Final Report:

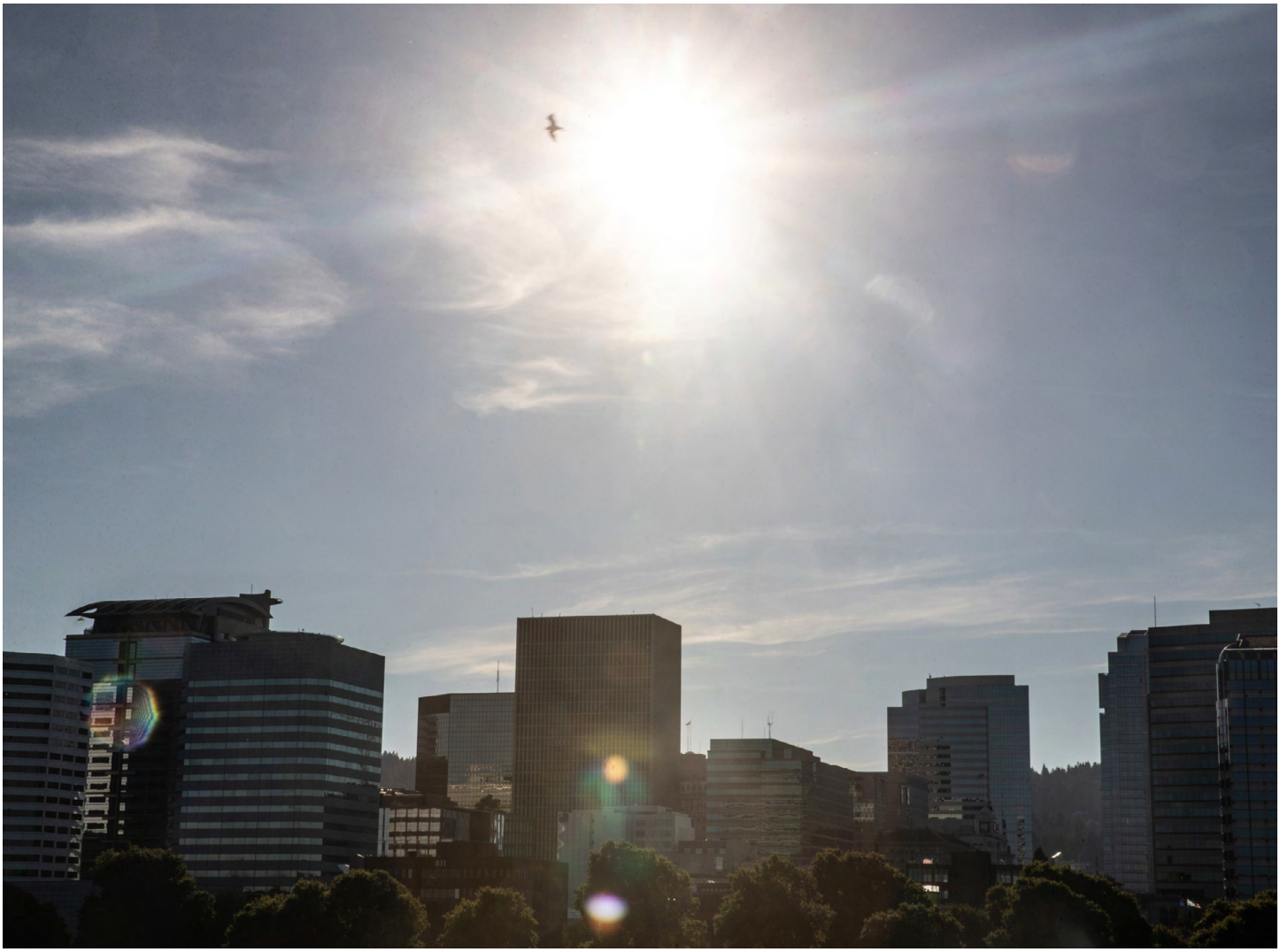
Health Impacts from Excessive Heat Events in Multnomah County, Oregon, 2021

Multnomah County

Published June 2022

Key findings

- There were 72 heat deaths in Multnomah County in 2021— with 69 of those deaths resulting from deadly heat in the last week of June. In a typical year there are zero.
- Deaths from all causes were double the normal level during the week of the heat dome, the week of June 27.
- There were 257 emergency department and urgent care visits for heat illness in Multnomah County in 2021. In a typical year there are 83.
- The following groups were disproportionately affected:
  - Males
  - Older adults
  - Non-Hispanic whites
  - People living alone
  - People living in multifamily buildings
  - People experiencing homelessness or unstable housing
  - People living in warmer areas of the County



Background

Since 2016 the Multnomah County Health Department has tracked emergency room visits and fatalities related to extreme heat. This report provides a final accounting of deaths and emergency department visits resulting from heat during the summer of 2021.

The June 2021 heat dome event made the summer of 2021 especially hazardous for health, with record-setting maximum temperatures of 116 degrees. Immediately after the June heatwave, Multnomah County Health Department produced a Preliminary Review on Excessive Heat Deaths, published July 13. Subsequently, there were two more heat waves in July and August. This report supplements the July 13 report with new information on:

- Heat-related deaths that were not confirmed at the time of the original report or occurred later in the summer.
- Deaths from any cause (all-cause mortality).
- Emergency department and urgent care clinic visits.

Methods

Data sources

Multnomah County Medical Examiner data

The Oregon State Medical Examiner's Office maintains a database of all deaths investigated under its jurisdiction. County death investigators gather information about residence and housing status, and important details from scene investigations and interviews with relatives and social contacts. That information allows the State Medical Examiner's Office to certify cause and manner of death. According to ORS 146.090, the Medical Examiner investigates and certifies the cause and manner of all human deaths that are:

a. Apparently homicidal, suicidal or occurring under suspicious or unknown circumstances;

b. Resulting from the unlawful use of controlled substances or the use or abuse of chemicals or toxic agents;

c. Occurring while incarcerated in any jail, correction facility or in police custody;

d. Apparently accidental or following an injury;

e. By disease, injury or toxic agent during or arising from employment;

f. While not under the care of a physician during the period immediately previous to death;

g. Related to disease which might constitute a threat to the public health; or

h. In which a human body apparently has been disposed of in an offensive manner.

For this final heat report, we counted deaths where the final cause was determined to be excessive heat, or hyperthermia, at any time in 2021. We limited the cases to incidents occurring within Multnomah County. Case information for all investigated deaths under Medical Examiner jurisdiction was extracted from the corresponding database. In 2021, the Multnomah County Medical Examiner's Office identified 72 deaths occurring in Multnomah County in which the final cause of death was hyperthermia. Three deaths occurred in August, outside the dates of the "heat dome," but are summarized here with the remaining 69 deaths. Note that the date of death may be estimated based on when a person was found and/or information about a person's last known contact with family and friends.

All-cause mortality data

Extreme heat is associated with an increase in death from any cause (all-cause mortality).[1] We can compare the number of deaths by month over time and also look at weekly averages of deaths over time to see how the heat event contributed to an increase in deaths even later into the year. These data come from Multnomah County's access to Oregon Health Authority Vital Records. Data from 2021 are considered unfinalized. Data are limited to Multnomah County residents.

Oregon ESSENCE (Electronic Surveillance System for the Early Notification of Community-based Epidemics)

Oregon ESSENCE provides data on heat-related illnesses in local emergency or urgent care clinics, allowing us to examine nonfatal visits related to heat. The heat-related query is based on both chief complaint and discharge diagnosis fields; the full query can be found at the end of this document. Data are limited to residents of Multnomah County. To gather information on the role of intoxicants, houselessness, and occupational exposure, two reviewers independently read the triage notes for each visit (when available) and marked if any of those three categorizations applied. Triage notes are free-text data that capture the presenting symptoms and complaints of a patient. Discordant results were reviewed and resolved by consensus. There are important limitations to using and interpreting ESSENCE data. Visit records represent visits, not individual patients; it is possible that one person could make multiple visits. We were not able to determine how many patients were admitted following their visit. Some visit records are incomplete; 15 percent of the 257 records did not have triage notes. To protect privacy, visit counts fewer than five are suppressed or aggregated.

1 Khatana et al. 2022

Results

Data source 1: Medical Examiner data

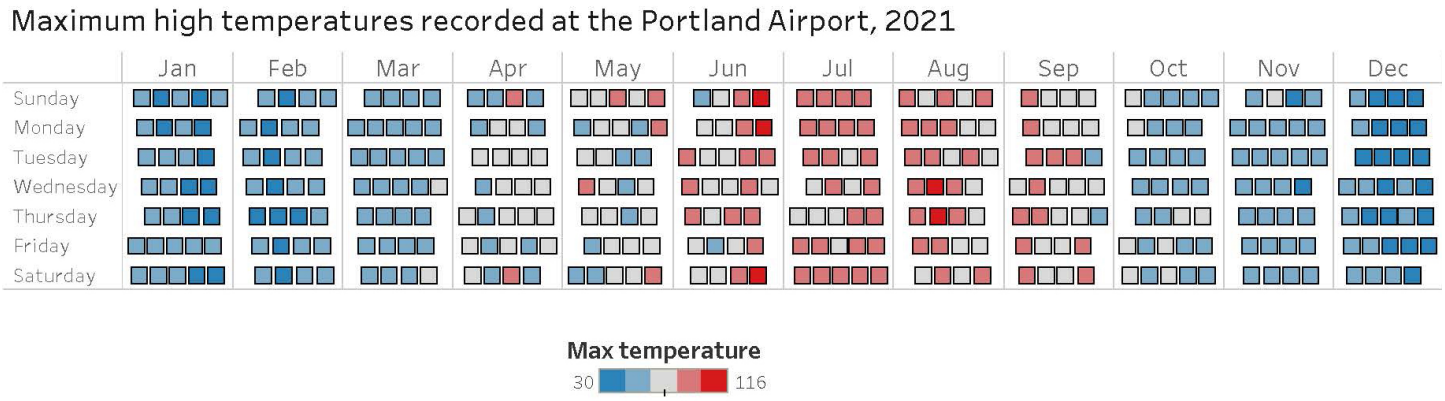
Date of death

The National Weather Service issued an excessive heat warning for the Portland Metro region beginning Friday, June 25, through Monday, June 28. The first reports of possible hyperthermia deaths were reported to the Multnomah County Medical Examiner on Sunday, June 27. The Portland Airport recorded confirmed temperatures of 95, 108, 112 and 116 degrees on June 25 through June 28, respectively.

In mid-August, there was another period of high temperatures; the Portland Airport recorded confirmed temperatures of 102 and 103 degrees on Aug. 12 and 13, respectively.

These daily temperatures are visualized in the following graphic, where the bright red boxes indicate temperatures over 100 degrees.

Chart 1. Daily temperature in 2021



Source: Oregon Live

Confirmed deaths investigated by the Multnomah County Medical Examiner most frequently occurred on June 29 (N=25), followed by June 28 (N=12).

Chart 2. Heat deaths by date of death

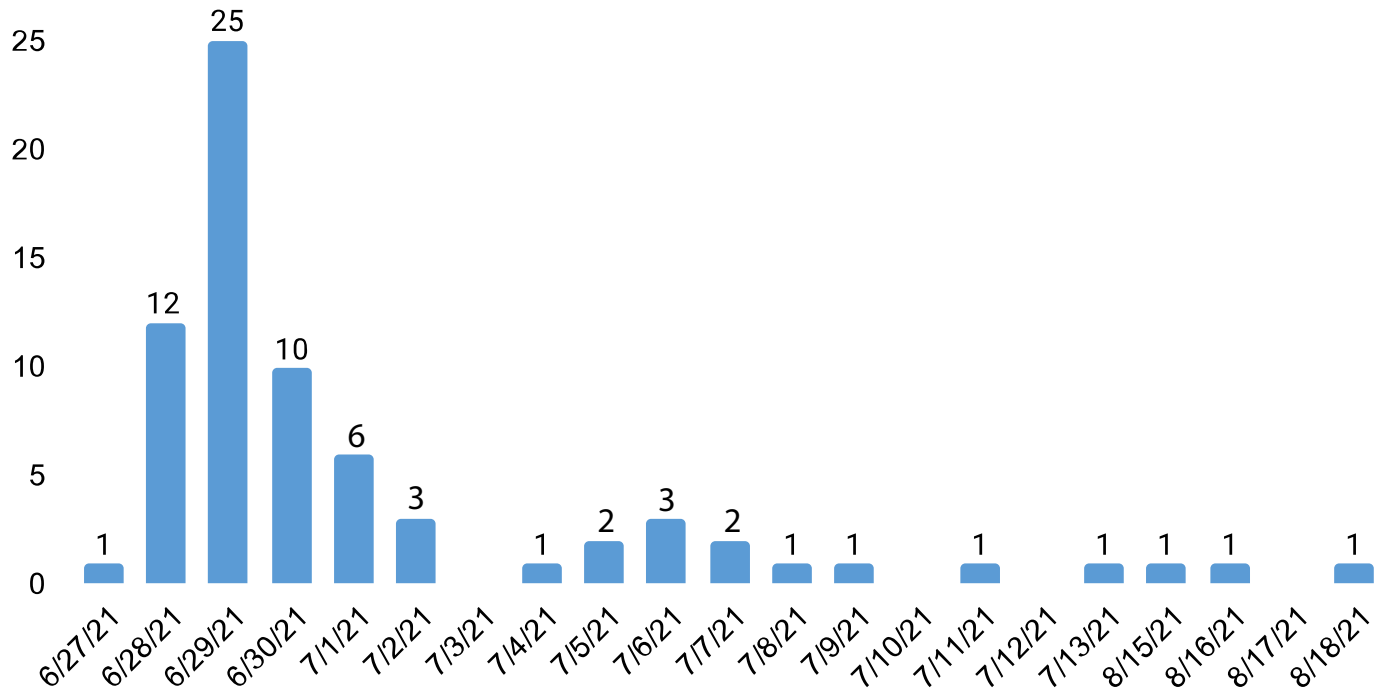


Chart 2 is a time series displaying the count of heat deaths by day during the summer of 2021. The highest count occurred on June 29, the day after temperature in Portland reached the all-time record of 116 degrees. All deaths in June and July are attributed to the heat dome event.

Sex, age, race/ethnicity

Detailed demographics of those who died as a result of heat are displayed in Table 1.

- Two-thirds of deaths occurred in males.
- Most of those who died were older adults; 78 percent of deaths occurred in people 60 years and older.
- The youngest was 36 years old, and the oldest was 97; the average age was 68.
- The majority of deaths were among non-Hispanic whites (59 deaths, 82%) followed by Black/African American (4 deaths, 6%).

Table 1. Demographics of decedents

Sex	Count	Percent (%)
Male	48	67%
Female	24	33%
Age	**Count**	**Percent (%)**
35 to 49	6	8%
50 to 59	10	14%
60 to 69	22	31%
70 to 79	23	32%
80+	11	15%

Table 1. Demographics of decedents (continued)

Race	Count	Percent (%)
White non-Hispanic	59	82%
Black non-Hispanic	4	6%
Hispanic	3	4%
Asian non-Hispanic	1	1%
American Indian/Alaska Native non-Hispanic	2	3%
2 or more races non-Hispanic	3	4%
TOTAL	**72**	**100%**

*From match to vital records death certificate

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Living alone is a known risk factor for heat death.

Housing Type

The vast majority of deaths (68/72, 94%) occurred in the decedent's own residence, more than half of which were multifamily dwellings (42/72, 58%). In Multnomah County, nearly 39 percent of housing units are in multifamily buildings.[2] Of the people who succumbed to the heat in multifamily dwellings, 14 of 42 (33%) lived on an upper floor (floor 3 or higher) of that building.

Four people died experiencing unstable housing.

- One person was found outside a business in Southeast Portland
- Two people were found inside RVs that did not appear to have fixed addresses (one in Northeast Portland, one in North Portland)
- The fourth person was found inside a truck in North Portland where they appeared to be living.

Living alone is a known risk factor for heat death.[3, 4] Of the 68 of 72 deaths in 2021 involving people who were stably housed, at least 48 decedents lived alone. Census data suggest that about a third of all households in Multnomah County are single-person households.[5]

2 American Community Survey 5-year estimates (2016-2020), Table S2504

3 Yale Climate Connections, 2020

4 Klinenberg, 2015

5 American Community Survey 5-year estimates (2016-2020), Table S2501

At least seven people died in apartment buildings charged with caring for vulnerable people. Six people died in apartment buildings owned and managed by Home Forward; one person died in a building owned and operated by Central City Concern.

Two people died in the same independent senior living community, while a third person who died at a local hospital resided in a separate independent senior living community.

Table 2. Housing characteristics of decedents

Residence type	Count	Percent (%)
Multifamily*	42	58%
Single-family*	18	25%
Mobile home or trailer	8	11%
Unstable housing	4	6%
Live alone**	**Count**	**Percent (%)**
Yes	48	71%
No	9	13%
Unknown	11	16%
TOTAL	**72**	**100%**

Note: Housing type is where the individual permanently or temporarily resided at time of death, regardless of location of death.

*Multifamily includes apartment buildings, SRO, hotels, duplexes, and single-family homes with attached apartment/ADU. Single family includes ONLY single-family dwellings.

**Excludes the 4 persons experiencing unstable housing

Cooling

Lack of air conditioning (AC) was a key driver in mortality. Whereas about 80 percent of people in the Portland area have some level of air conditioning in their homes — and about 50 percent have central air — only 10 individuals (14%) had any mention of air conditioning in the investigator's narrative. Of these 10 individuals, at least seven had units that were unplugged or not working properly.

- In one case, an individual did not use the unit out of fear it would catch fire.
- In another case, a portable air conditioning unit was found in use, but unable to keep up with the heat to sufficiently cool the home.

Half of those who died had only a fan. Using a fan at the outdoor temperatures reached during these types of extreme heat events can make the body warmer and drier. At temperatures in the upper 90s, fans simply move hot air around. The breeze they produce must be cooler than body temperature to cool the body down.

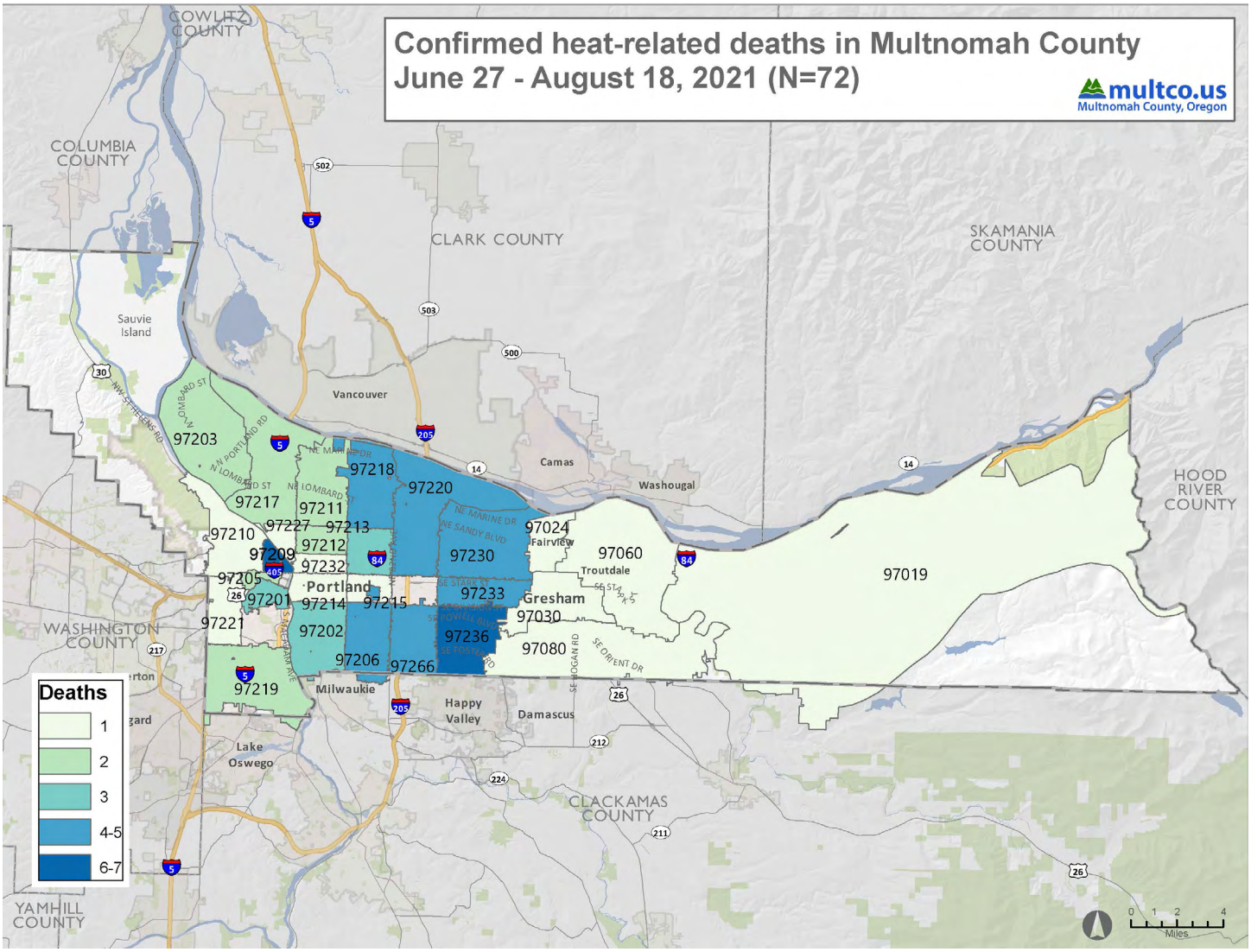
Table 3. Cooling availability among decedents

Cooling type	Count	Percent (%)
Fan only	36	50%
None	13	18%
AC w/ or w/o fan	10	14%
Unknown	13	18%
TOTAL	**72**	**100%**

Geography

Deaths occurred in nearly every corner of Multnomah County, with at least one person succumbing in 28 of the County's ZIP codes. No ZIP code had more than seven deaths (97209, 97236). Map 1 shows the primary location of residence for confirmed cases throughout the duration of the heat event.

Map 1. Heat deaths by ZIP code



Urban heat island effects

Urban heat islands refer to differences in temperature between local areas, generally between urban and rural areas.[6] These differences can appear when vegetation is replaced by hardscape, such as roads and buildings. When this happens, both surface temperature and overall ambient temperatures increase, due to factors such as:

- Excess heat absorption and decreased heat reflection
- Trapping of heat between tall buildings
- Waste heat from vehicles, factories and air conditioners

Map 2 shows mean urban heat island index values by Census tract and corresponding heat-related deaths. Tracts are shaded from "cool to warm," where blue indicates a lower heat index value and orange-red indicates a higher index value. Dividing the mean heat index values into five categories (Table 4) (as displayed in Map 2*) shows:

- 42 deaths (58%) occurred in tracts that had the two highest values (the orange and red on the map)
- 10 deaths (14%) occurred in tracts with the two lowest values (the blue shades on the map) (Table 4).

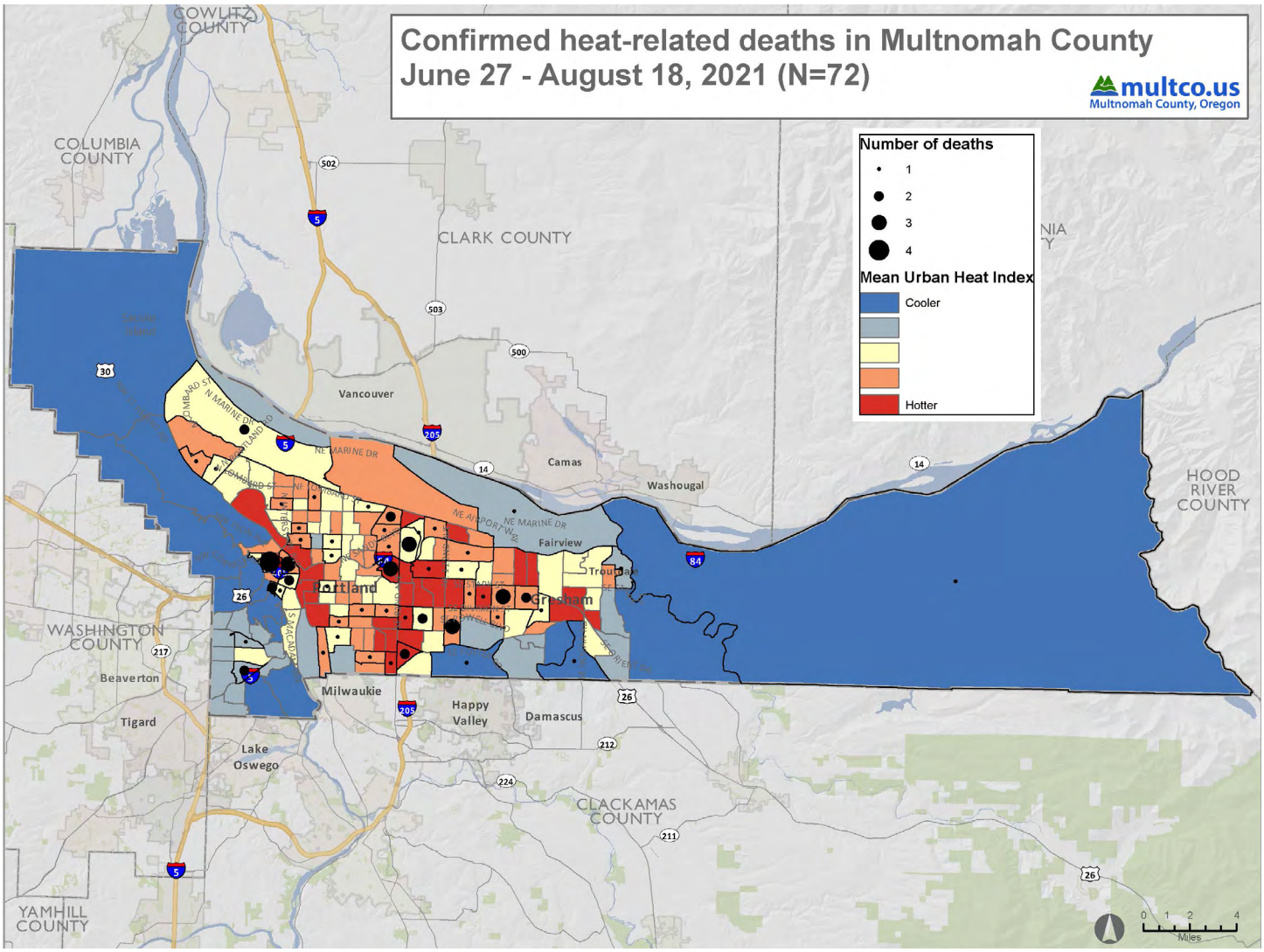
Table 4. Total deaths by range of mean urban heat island index value

Index value	Count	Percent (%)
-10.04 to -4.74 (cooler)	3	4%
-4.73 to -0.48	7	10%
-0.49 to 1.94	20	28%
1.95 to 3.39	33	46%
3.40 to 4.88 (hotter)	9	13%
TOTAL	**72**	**100%**

*Jenks natural breaks method

6 UCAR, 2022

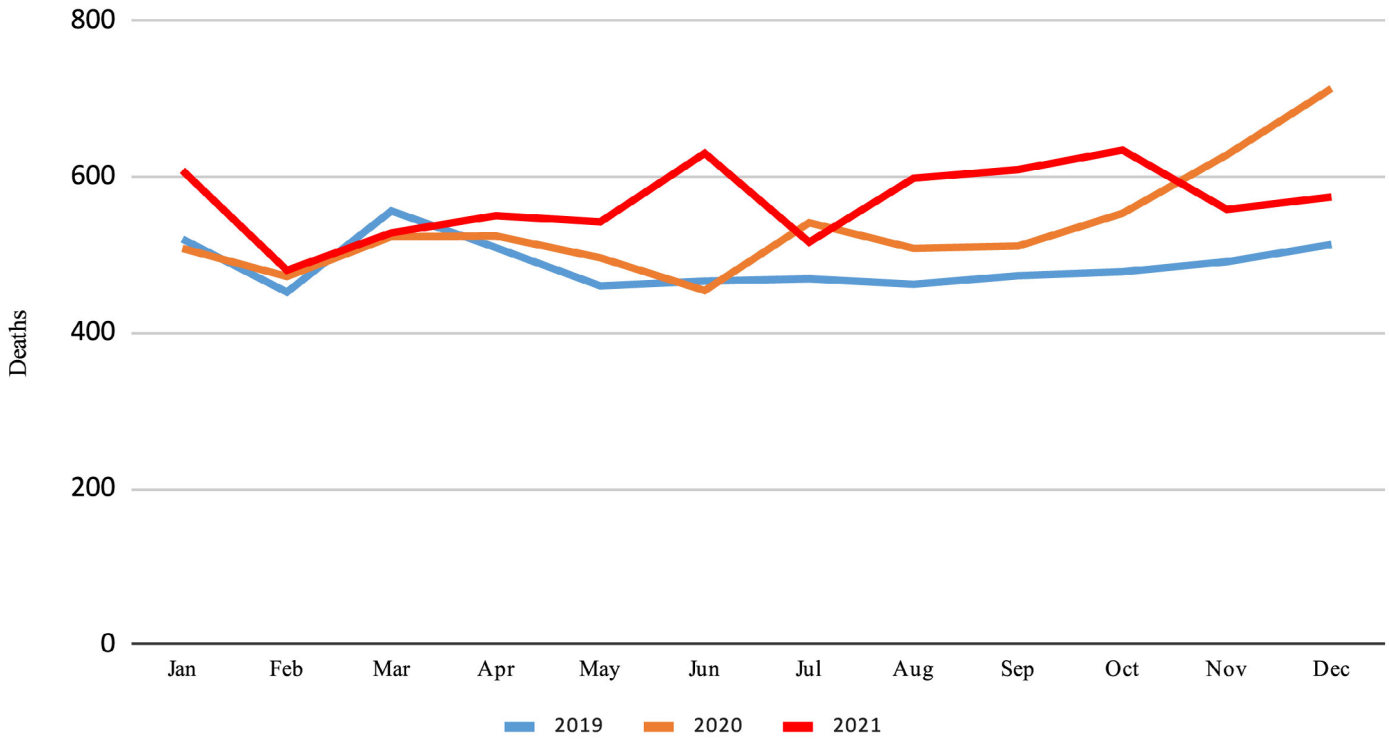
Map 2. Heat-related deaths by Census tract and heat island index



Data source 2: All-cause mortality, Multnomah County

All-cause mortality (deaths from any cause) in 2021 is higher than in both years prior. A large increase in all-cause mortality by month can be seen in the June 2021 mortality number (red line in Chart 3). The total of 630 in 2021 is 37 percent higher than the average value from 2019 and 2020 (460).

Chart 3. Monthly all-cause mortality in Multnomah County 2019-2021

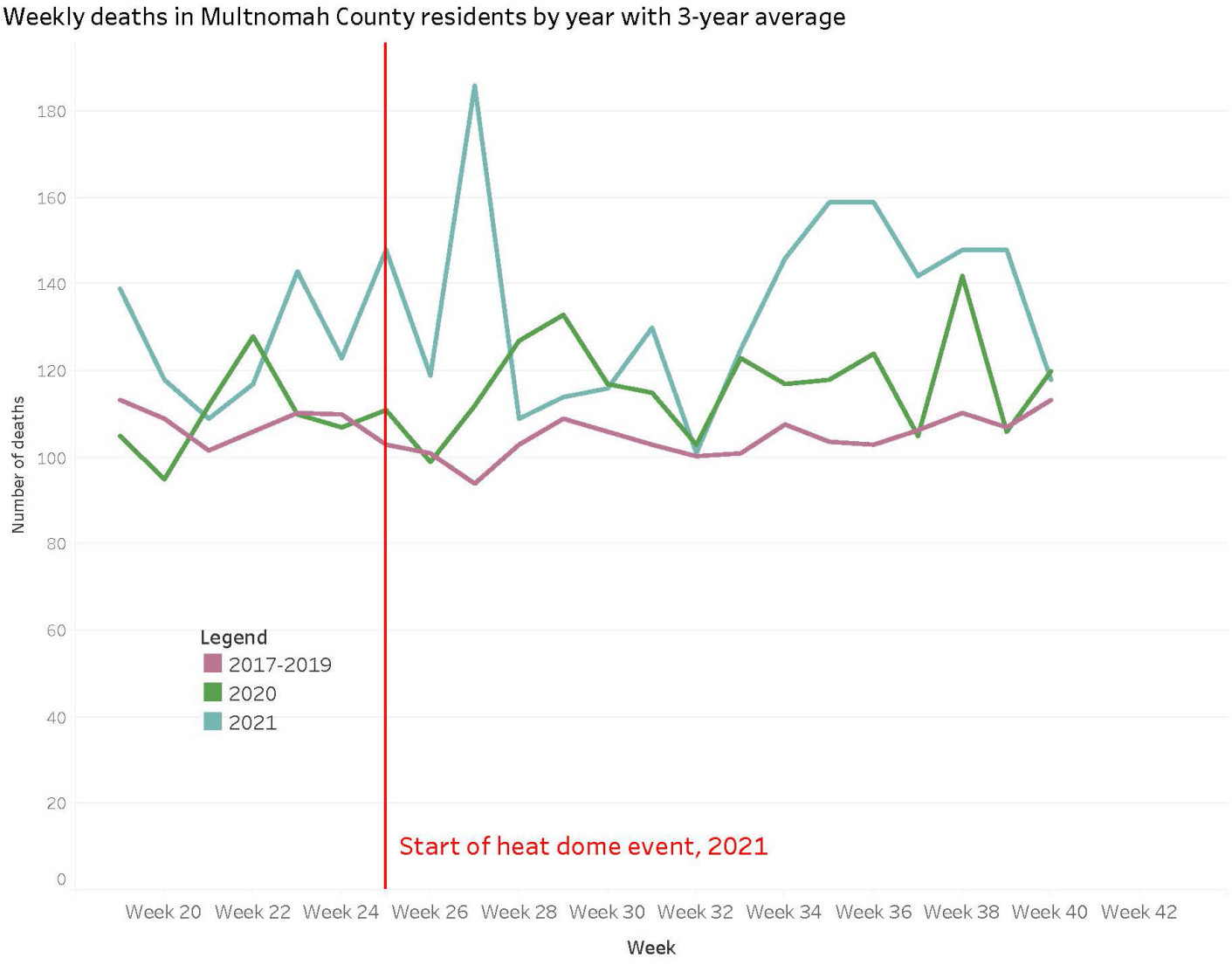


Another way to visualize the mortality data is to look at the 2021 deaths compared to the three-year average of 2017-2019. In Chart 4, the vertical red line indicates the start of the heat dome event. A large spike of 186 deaths is visible in the few weeks after this time period in 2021 (represented by the red arrow). The 2017-2019 average for that week was 94 deaths, or nearly half of the number for 2021. The true increase in deaths is likely due to numerous factors in addition to the heat dome, including the COVID-19 pandemic. However, excess heat is associated with an increase in all-cause mortality, especially for older adults.[7, 8]

7 Khatana et al. 2022

8 CDC 2013

Chart 4. Weekly all-cause mortality in Multnomah County, summer 2021



Data source 3: Oregon ESSENCE

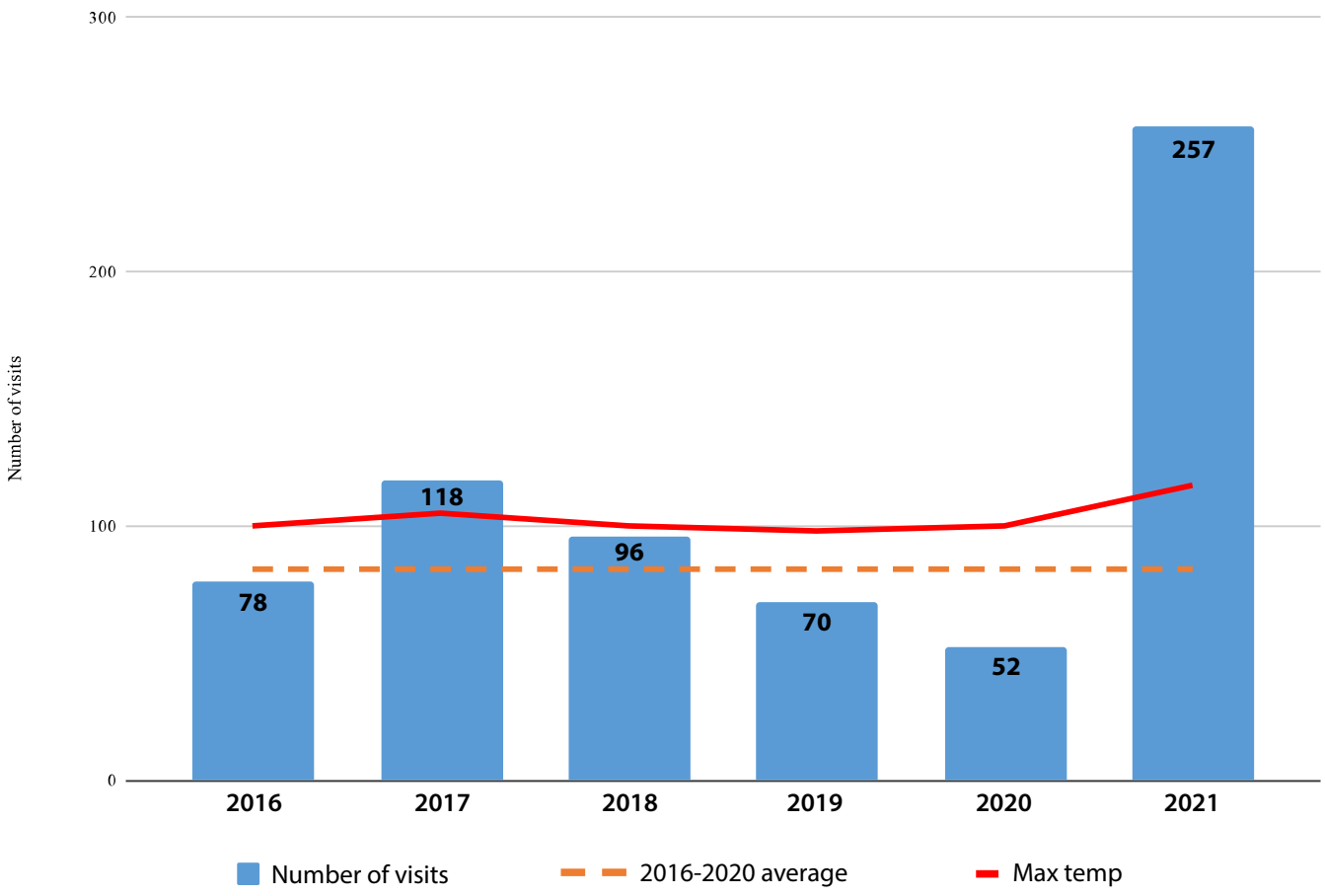
Visits to emergency departments and urgent care centers for heat-related illness are tracked in the Oregon ESSENCE system. Chart 5 illustrates the relationship between heat-related illness visits and maximum temperatures by year.

- The red line in Chart 5 shows the peak temperature recorded at the Portland Airport for 2016 through 2021. Years with the highest number of heat-related illness visits correspond with the highest maximum temperature recorded.
- The black dashed line shows the average number of heat-related illness visits from 2016 through 2020 (May 1 to September 30). At an average of 83 visits, this is just 0.5 visits per day.
- The 2021 value of 257 visits is more than three times higher than the previous five-year average.

Counts were low in 2020 in part because patterns of exposure were significantly changed during the COVID-19 pandemic. Events were canceled that often lead to exposure, such as festivals and large athletic events. People may also have been avoiding treatment for fear of exposure to the COVID-19 virus.

The heat dome event of June 25-30 accounted for 158 visits, or 61 percent of all heat-related visits in summer 2021. During a typical summer, only about three visits would be expected in the same time period. This means that the number of visits during the heat dome was about 53 times greater than would be expected under normal conditions.

Chart 5. Heat-related illness visits to emergency departments and urgent care clinics May 1- September 30, by year with maximum temperature recorded at Portland International Airport.



Patient demographics are different from the population as a whole (Table 5).

- Non-Hispanic white patients accounted for 71 percent of visits but were 66 percent of the County population in 2020.[9]
- Males are overrepresented among patients, accounting for 60 percent of all visits.
- Adults 60 years or older are also disproportionately represented. This age group made up 19 percent of the County population in 2020 but accounted for 42 percent of all visits, and 49 percent of visits during the heat dome event.[10]

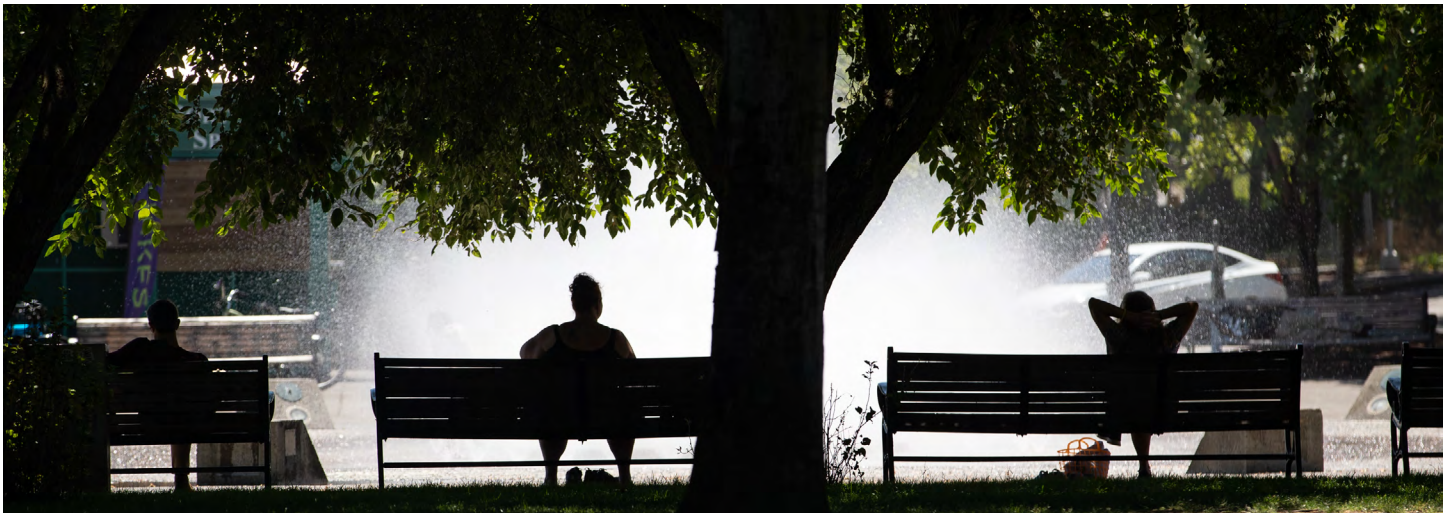
9 United States Census Bureau, 2020 Decennial Census, Table P2

10 American Community Survey 5-year estimates (2016-2020), Table S0101

Table 5. Demographics of emergency department and urgent care clinic patients

Sex	Count	Percent (%)
Male	153	60%
Female	104	40%
Age group (years)	**Count**	**Percent (%)**
0-17	15	6%
18-29	28	11%
30-39	36	14%
40-49	41	16%
50-59	29	11%
60-69	45	18%
70-79	35	14%
80+	28	11%
Race/ethnicity*	**Count**	**Percent (%)**
White non-Hispanic	183	71%
Black non-Hispanic	27	11%
Hispanic	16	6%
Asian non-Hispanic	7	3%
Other or missing	24	9%
TOTAL	**257**	**100%**

*Race and ethnicity categories with fewer than five visits are aggregated in the other or missing category



Health Department staff coded triage notes to identify visits with evidence of the following risk factors for heat illness: housing instability, residential cooling type, occupational exposure, in-vehicle exposure, and intoxication. Despite initial attempts, we were not able to reliably identify housing type or whether the patient lives alone. Triage notes were missing for 39 visit records, or 15 percent.

- The most common of these variables was occupational exposure, with 32 visit records, including evidence of exposure on the job or in a work vehicle.
- About one in 10 visit records included evidence of housing instability, a proportion that far exceeds the proportion of County residents experiencing homelessness, suggesting that this group is over-represented among patients.
- Visit records including evidence of intoxication accounted for 9% of the total.
- In-vehicle exposure, including among people living in vehicles, was indicated in 6% of visit records.

Table 6. Evidence of selected risk factors

Risk factor	Heat dome	Remainder of season	Total	Percent of all heat-related visits (%)
Intoxicants	14	10	24	9%
Housing instability	14	11	25	10%
Occupational exposure	13	19	32	12%
In-vehicle exposure	10	6	16	6%

> Access to air conditioning is a life-saving intervention during extreme heat.

Access to air conditioning is a life-saving intervention during extreme heat. Staff examined visit records to determine whether conclusions could be drawn about access to AC. However, it was very uncommon for triage notes to include information on cooling type available; 86% of records included no mention at all. Almost every mention of air conditioning was to stipulate that it was broken or not working. In 11% of records, notes confirmed that no AC was available. We include these frequencies below but caution that this is incomplete information, and reliable conclusions about the role of cooling cannot be drawn from these data.

Table 7. Evidence of cooling equipment

Cooling type	Count	Percent of all heat-related visits (%)
AC	7	3%
Fan only	1	0%
None	27	11%
Missing	222	86%

Ten ZIP codes had 10 or more visits, accounting for more than half (52%) of all visits (Table 8). In Map 3, the ZIP codes with high visit counts are distributed throughout the County, with a concentration in east Portland and Gresham. This is mostly unsurprising, as these are also the most populous ZIP codes. As a rate per 100,000 population, visits in these ZIP codes are similar to the County as a whole. Two exceptions are 97209 (Old Town, Pearl District, Slabtown) and 97205 (Downtown, Goose Hollow, Washington Park), which have a rate far above the County-wide rate of 32 visits per 100,000 population. According to PSU estimates of urban heat island effects, these two ZIP codes are cooler than most of the city during the afternoon and evening, but tend to be warmer in the morning. In part this is attributed to shading and wind channeling in parts of town with taller buildings.[11]

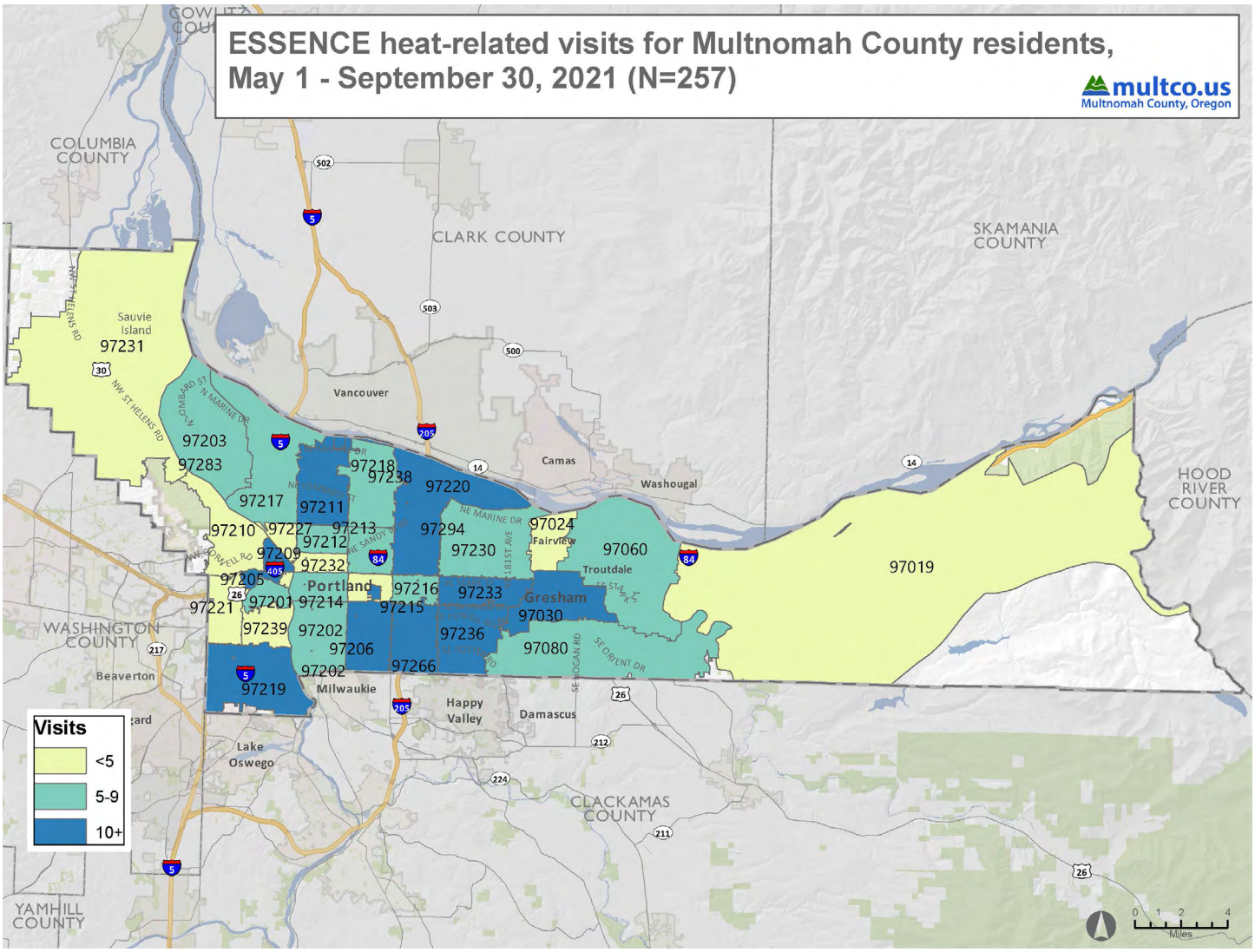
Table 8. Emergency room and urgent care visits for heat illness by ZIP code

ZIP code	Count	Percent (%)	2020 population*	Crude Rate per 100,000
97209	20	8%	19,824	101
97206	19	7%	54,248	35
97219	15	6%	43,274	35
97030	13	5%	38,980	33
97233	13	5%	38,779	34
97211	13	5%	35,738	36
97236	11	4%	39,669	28
97266	11	4%	36,818	30
97205	11	4%	7,679	143
97220	10	4%	29,318	34
TOTAL FOR ALL ZIP CODES	**257**	**100%**	**815,428**	**32**

*American Community Survey, 2020 5-year estimates detailed tables, Table B01003

11 Voelkel, J., Shandas, V., & Haggerty, B. Developing high-resolution descriptions of urban heat islands: A public health imperative. Prev Chronic Dis 2016; 13:160099. DOI: http://dx.doi.org/10.5888/pcd13.160099.

Map 3. Emergency department and urgent care clinic visits for heat illness by ZIP code



Conclusions

Climate change makes it more likely that we will experience more summers like 2021, one that was unlike any experienced in memory. As detailed in this report, extreme heat caused a massive increase in illness and death. While in most years, there are no heat deaths in Multnomah County, or just one, there were 72 in 2021. Similarly, in most years there are fewer than 100 emergency department visits for heat illness, but in 2021 visits surged to 257. The June heat dome was a major driver of these outcomes, accounting for 60 percent of all emergency department visits and nearly all of the deaths. Groups who were disproportionately affected include males, older adults, non-Hispanic white people, people living alone, people living outside or in unstable housing, people living in multifamily housing, and people living in warmer parts of the County.

Vulnerability to climate hazards, including heat, is often described through three components:

- Sensitivity, such as underlying health conditions or biological traits like age
- Exposure, which may be increased by the urban heat island effect, working outdoors, housing type, or having unstable housing
- Adaptive capacity, or the resources available to cope and withstand hazardous conditions

Each of these dimensions of vulnerability likely played a role in the health outcomes observed during summer 2021.

Regarding exposure:

- Deaths appear to have occurred more in places that are part of urban heat islands, while evidence is mixed on emergency department visits.
- Emergency department visit records show that at least some of the visits were related to exposure on the job or in vehicles.
- Lack of stable housing played a role in both illness and deaths.

Regarding sensitivity, the age of decedents and emergency department patients strongly reflects the greater sensitivity of older adults.

Finally, while we have limited evidence on adaptive capacity, it is clear that air conditioning was not readily available for many of the decedents and ill patients.

Acknowledgements

Multnomah County Medical Examiner's Office

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Multnomah County Public Health

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