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Portland's Response to the Western North American Heatwave: A Brief Report

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Brief Report

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Abstract

Background: In June of 2021, a heatwave resulted in high mortality across the Pacific Northwest region. The city of Portland, Oregon, had many advantages: emergency response personnel, science-based policies, political support for climate change adaptation, and collaboration among municipal, county, state, and federal authorities. Though the city's response likely prevented many deaths, heat-related mortality was high.

Methods: This study presents a retrospective case analysis of the 2021 Western North American Heatwave in Portland, Oregon. Specifically, the study examines the limitations of current heatwave response paradigms by means of a narrative review of the heatwave response and impacts.

Results: Most deaths occurred at home, and most of those who died lived alone. Most of the deceased did not have access to functioning air conditioning.

Conclusions: Heatwaves exhibit high predictability in the demographics of those most affected and have rising rates of recurrence. Given the effectiveness of residential cooling systems in preventing heat-related mortality, findings suggest that future public health and policy initiatives should put increased focus on the primary prevention of heat exposure.

Heatwaves are a growing threat to human health across the globe. Climate change is increasing the frequency and severity of extreme heat events, and mortality attributable to heat is projected to increase throughout the 21st century.[1] Extreme heat causes a greater burden of mortality than other natural hazards in the United States. However, heatwaves often fail to elicit proportional investments in preparedness or response in comparison with other natural disasters.[1]

With the existence of cooling technologies, deaths due to extreme heat are now potentially avoidable. Preventable heatwave deaths are not just a failure of disaster response; they also reveal the failure of government policies to safely house low-income populations. Heatwaves are a pressing social justice issue, with disproportionate baseline vulnerabilities driving unequal health impacts.[2] Urban planning policies have contributed to inequitable heat hazards in marginalized communities; for example, previously redlined areas experience more severe urban heat island effects. The built environment is intended to protect humans from natural hazards; now, through urban heat, it is becoming a mediator of risk. The 2021 Western North American Heatwave highlights the dangerous health implications of inequitable access to safe housing in a changing climate.

Aims and Setting

This study assesses the limitations of response-oriented strategies to heatwaves through a case study of the 2021 heatwave in Portland. Portland has a well-documented urban heat island effect and modern heatwave response capabilities,[3] and experiences urban heating comparable to cities across the United States. Multnomah County, which contains Portland, had recently updated plans for responding to extreme heat events. Both the city of Portland and Multnomah County have award-winning climate action plans, which explicitly address urban heat, though lack explicit strategies for primary prevention. Learning from this disaster is paramount to improving preparedness for future heatwaves, which are expected to be hotter, longer, and more frequent.[1]

Methods

A retrospective case study of mortality in Portland, Oregon, was performed based on coroner reports from the 2021 Western North American Heatwave in Portland. This narrative review of

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the heatwave synthesizes weather conditions, mortality, municipal documents, and existing literature. Data on deceased individuals were determined to be important for understanding policy implications and, therefore, were released to the public by order of the Attorney General of the State of Oregon. This analysis was determined to not involve human subjects research, and, therefore, full institutional review board (IRB) review was not required by the Harvard Longwood Campus Institutional Review Board.

Event Narrative and Results

During the final week of June 2021, Portland endured 6 days of temperatures above 90°F, 3 days of temperatures above 100°F, and peak temperatures reaching 116°F.[4] The heatwave had features that predicted a high mortality event, specifically unprecedented temperatures, long duration, and limited baseline adaptation to heat in the affected region. Calculations for nearby British Columbia estimate 740 excess deaths in the province alone.[5]

Government agencies in the Portland area were well prepared. The heatwave response drew upon 3 reports that anticipated extreme heat events: the 2015 Oregon Natural Hazards Mitigation Plan, the 2015 Multnomah County Climate Change Action Plan, and the 2017 Multnomah County Natural Hazards Mitigation Plan. In addition, Portland had developed an extreme heat response plan after a heatwave in August of 2017. The Multnomah County Emergency Management Team had reviewed their extreme heat response plan just 2 months prior, after an atypically hot day in May. Portland has been found to have equal or superior cooling center coverage compared with other US cities of similar latitude.[6]

In addition, Portland organized a considerable response to the heatwave. Multnomah County coordinated with nearly 100 different nonprofit and outreach organizations across the city.[4] The city opened 3 cooling shelters which remained open overnight, and 9 supplemental cooling spaces.[7] There were targeted outreach campaigns to unhoused persons, elderly populations, and disabled populations.[4] Despite this, officials reported 72 deaths within Multnomah County directly attributable to heat exposure during 2021, of which 69 occurred during the Western North American Heatwave.[8] In contrast to the excess death calculations reported prior, this only includes deaths which a coroner attributed directly to heat exposure. The true burden of the heatwave, including deaths due to the exacerbation of chronic disease, is likely higher.

Of the 72 confirmed dead, most were male (67%), 60 years of age or older (78%), and of white race and non-Hispanic ethnicity (82%).[8] Likely as a result of outreach efforts, only 4 of the 72 deaths occurred in people experiencing homelessness (1 unhoused person, 1 person living out of a car, and 2 people living in RVs without fixed addresses).[8] People living in multifamily dwellings and those living alone were overrepresented among those who died. Of the 68 deaths that occurred in formal housing, at least 48 victims lived alone (71%).[8] For reference, only a third of households in Multnomah County are single-person households.[8] Almost all heatwave deaths (94%) occurred in the victim's home. These deaths reflect the inherent difficulty of identifying and rescuing isolated patients with heat exposure injuries, who may be unable to initiate their own rescue due to early onset confusion and weakness.

Discussion

The Portland Heatwave reveals the limitations of a response-based approach to extreme heat events. Portland's use of cooling centers, public health messaging, wellness checks, and other active approaches likely saved many lives. While it is impossible to assess how many deaths were averted by coordinated municipal action, process indicators reveal the scope of Portland's response to the event. The 3 primary cooling centers opened during the event served a total of 1,400 overnight guests.[7] Additionally, outreach teams delivered approximately 14,000 cooling towels and 32,000 electrolyte packets, among other goods, to community members.[7]

Despite this response, a large burden of mortality remained, particularly among the city's vulnerable. This points to the need for policies from all levels of government to work toward preventing future deaths due to extreme heat. Specifically, long-term investments in primary prevention of heat exposure can complement existing heat action plans. Primary prevention of heat exposure will be increasingly important as society seeks to address a hazard that is recurrent, increasing in frequency and severity, disproportionately affects a predictable population, and can be mitigated by means of readily available cooling technologies. Increased attention to primary prevention is timely and necessary for the following reasons.

First, the population at risk for mortality during heatwaves is predictable across settings, but can be difficult to reach during an active response. Advanced age, limited mobility, certain medical conditions, and living on upper floors are known to be significant risk factors. Air conditioning, access to transportation, and social connectivity tend to be protective. Factors that make a population vulnerable to extreme heat are often collinear; low-income populations often live in urban heat islands, experience a high burden of comorbidities, are more likely to live in multifamily dwellings, and are less likely to have air conditioning. The City of Portland and Multnomah County Climate Change Action Plan, published in 2015, identified the characteristics of vulnerable individuals and mapped the city's urban heat island.[9] Its predictions, made 6 years prior, align with observed mortality during the heatwave event.[8] Predictability creates an opportunity for targeted long-term investments in prevention.

Second, heatwaves are becoming increasingly frequent and hazardous, and must be planned for as an expected feature of urban life. As climate change intensifies, many cities will face multiple heatwaves every year during the summer months. Just as settlements in floodplains invest in levies, cities must now invest in infrastructure to reduce the exposure of vulnerable populations to hazardous levels of heat. Examples of such investments include greenspaces that reduce local temperatures, architectural approaches that use shade and ventilation to passively cool indoor and outdoor spaces, and upgrades to the aging electric grid to ensure stability during hot conditions and high demand.

Finally, heatwave deaths can be prevented using widely available technologies. Residential cooling has been shown to reduce morbidity and mortality during hot weather. While 79% of Portland housing units have some form of air conditioning (window units, central air, etc.),[10] only 3 of the 72 victims had a properly functioning air conditioning unit.[8] Seven victims had air conditioning, but the units were either unplugged, not functioning, or unable to offset the extreme temperatures.[8] Among the 49% of Portland housing units that have central air conditioning,[10] no documented deaths occurred.[7] The majority of those who died had access to only a fan for cooling (61%), and a significant portion had no fan and no air conditioning (17%).[7] While fans may be effective for some individuals in moderate heat or with active wetting of the body, fans provide little or no benefit to persons who have impaired thermoregulation and may be harmful when the air temperature exceeds that of the human body. Ensuring access to

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Table 1. Summary of policy recommendations to increase primary prevention of heat exposure

Intervention	Timeline	Notes/examples
Begin voluntary screening at health-care facilities to identify high-risk individuals.	Immediate	Those with medical risk factors could be screened for resources to support A/C access.
Provide A/C units to previously identified high-risk individuals without A/C access.	Immediate	Window air conditioning units are relatively affordable and can be easily retrofitted onto older buildings. Distribution programs have been used in New York and Massachusetts.
Formally organize the existing workforce of trained A/C technicians so that they are prepared to respond during extreme heat events.	Immediate	Technicians could confirm proper installation of window A/C units for high-risk individuals, as improper installation contributed to mortality during the 2021 heatwave in Portland. Additionally, technicians could travel regionally to areas of increased demand during a heatwave event, similar to the pooling of EMS resources during other natural disasters.
Limit employment involving outdoor work, or hot indoor work, to essential activities.	Immediate	Work-related outdoor activity contributes to mortality among younger individuals, despite lower baseline vulnerability. Limiting heat exposure across the population could reduce the number of excess EMS calls and emergency department visits during heatwaves.
Continue to provide emergency shelters during extreme heat events; specifically, ensure overnight availability of shelters. Improve access to shelters by opening multiple shelters in vulnerable communities, as opposed to relying on large, centrally placed shelters.	Immediate	Nighttime heat exposure is understood to be a key driver of mortality. Decentralized shelters are favored as extreme heat can disrupt public transportation infrastructure (which occurred in Portland). Factors such as limited mobility and poverty that increase risk during a heatwave often also make travel difficult.
Advocate for the inclusion of effective cooling as a legal obligation of landlords to provide tenets, especially in northern states which historically do not require this.	Short Term	After significant advocacy, the State of Oregon passed the "Right to Cooling Bill" following the 2021 extreme heat event, which prevents landlords from restricting tenet's access to air conditioning. In Vancouver, a new by-law requires the ability to maintain 26°C or lower temperatures in everything built after 2025. Future policies could make effective cooling to be a mandatory provision from landlords to tenants, similar to the status of heating in many areas.
Establish WIFI-enabled temperature monitors to track and provide real time alerts of dangerous temperatures in public housing, prisons, and other high-risk areas.	Short Term	Current project sponsored by the City of Portland's Bureau of Emergency Management and in partnership with Home Forward, CAPA Strategies LLC, and Multnomah County Public Health.
Develop municipal level multi-pronged heat action plans focused on community engagement when selecting among other strategies mentioned in this table.	Short Term	Community engagement aids in disseminating information regarding the threat of extreme heat, building local capacity, and selecting appropriate methods for the context and specific vulnerable communities.
Work with city planners to curb the urban heat island effect.	Medium Term	New York City commissioned the "CoolRoofs" project, which has coated roofs throughout the city with a white paint. This increases solar reflectance of the roofs and reduces radiative energy absorption. The City of Portland commissioned the "Planting a More Equitable Urban Forest" report, which aims to focus on low-income low-tree canopy neighborhoods.
Improve the resilience of the electrical grid.	Medium Term	A sustained power outage during a heatwave is a probable climate disaster in the United States. This could result in clinically significant extreme heat exposure to most of the population in many metropolitan areas of the United States.
Ensure resilience to hot summer climate is a focus when constructing new buildings in an urban setting.	Medium Term	New buildings should use a combination of urban form, passive measures, and mechanical cooling to become heat resilient. Passive cooling measures which have been used in hot environments for many years should be drawn upon to reduce the reliance on active cooling. Examples of these technologies include shutters, awnings, light colored building materials, and courtyards.
Increase climate change mitigation.	Long Term	Climate change mitigation, for example through reducing greenhouse gas emissions, can address the root cause of increasing extreme heat exposure.

safe, effective cooling technologies for those at highest risk is an essential aspect of addressing the inequitable health impacts of heatwaves.

Policy Implications

Portland's experience suggests that some deaths cannot be prevented by municipal responses activated in the days preceding a predicted heatwave. Primary prevention of heat exposure can augment current response-based approaches to extreme heat events. The lethal impacts of heatwaves are concentrated in predictable populations, that is, those who are older, poorer, and sicker, providing an opportunity to focus preventative efforts.

Increasing access to residential cooling is an actionable, accessible objective for policy-makers seeking to protect health during heatwaves. While building codes often dictate features related to wintertime heating, residential cooling is not commonly required. Regulation through building or rental codes could improve access to this life-saving resource, which is becoming increasingly essential as the effects of climate change intensify.

The limitations of active cooling, particularly air conditioning, must be acknowledged. A window unit, while effective, does not offer the same protection as central air. Air conditioning

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contributes to carbon and air pollution when using electricity produced from fossil fuels, transfers heat into the air around buildings, and can contribute to surges in electricity demand and blackouts during hot weather. Air conditioning is also expensive to install and run. While modern technologies such as heat pumps offer improved efficiency, their grid dependence and cost remain substantial concerns. Despite these limitations, increasing access to residential cooling in high-risk urban communities presents a substantial opportunity to advance health equity and reduce mortality during future heatwaves.

Sustainable solutions to urban heating should continue to be developed. Shared cooling spaces can provide access to cooling at the neighborhood level, reducing the demand on air conditioning within private residences. Communal cool rooms in multi-unit residential buildings could help improve cooling accessibility for residents without air conditioning. Passive cooling can be improved through innovative use of ventilation, evaporative cooling, shading, reflective surfaces, vegetative cover, and other aspects of urban design. Cultural adaptations to heat, for example shifting work hours, can be explored.

Primary prevention approaches that can augment existing heatwave response efforts are described in Table 1. To be most effective, these will require sustained investment and management in anticipation of future heatwaves.

Conclusions

The 2021 Portland Heatwave demonstrates the need for increased focus on primary prevention of heat exposure. While existing response-based efforts are necessary and should continue, in isolation they are unable to prevent all heat-related mortality. Heatwaves are increasing in frequency and severity and must be planned for as a recurrent feature of urban life. The combination of a predictable at-risk population, the effectiveness of active cooling, and the increasing rates of recurrence justify long-term investment. Ensuring that vulnerable communities have access to reliable and effective cooling in their place of residence should be an immediate priority.

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Competing interests. None.

Ethical standard. Data on deceased individuals were determined to be of such importance for understanding policy implications of the 2021 heatwave that, by order of the Attorney General of the State of Oregon, they were released to the media and to the general public by the Oregon Medical Examiner's Office and are thus a matter of public record. This analysis was determined to not involve human subjects research; therefore, full IRB review was not required by the Harvard Longwood Campus Institutional Review Board.

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