XXXX

Semi-Structured Interview Questions

The one-on-one interviews with key informants will be conducted, recorded, and transcribed using Zoom. The semi-structured interview questions will be tailored to each individual's area of expertise, but will all be related to residential extreme heat mitigation and age-friendly housing design. These questions were developed with this research question in mind: **What are strategies to improve residential extreme-heat resilience and enhance living conditions for people as we age in place?**

Examples of semi-structured interview questions include:

- In your experience, what are the most significant challenges or barriers to incorporating both climate-adaptive and age-friendly design elements into residential housing, especially in regions prone extreme heat?

- Can you share examples of successful projects or strategies that have effectively integrated age-friendly design with climate-adaptive measures against extreme heat? What lessons can we learn from these projects to advance the dual goals of climate resilience and age-friendliness in residential design?

- In your professional opinion, which design recommendations or strategies from extreme heat and age-friendly design are most crucial for creating climate-resilient housing that caters to the needs of older adults? Are there any recommendations that seem to conflict or create challenges when combined?

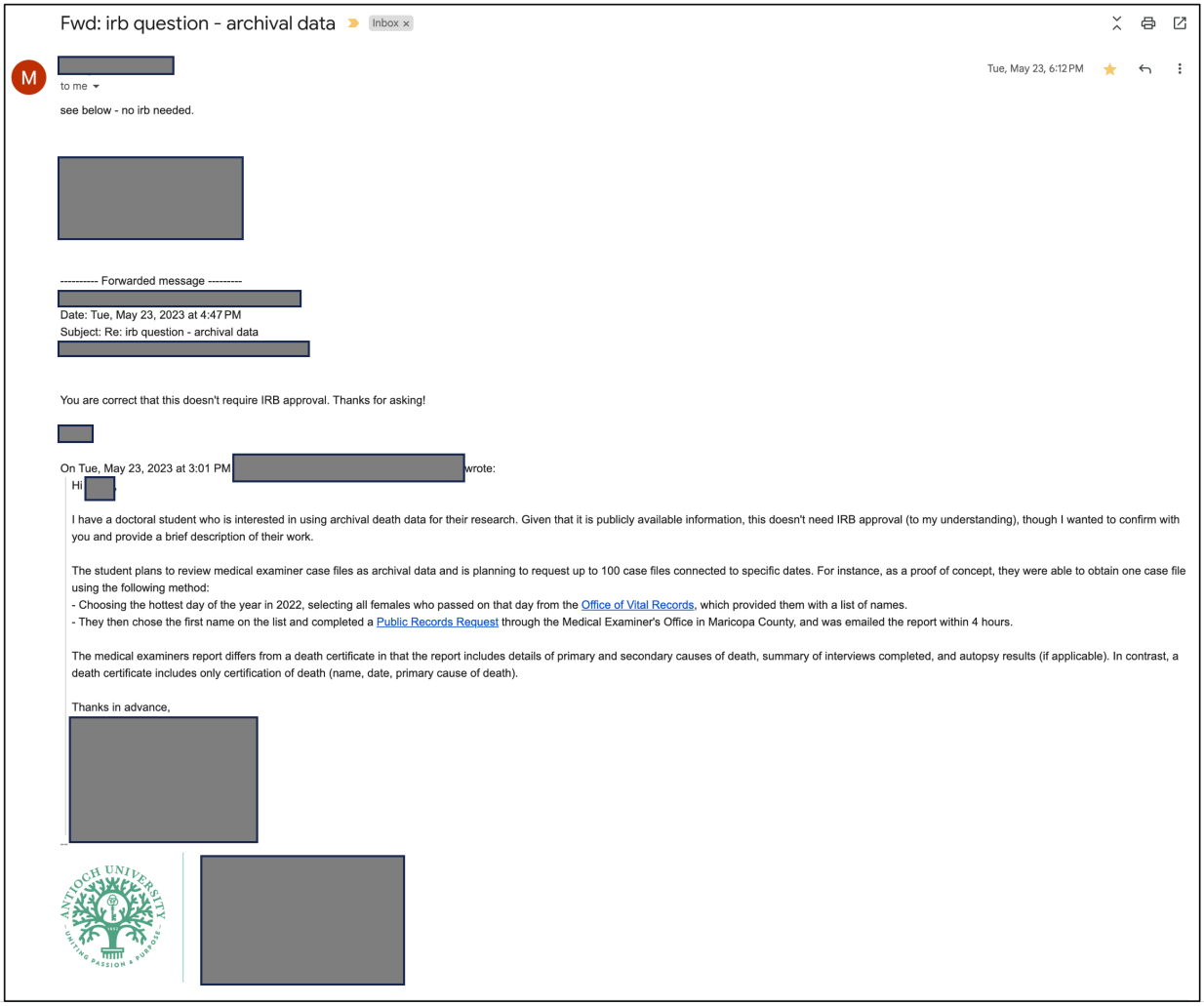
- What role do you think policy changes, financial incentives, or other support mechanisms can play in encouraging the adoption of climate-adaptive and age-friendly housing designs? Can you suggest specific policies or initiatives that could help overcome existing market barriers?

- Collaboration across different sectors and disciplines is often essential for implementing innovative solutions. In your experience, what kind of partnerships or collaborations would be most effective in promoting the dual goals of climate resilience and age-friendliness in residential design? How can industry professionals, policy makers, and older adults work together to advance this objective?

APPENDIX D: SUPPLEMENTAL INFORMATION FOR PART I, ARCHIVAL REVIEW

IRB Exemption

Confirmation email indicating no IRB review is needed for this archival study, with personal information redacted.



Fwd: irb question - archival data Inbox ×

M [redacted] Tue, May 23, 6:12 PM

to me

see below - no irb needed.

[redacted]

---------- Forwarded message ---------

[redacted]

Date: Tue, May 23, 2023 at 4:47 PM

Subject: Re: irb question - archival data

[redacted]

You are correct that this doesn't require IRB approval. Thanks for asking!

[redacted]

On Tue, May 23, 2023 at 3:01 PM [redacted] wrote:

Hi [redacted],

I have a doctoral student who is interested in using archival death data for their research. Given that it is publicly available information, this doesn't need IRB approval (to my understanding), though I wanted to confirm with you and provide a brief description of their work.

The student plans to review medical examiner case files as archival data and is planning to request up to 100 case files connected to specific dates. For instance, as a proof of concept, they were able to obtain one case file using the following method:

- Choosing the hottest day of the year in 2022, selecting all females who passed on that day from the Office of Vital Records, which provided them with a list of names.
- They then chose the first name on the list and completed a Public Records Request through the Medical Examiner's Office in Maricopa County, and was emailed the report within 4 hours.

The medical examiners report differs from a death certificate in that the report includes details of primary and secondary causes of death, summary of interviews completed, and autopsy results (if applicable). In contrast, a death certificate includes only certification of death (name, date, primary cause of death).

Thanks in advance,

[redacted]

ANTIOCH UNIVERSITY UNITING PASSION & PURPOSE

[redacted]

APPENDIX E: HANDOUT FOR THE GENERAL PUBLIC

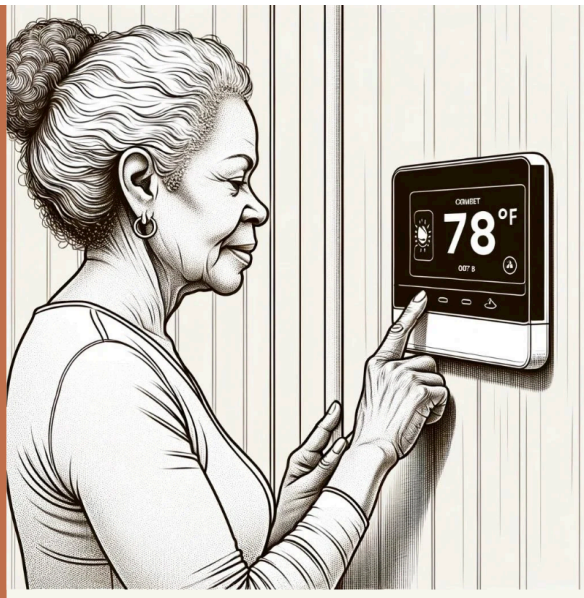
Our homes are one of the most important places to find safe shelter during intense weather events.

Extreme heat is the deadliest weather-related disaster within the United States, killing more people than all other weather events combined.

Tragically, most people killed by extreme heat are older than age 65 and die in their homes.

While extreme heat is not preventable, you can take steps to prepare your home to increase your chances of survival.

If you live in a place where the heat is becoming more intense, take time to prepare your home and protect yourself and loved ones, as you'll learn in this handout.



INSIDE YOUR HOME

Electric Fans

Do not rely on electric fans or opening windows to stay cool. Fans create a false sense of comfort, but do not reduce body temperature.

Air Conditioners

Use an air conditioner. Consider installing an energy efficient system or smart thermostat that adjusts your indoor temperature automatically.

If You Lose Power, Leave

Do not rely on your home to keep you cool if your area loses power during days of extreme heat.

How to stay cool if your home loses power

Visit a friend, ride the city bus, swim, visit a location with power: your church, community center, library, or mall.
Nationwide, PetCo stores double as pet-friendly cooling centers.

Home Insulation Programs

Find insulation assistance programs in your state:

https://www.energy.gov/scep/wap/weatherization-assistance-program

Insulation

Updating your home's insulation in the walls and attic is the best way to protect yourself from extreme heat. Be sure to also seal cracks and gaps around windows and doors where cool air could escape.

Low-Cost Solutions

- Close window blinds to prevent sun from heating the home's interior
- Designate a "cool room" with a window air conditioner on the lowest level of the home
- Use draft stoppers around doors and windows
- Keep pathways free of clutter to reduce risk of falling

High-Cost Solutions

- Replace standard roofing with cool roof technology
- Use solar panels and battery to provide power in case of outage
- Upgrade insulation throughout home, including windows and doors

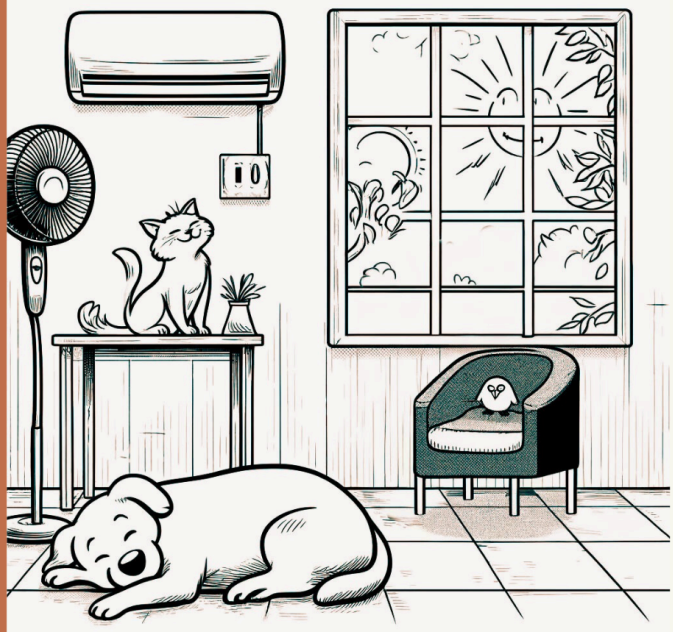
OUTSIDE YOUR HOME

Prevent Heat From Getting in the Home

- Plant shade trees or use shade sails
- Keep a small garden outside South-facing windows to provide shade to the interior
- Complete routine maintenance on external air conditioning units

Age-Friendly Ideas

Adjust your schedule to avoid being outside during heat of the day



PROTECT LOVED ONES

Pets

Pets rely on you to stay safe from extreme heat. Make sure they are drinking water and have continual access to air conditioning.

Pregnancy & Children

Children and pregnant people are especially vulnerable to extreme heat. Take care to ensure they have reliable access to air conditioning.

Community

People who know their neighbors are more likely to survive extreme weather. Host gatherings at your house or in the community, check on your neighbors during prolonged days of high heat.

Hydrate!

Hydration is essential to survival.

ADDITIONAL RESOURCES

Warning signs of heat-related illness

Learn the warning signs and what to do for heat-related illnesses.
https://www.cdc.gov/disasters/extremeheat/warning.html

Mobile app for heat notifications

Receive location-specific notifications for current and forecasted heat risks. Created for outdoor workers, but helpful for all.
https://toolkit.climate.gov/tool/heat-safety-tool

Be prepared

Learn how to assess your need, create a plan, and engage your network: https://www.ready.gov/older-adults

ANTIOCH UNIVERSITY
1852
UNITING PASSION & PURPOSE

HOME AND PLACE PROJECT

APPENDIX F: POLICY RESEARCH BRIEF

Antioch University New England

Policy Research Brief - July 2024

U.S. Housing Priorities for Aging with Extreme Heat

Overview

Aging populations—particularly in areas prone to extreme heat—face unique challenges at home. Extreme heat is a period of high heat and humidity with temperatures above 90 °F for at least 2–3 days (1). Prolonged exposure to these high temperatures can cause dehydration, heat exhaustion, heatstroke, and death (2). People age 65+ are disproportionately represented as the majority of heat victims, and are likely to perish in their own homes during these events (3; 4; 5). Every day, 10,000 people turn 65 in the U.S., and many are choosing to age and retire in places prone to extreme heat (5, 6). In the past 10 years, extreme heat has killed more people in the United States than all other weather hazards combined (2; 7), and it is expected to get hotter, with extreme heat events happening more often in the future (1; 2).

Key Points

Victims of extreme heat are likely to be over the age of 65.

Their home is the most common place for an older victim to be found.

While people over age 65 are not a homogeneous group, predictable changes that occur naturally with aging cause increased vulnerability when living with extreme heat (5; 6). These vulnerabilities include limited mobility, the tendency to live alone, and the presence of health conditions that cause negative responses to environmental stressors (6; 7). Nichole Kain, PhD Candidate at Antioch University New England, conducted research exploring connections between the design of homes and adaptive behaviors of people age 65+ during days of prolonged heat.

Methods

Kain conducted a convergent parallel mixed-methods research study in three parts: archival review of 2022 Medical Examiner reports from the three hottest days in Maricopa County, AZ; digital survey open to all people aged 65+ in Arizona; and semi-structured interviews with older Arizonians and professional key informants (i.e. with expertise in emergency management, housing, climate change, and aging). The research was designed and analyzed utilizing a new conceptual framework of her own making titled PLACE: Preparing Living spaces for Aging with Climate Extremes.

Findings

Among older Arizonians in this study, there was strong support for updating residential building codes to prioritize energy efficiency and age-friendly design. Participants also reported actively adapting their homes and lifestyle to the increased heat. However, awareness of one's own risk to heat varied. Findings indicated that participants would readily adjust their daily plans due to the immediate heat of the day, but had not considered what would happen if their neighborhood lost power during a heat wave. Lastly, barriers to cooling persist; the most pressing being high cost of energy and AC maintenance, and homeowners' associations (HOAs) preventing potentially lifesaving changes.

Policy Takeaways

- Institute federal requirements for municipalities to update local residential building codes to meet the projected climate and population aging needs for their region.
- Continue/increase federal support for efforts to offset high electricity costs and enhance residential insulation, for both existing and new construction homes. Support should be linked to the specific needs of older people in the community.
- The most promising way to adapt people's current homes to extreme heat is to prevent HOAs from restricting health-related changes to people's homes. For example, nationally, HOAs would no longer be allowed to prevent the installation of a window air conditioner or wheelchair ramps.

References

(1) Asseng, S., Spänkuch, D., Hernandez-Ochoa, I. M., & Laporta, J. (2021). The upper temperature thresholds of life. The Lancet Planetary Health, 5(6), e378–e385. https://doi.org/10.1016/S2542-5196(21)00079-6

(2) Faurie, C., Varghese, B. M., Liu, J., & Bi, P. (2022). Association between high temperature and heatwaves with heat-related illnesses: A systematic review and meta-analysis. Science of the Total Environment, 852, 158332.

(3) IPCC (2022). Summary for Policymakers: Working Group II (WGII) contribution to the Sixth Assessment Report (AR6). H.-O. Pörtner, D.C. Roberts, E.S. Poloczanska, K. Mintenbeck, M. Tignor, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem (eds.). Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 3–33, doi:10.1017/9781009325844.001.

(4) Kelman, I (2020). *Disaster By Choice: How our actions turn natural hazards into catastrophes.* Oxford University Press.

(5) Molinsky, J., & Forsyth, A. (2022). Climate Change, Aging, and Well-being: How Residential Setting Matters. Housing Policy Debate, 33(5), 1029–1054. https://doi.org/10.1080/10511482.2022.2109711

(6) Arigoni, D. (2023). *Climate Resilience for an Aging Nation*. Island Press.

(7) Jones, B., Dunn, G., & Balk, D. (2021). Extreme heat related mortality: spatial patterns and determinants in the United States, 1979–2011. *Spatial Demography*, 9(1), 107-129.

(8) Kain, N. (2024). *Aging in place with a warming climate: Housing design and policies for aging with extreme heat.* [Doctoral Dissertation - Antioch University New England].

Author

Nichole M. Kain, OTR/L, M.A., M.Sc., Ph.D.
Antioch University New England

Environmental Gerontologist, Nichole Kain, studies climate-adaptive lifelong housing.