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Research Article

Beat the Heat: Community Perspectives Around Extreme Heat in Spokane, WA, Post-2021 Northwest Heat Dome

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Abstract

Extreme heat events are the leading weather-related causes of death in the United States. Despite heat familiarity in eastern Washington, at least 19 heat-related deaths occurred in Spokane County during the 2021 "heat dome" in the Northwest. To assess heat concerns among vulnerable groups and identify cooling access barriers, surveys were conducted with Spokane County residents from July to November 2022. Descriptive statistics and ordinal logistic regression characterized perceptions of heat, access to home cooling, and interest in public cooling for vulnerable populations. A total of 1477 adults completed the survey. Demographics were comparable to the Spokane County US Census: 22.8% were 65+ years old, 83.1% non-Hispanic White, 30.2% had elderly at home, 29.6% had children at home, 40.9% had a disability or chronic illness at home, and 26.8% were renters. Nearly half perceived a mild-to-no threat of heat to personal well-being. Households with disabilities/medical illness, history of seeking medical attention due to heat, no AC, or renters having significantly greater heat concerns. Among those without AC, 66.9% preferred to stay home on very hot days and 44.4% would not consider using a public cooling center. Barriers to using public cooling included accessibility, entertainment, infection risk, and personal safety. Effective communication and intervention strategies should be tailored to the needs and perceptions of at-risk groups. Multimodal approaches are needed to address strong preferences to stay home and obstacles for utilizing public cooling spaces.

Keywords: Heat waves; Community preparedness; Risk perception; Health behavior; Public cooling centers

Introduction

Climate change poses a significant public health threat to communities worldwide. Extreme heat events are predicted to occur more frequently due to global warming [1]. In the U.S., such events are the leading cause of weather-related fatalities [2].

The 2021 "heat dome" event severely affected the Northwest [3] particularly cities like Seattle, WA and Portland, OR which reached temperatures of 108°F and 116°F respectively, and persisted at these high temperatures for three consecutive days [4]. This unprecedented heat wave resulted in over 100 heat-related deaths in Washington State alone [5], alongside significant increases in emergency department visits and unplanned hospitalizations [6]. Temperatures in Spokane, WA reached a record 109°F, where there were 19 documented health-related deaths [7]. This event highlighted the need to identify populations most at risk to extreme heat events in eastern Washington and to evaluate preparedness of communities for future occurrences.

Extreme heat does not affect everyone equally. Individual factors including chronic medical conditions [8], disability [9], age (particularly the elderly [10] and children [11]) are associated with increased susceptibility to adverse heat-related health outcomes. Recent studies have expanded our understanding, indicating that individuals as young as 45 years of age are also at heightened risk for negative impacts of extreme heat [12]. Additionally, socioeconomic variables such as income and race/ethnicity are indirectly related to heat-associated mortality [9]. These relationships may be mediated by factors including limited access to cooling, poorer overall physical health, residency in areas with less vegetative shade, institutional racism, and disparities in of educational awareness about heat risks [9,13]. Given the complex interplay of vulnerabilities, developing heat-resilient communities requires an approach that ensures all community members have the necessary support and infrastructure to withstand future extreme heat events.

Heat-related illness and mortality are often preventable by taking protective actions [14]. Utilizing home Air Conditioning (AC), visiting other air-conditioned places, and increasing social contact can improve health outcomes [15]. Understanding the access and limitations to home and public cooling is essential to addressing socioeconomic and infrastructural barriers that limit the use of cooling resources. Additionally, effective public communication through heat warning systems and emergency preparedness helps raise awareness and promote behaviors that mitigate heat-related risks [16]. Understanding community attitudes, beliefs, and fears regarding heat threat and cooling adaptations can inform messengers to tailor heat warnings that reach and engage vulnerable populations [17].

We conducted a survey of perceptions of heat threat, access to resources, and factors that influence decision-making around adaptation behaviors of community members in Spokane County, WA. This survey aimed to explore the following: (1) examine the level of concern and impact of heat among heat-vulnerable groups, and (2) examine the access and barriers to utilizing home and public cooling.

Materials and Methods

This was a cross-sectional study that analyzed information collected from July 21 to November 30, 2022 via a one-time anonymous digital and paper survey of Spokane County's residents. Spokane County is located in eastern Washington and has a population of approximately 550 000 individuals [18]. A variety of recruitment strategies were employed through social media posts, distribution of brochures/flyers at community centers, and neighbourhood canvassing. Incentives for survey completion included 98 five-dollar gift cards to local grocery stores and 8 tickets were raffled for multiple local sports games.

The survey contained 52 multiple choice questions with free-text short answers for "other" response options, of which we focused on 17 of the questions that covered three topic domains: (1) perceptions of heat threat and impact of heat on health, work, and community (2) access and barriers to utilizing home cooling, and (3) interest and barriers to utilizing public cooling opportunities. The survey was adapted from an instrument created by the Indiana University Environmental Resilience Institute [19]. The survey was accessible online via Qualtrics and available in English, Spanish, Russia, and Dari. The Gonzaga University's Institutional Review Board determined this study exempt.

Descriptive statistics were analyzed using R (version 2023.03.1). As all questions could be skipped, percentages were calculated by the responses per selected option divided by the total respondents that answered the given question. Several responses were regrouped; for example, perceived threat levels were collapsed into mild-to-no threat (no threat, very mild threat, and mild threat) and moderate-severe threat (moderate threat and severe threat) to simplify the descriptive reporting, though left ungrouped for the regression analysis.

Vulnerability factors to heat risk were chosen a priori from literature review and included household presence of elderly, children, disability/chronic illness, respondent's age, access to home cooling [8], history of seeking medical attention related to heat illness, home ownership and home location.

Multivariate ordinal regression was used to characterize the association between vulnerability factors and heat perceptions, as well as access to home cooling and interest in public cooling centers. We tested the proportional odds assumption using a graphical method [20]. We report significant vulnerability factors at p-value <0.05 and adjust for multiple comparisons using the Benjamini-Hochberg procedure [21].

A qualitative content analysis [22] was conducted on "other" or "please explain" free-text responses with more than 10% response rate. Two research team members [JL, KT] used an inductive approach to develop a codebook and label all free-text responses with a consensus-based discussion. Labels for free-text responses were summed together in the total counts when they matched provided options.

Results

Sample characteristics

Of the 1,799 survey respondents, 1,477 participants were >18 years old and responded to at least one or more heat related questions. Survey demographics were comparable to the study location's US Census [18] with 22.8% 65+ years old, 83.1% non-Hispanic White, 30.2% with an elderly at home, 29.6% with children at home, 40.9% disability or chronic illness at home, 15.6% below $25k yearly household income, and 26.8% renter. Compared to the Spokane County US Census, our sample had a lower representation of Hispanic/ Latino (2.1%) and individuals without health insurance (2.7%) (Table 1).

	n	%
Total surveys returned	1799	
Completed one or more heat related question and meeting eligibility criteria	1477	82.10%
Age (n=1441)		
18-44 years old	586	40.70%
45-64 years old	526	36.50%
65+ years old	329	22.80%
Race/Ethnicity (n=1367)		
Asian	30	2.10%
Black or African American	22	1.50%
Hispanic or Latino	30	2.10%
American Indian and Alaska Native	26	1.80%
Native Hawaiian and Other Pacific Islander	3	0.20%
White, not Hispanic or Latino	1201	83.10%
Two or More Races	82	5.70%
Location by Spokane District (n=1372)		
District1	317	23.10%
District2	420	30.60%
District3	383	27.90%
OUTSIDE CITY	252	18.40%
Child at home (n=1427)		
Yes (at least 1 or more)	423	29.60%
Elderly at home (n=1424)		
Yes (at least 1 or more)	430	30.20%
Disability or long-term illness at home (n=1348)		
Yes (at least 1 or more)	551	40.90%

Persons without insurance at home (n=1369)		
yes (at least 1 or more without insurance)	37	2.70%
Median Yearly Household Income (n=1404)		
$0 - $24,999	219	15.60%
$25,000 - $49,999	274	19.50%
$50,000 - $74,999	253	18.00%
$75,000 - $99,999	208	14.80%
$100,000 - $149,999	245	17.50%
$150,000 - $199,999	117	8.30%
$200,000 or more	88	6.30%
Housing status (n=1428)		
Rent home	382	26.80%
Own home	979	68.60%
Currently Homeless	10	0.70%
Staying with friends	26	1.80%
Other	31	2.20%

Table 1: Demographics.

Perceived Heat threat and Impact

Our findings indicate a disparity in how respondents perceive the impact of heat on themselves compared to the broader community. The majority of respondents rated heat as a moderate-severe threat to the health of Spokane's community (84.3% 1195/1417) and Spokane's economy (71.7%). Fewer people rated heat as a moderate-severe threat to their personal health (53.1%) and to their personal economy (39.7%). Further exploring personal impact of heat, we observed that discomfort (79.6% 557/1351), heat exhaustion (41.2%), and fainting/dizzy (27.4%) were the most common symptoms experienced from prior heat exposure. Heat stroke, a serious symptom, was self-reported for 6.4% of respondents. Lack of sleep (59.2% 325/549), negative health (50.1%), transportation (20.9%) were the most common impacts on ability to work. We found that 8.5% (117/1321) of all household members had been hospitalized or visited the emergency room or urgent care because of a heat-related health issue.

To further describe any effect modification between household level characteristics and perception of heat risk, we conducted an ordinal logistic regression to understand if the heat threat level to personal health differs among vulnerability factors. We found statistically significant differences (adjusted p-value <0.05) in heat risk perception for respondents with: a household disability / chronic medical illness, history of seeking medical attention due to heat, homes without cooling/AC, households who rented), with respondents age 45-64, and respondents age >64 (Table 2). All vulnerability factors met our qualitative inspection of the proportional odds assumption, with the exception of the history of seeking medical attention that didn't have a comparison to the "no heat threat".

	OR	95% CI	Raw p value	Adjusted P-value
Age Group 45-64	1.40	1.08-1.81	**9.85E-03***	**1.81E-02***
Age Group >64	1.92	1.19-3.08	**7.06E-03***	**1.55E-02***
Has elder at home	1.01	0.68-1.50	9.76E-01	9.76E-01
Has child at home	0.81	0.63-1.05	1.07E-01	1.18E-01
Has disability/illness at home	2.25	1.79-2.83	**3.41E-12***	**3.75E-11***
ER/Urgent Care history	2.07	1.37-3.11	**5.08E-04***	**2.72E-03***

Without home cooling	1.78	1.25-2.54	**1.46E-03***	**4.01E-03***
Renter	1.56	1.20-2.01	**7.42E-04***	**2.72E-03***
Location District 1	1.43	1.01-2.02	4.42E-02	6.94E-02
Location District 2	1.35	0.98-1.86	6.74E-02	9.27E-02
Location District 3	1.33	0.97-1.84	8.02E-02	9.80E-02

Table 2: Statistical results for ordinal regression model investigating if heat threat level to personal health differs among vulnerability factors. Abbreviation: ER Emergency Room. * indicating significance for raw and adjusted p-value <0.05.

Home Cooling

We observed widespread access to home cooling systems among respondents, highlighting the concerns for utility costs, repair expenses, and infrastructure inadequacies. The majority of respondents (90.0%, 1220/1355) indicated they had access to home cooling, of which 58.8% had central AC, 34.9% had window AC, and 4.6% had only an electric fan. Overall, 84.4% of all respondents had access to home AC. Among those with home cooling systems, 23.0% (307/1337) reported usage limitations including: cost of utilities (79.0%), cost of repairs (9.2%), and broken cooling (8.2%) as three most common reasons. We conducted a qualitative analysis on the 76 “other” responses. The most common category was adequacy of the home electrical grid (27% 20/73). One respondent wrote “Like many houses in Spokane, the house is from 1905 and needs updated wiring in order to run AC effectively. It can only run one room at a time.”

Looking at effect modification between household level characteristics and access to home cooling, no significant differences were observed in the ordinal regression modelling for raw or adjusted p-values. We did observe several trends. Renters were less likely to have access to AC (OR 1.16, 95% CI=0.73-1.83). Households with disability/medical illness (OR 0.84, 95% CI 0.55-1.28), children (OR 0.70, 95% CI 0.43-1.14), respondents age 45-64 (OR 0.84, 95% CI 0.52-1.36), and respondents age >64 (OR 0.47, 95% CI 0.21-1.04) were more likely to have access to AC.

Public Cooling

We observed significant preferences towards staying home versus seeking alternative cooling during extreme heat, emphasizing respondents’ reliance on home AC and their attitudes towards cooling centers. When asked about leaving one’s home on very hot days, 88.8% (1213/1366) of respondents indicated they prefer to “stay home” compared to going generally “somewhere else” to cool (10.4%). Asked more specifically, “if a public community cooling center…were available in your neighbourhood this summer, would you consider using it?” 22.9% (310/1355) said yes, 19.5% said maybe, and the remainder 57.6% said no. In our qualitative analysis of the 264 short responses for “maybe”, the most common label was “prefer home cooling” (31.6%) which aligns with the high access to home AC. One respondent wrote “I would absolutely use it if we had any issues with our cooling system at home, but I don’t anticipate any issues so we’re more likely to stay home”.

Asked where they might go for cooling outside of one’s home, most people preferred indoor locations that provided entertainment and socialization: shopping center (41.1% 403/974), friend’s house (37.3%), movie theatre (37.0%), library (29.6%). In our qualitative analysis of the 287 responses for “other”, the most common categories are: lake/river (45.7%), food locations (cafe, bar, restaurant) (10.6%), and work/school (9.6%). If people were to leave their homes for cooling, they expected to be able to go to places with friends and family (Figure 1).

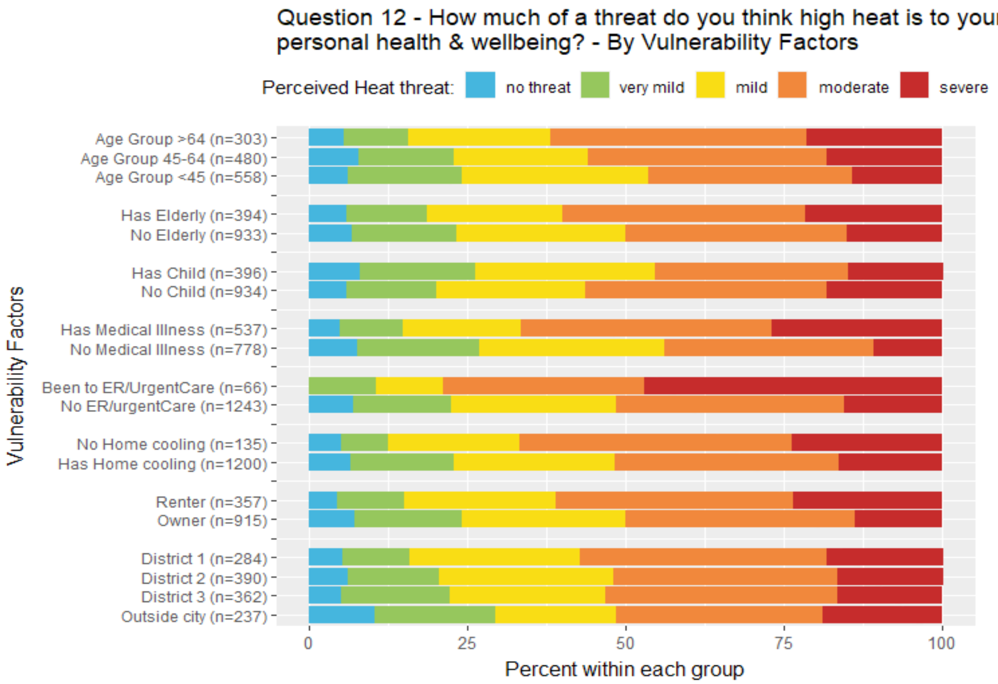

Figure 1: Perception of heat threat to personal health & well-being separated by vulnerability factors. Levels shown as percentage distributions for each vulnerability group. Abbreviation: ER: Emergency Room.

Investigating the facilitators for public cooling centers, people were incentivized by food and entertainment: food (52.1% 642/1232), swimming (51.1%), free Wi-Fi (50.9%), movie screenings (45.0%), and music (40.0%). Familiarity and accessibility were two major barriers with the most common responses: "not in the neighbourhood" (37.0% 439/1186), "not knowing anyone there" (29.1%), "more than a few blocks away" (21.7%), and "transportation was difficult" (21.3%). In the "other" reasons, one respondent wrote, "As a disabled person, the spaces can be more difficult for me to be in. Accessibility, privacy and spaces for pets are also important to me."

Infection risk, personal safety, and privacy concerns were themes identified from our qualitative analysis of 248 short responses for "other" barriers from using public cooling centers. Given the timing of this survey, many people expressed concerns about Covid and other health risks. Concerns around personal safety included security and fear of sharing the space with people experiencing homelessness, "I feel like it would be a lot of homeless people using it and I'm unsure if I'd be safe..."

We conducted a subgroup analysis among the 135 respondents without home AC to understand if their perspectives differ in utilizing cooling opportunities compared to the overall respondents. We observed no change in the relative rank order for multiple choices. Despite not having home AC, 66.9% preferred to stay home instead go elsewhere. A friend's house (52.4%), shopping center (43.8%), and library (41.9%) were the most common places people found respite outside their home. Asked specifically about utilizing a public community cooling center in their neighborhood, 32.3% said yes, 23.3% said maybe, and 44.4% said no. We observed a similar reluctance to leave one's home and utilize a public cooling opportunity regardless of access to AC.

To understand any effect modification between household level characteristics and interest in utilizing public cooling centers, we fitted a logistic regression to see "if a public community cooling center were available in your neighbourhood this summer, would you consider using it?" differs among vulnerable groups. In both raw and adjusted p-values, we found statistically greater interest in cooling centers from respondents with a history of seeking medical attention due to heat, household disability / chronic medical illness, without home cooling, and households who rented (Table 3). These vulnerability factors follow a similar pattern as perception of personal heat threat, except for age. We observed that respondents aged 45-64 years old had the least interest in cooling centers (Figure 2).

	OR	95% CI	Raw P-value	Adjusted P-value
Age Group 45-64	0.64	0.47-0.87	**4.40E-03***	**1.03E-02***
Age Group >64	0.91	0.50-1.63	7.40E-01	8.07E-01
Has elder at home	0.94	0.57-1.54	8.09E-01	8.09E-01
Has child at home	0.78	0.57-1.05	1.04E-01	1.39E-01
Has disability/illness at home	1.92	1.47-2.49	**1.30E-06***	**1.56E-05***
ER/Urgent Care History	2.65	1.60-4.39	**1.49E-04***	**4.46E-04***
Without home cooling	1.73	1.13-2.66	**1.21E-02***	**2.07E-02***
Renter	1.90	1.42-2.56	**2.20E-05***	**8.81E-05***
Location District 1	1.80	1.19-2.72	**5.16E-03***	**1.03E-02***
Location District 2	1.23	0.85-1.79	2.74E-01	3.29E-01
Location District 3	1.45	1.00-2.11	5.26E-02	7.89E-02

Table 3: Statistical results for logistic regression model investigating if interest in using a public community cooling center the upcoming summer differs among vulnerability factors. Abbreviation: ER Emergency Room. * indicating significance for raw and adjusted p-value <0.05.

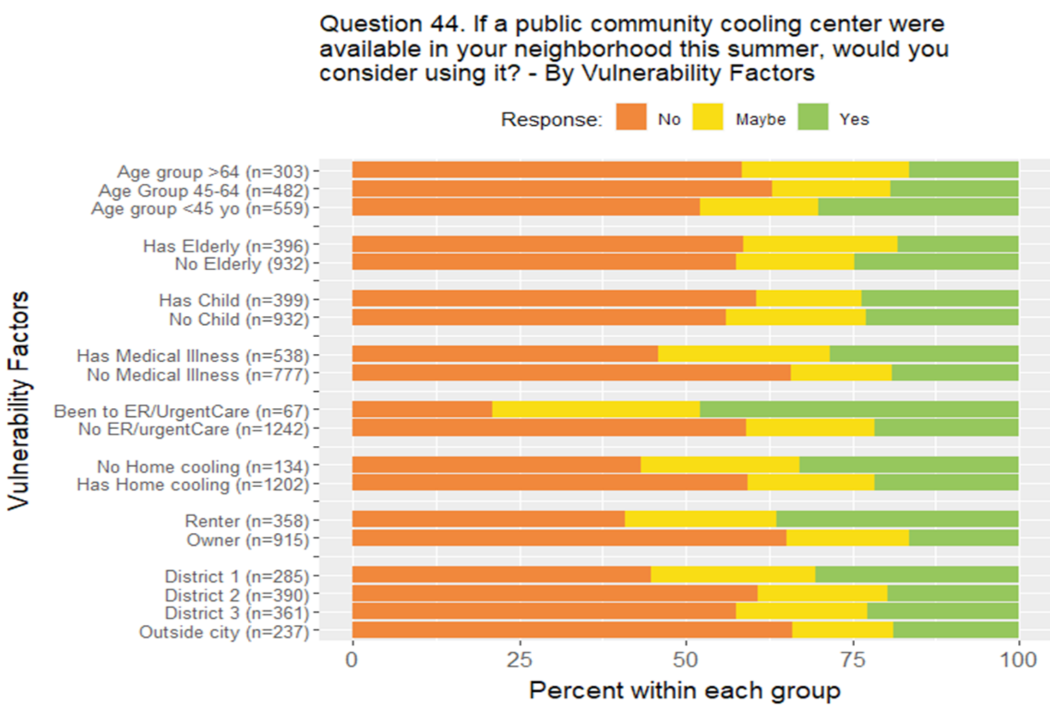

Figure 2: Interest in using a cooling center in the upcoming summer by vulnerability factors. Levels shown as percentage distributions for each vulnerability group. Abbreviation: ER: Emergency Room.

Discussion and Conclusion

This study examined the perceptions around heat risk and cooling interventions in Spokane, WA following the extreme heat event of 2021. We found household characteristics of those with disability, chronic medical illness, history of seeking medical attention due to heat, absence of AC, renters, and age over 45 years reported increased perceived heat susceptibility. Although at-risk groups acknowledged a higher perceived risk to extreme heat events, we found that a near majority of residents did not perceive a personal health threat from heat, underscoring the need to enhance public health messaging. Effectively reaching and communicating health risk is challenging as people tend to underestimate their personal risk relative to others [23]. Additionally, elderly and socially isolated individuals are often not aware of heat alerts and education messaging [24]. To address these issues, collaboration between health clinics, community-based organizations, and public health departments can improve outreach to the elderly and disabled populations. Partnerships with electric companies could provide more effective support to renters and socially isolated individuals. Employing inclusive messaging that emphasizes "anyone can be at risk" may be more engaging than messages about specific vulnerable groups [17]. These approaches could enhance the effectiveness of public health communication and mitigate the health impacts of extreme heat events.

Perceptions of home and public cooling facilities can inform communication strategies for promoting cooling adaptations. We found access to home AC to be notably high in Spokane (84.4%), much higher than in nearby major cities like Seattle, WA (53%) and Portland, OR (78%) [25]. Even among those without home AC, there was a strong preference to remain indoors during extreme heat. Such behavior is influenced by factors like familiarity of the hazard, uncertainty of the outcomes, and perceived personal control over the outcomes [26]. Spokane residents, accustomed to the warmer climates and possessing greater access to air conditioning, may perceive increased control over their environments. Drawing from immunization studies, increased familiarity with health outcomes can paradoxically delay care and immunizations, as the hazard is not considered to be as severe [27]. Additionally, even when individuals receive warnings, few people may actually change their behaviors [28]. Although various strategies have been implemented across cities, there remains a deficiency in robust methods for evaluating whether heat messaging effectively leads to behavioral changes [29]. For example, correlating media broadcasting with increased hydration or using mist fans can be very challenging. Social behavior frameworks such as the health belief model30 try to explain how attitudes and fears lead to individuals' responses. Researchers have utilized this model to characterize public perceptions of heatwaves [30] and develop targeted communication that address barriers for clinicians caring for the elderly [31]. Future research should aim on developing metrics to evaluate the efficacy of various messaging modalities and content that foster adaptive behavioral changes.

Interventions tailored to individual preferences may be more readily adopted, particularly in populations that prefer to remain indoors. Although no significant disparities in AC access among various at-risk groups were detected in our study, research indicates that access is disproportionate for low-income households, renters and minority race and ethnicities [32]. While home AC is one of the most effective cooling adaptations [33], it is financially costly. We found many people were concerned about the cost of utilities and repairs, echoing findings from other studies [28]. Targeted financial assistance programs or AC rentals could directly benefit vulnerable populations. Promoting home AC is also controversial since it is environmentally costly while there is a heavy reliance on fossil-fuel electricity. An over reliance on AC can also leave many defenseless from extreme heat during power outages [34]. AC is also not a viable solution for those experiencing homelessness or outdoor workers. Low cost interventions such as mist fans, foot immersion, and cold showers can help to reduce heat stress. Yet these interventions are not always included in heat messaging [14]. The most effective solutions will depend on the setting and needs such as workplaces, schools, or aged care homes.

Public cooling spaces offer a low-cost solution to reduce heat-related mortality [35]; however, the effectiveness depends on actual usage. Despite their potential, cooling centers in many cities suffer from low attendance [36]. We observed a reluctance to utilize cooling centers in our study, particularly elderly, who showed higher concern about heat threats. Our findings revealed a variety of perspectives and barriers to public cooling. People want entertainment and socialization with friends and family, where they can work and maintain daily activities. Specific groups may encounter obstacles, especially those with mobility challenges or medical equipment. Additionally, individuals were concerned about personal safety, infection risk, and privacy. In other studies, seniors have expressed concerns about safety of travel to cooling sites [37]. Other studies have found similar stigma or misconceptions that cooling centers are only for seniors or homeless individuals [38,39]. Effective communication about the range of provided services, such as extended library hours or social events at shopping malls, may help realign public expectations. The diverse needs and expectations highlight the importance of a multimodal approach and the critical role of community leaders in participating in the implementation of interventions that are tailored to the needs of at-risk groups.

There are several study limitations to note. First, data was collected with a convenience sampling method making it difficult to extend findings to the whole Spokane County population. Second, associations with low income were omitted in the analysis, despite the wide distribution of median household income levels. A more meaningful low-income measurement could be utilized if the income and number of household members are collected together. Third, despite the availability of a multi-language survey, the Hispanic/Latino representation is much lower than Spokane county's US Census distribution. Future studies should focus on identifying trusted messengers and strategies to engage these underrepresented communities. Fourth, the data was based on self-reports of residents and therefore susceptible to various biases in responding. Last, the analysis was largely exploratory because of the lack of previous knowledge of the Spokane region to base hypotheses on.

This research highlights the complexity in mitigating heat risk in Spokane, WA, following the extreme heat events of 2021. While a substantial portion of the population does not perceive heat as a severe threat, at-risk groups including elderly, disabled, and chronically ill are more cognizant of the potential dangers. The preference to remain home may be influenced by widespread access to home AC and familiarity to the warm climate in Spokane. Our results indicated that communication and interventions strategies should be tailored to the needs and perceptions of each at-risk group. Financial and environmental costs of AC use highlight the need for a diverse set of adaptation strategies. While using public cooling centers is a viable low-cost option, obstacles such as accessibility, social entertainment, and safety concerns need to be addressed. Multimodal approaches that engage community leaders and reflect the unique context of at-risk populations is critical for enhancing resilience to extreme heat.

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Human Participant Compliance Statement

Ethical approval for this research was obtained from the Gonzaga University's Institutional Review Board on July 8, 2022 (Protocol #2206HENCLIMATE)

Conflicts of Interest

The authors declare that they have no conflicts of interest. The authors declare that they have not financial disclosures

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