HEAT

EFFECTS ON THE ELDERLY AND OTHER VULNERABLE POPULATIONS

Alan H Lockwood, MD

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We live in "a world accelerating in the wrong direction."

The 2023 report of the *Lancet* countdown on health and climate change, Reference 14

"Every health dimension tracked by the Lancet Countdown is worsening as the climate changes."

Climate change mitigation: tackling the commercial determinants of planetary health inequity, Reference 15

How to use this pamphlet

This pamphlet is not copyrighted. Some of the figures in it are subject to copyright restrictions. To maximize the utility to readers and to provide resources needed for writing letters to the editor, OpEds, etc. and contacts with others, including elected officials, I have included links to maps of many redlined cities and, with supplements they yield temperature data for 108 of these cities (references 18 and 19). Finally, the Agency for Toxic Substances and Disease Registry (ASDR) and CDC website for the Social Vulnerability Index (see link in Table footnotes) and NOAA data lead to interactive maps of the U.S. that predict city temperatures at various times in the future and SVI data at the county and census tract level.

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Monique Taupin, a French woman, and Petar, a Serbian man who had lived in Paris for about 20 years, had several things in common. They were both more than 70 years old, they both lived alone, and they both died during the 2003 European heat wave.[1, 2] An early warning of the disaster yet to come came from Les Pompes Funèbres Générales, the largest organization of French undertakers. They reported a 50 percent increase in demand for their services. News reports of an exceptional number of deaths among nursing home patients was another harbinger of what was to come. This heat wave claimed an estimated 70,000 lives before it ended.[3]

Petar lived and died in a small attic-like room in a dark-roofed building that was typical of the popular Haussmann style as shown in Figure 1. The deaths of Petar and Monique were preventable.

Figure 1: East facade of Prefecture of Police seen from the Notre Dam Cathedral, Paris. Photographer, Christian Bortes, Reproduced under the Creative Commons Attribution 2.0 Generic license.

Heat Causes Illness and Death

There are four major types of heat-related illnesses: heat rash, or prickly heat; heat cramps; heat exhaustion; and heat stroke. Heat exhaustion is a warning of more serious things to come. Progression to heat stroke may occur without treatment. Heat stroke is a life-threatening medical emergency that requires hospital treatment.

Normal body temperature is maintained within narrow limits. Neural reflexes control sweat production and dilation of blood vessels in the skin. These mechanisms mediate the loss of excess body heat by radiation and evaporation. Heat exhaustion develops when these mechanisms are overwhelmed. Symptoms include heavy sweating and a cool moist skin. Dehydration occurs in the absence of fluid and electrolyte replacement. Additional symptoms may emerge without treatment including dizziness or faintness after standing up from a sitting or lying down position. Cramps, headache, nausea, weakness, or excessive fatigue may be present. A rapid heart rate and a low blood pressure are typical. Prompt fluid replacement and cooling measures are necessary to prevent a pathological increase in body temperature. Heat stroke occurs if the body temperature increases to 104˚F (40˚C). Nausea and vomiting may be associated with skin that is reddened, hot and moist, or dry. Headache may progress to a state of confusion or coma. These individuals must be transported to an emergency room promptly to prevent death.

External factors that affect the ability to maintain a normal body temperature depend on the interaction between the ambient temperature and humidity. The body's control mechanisms become ineffective at 95˚F when the relative humidity is 100 percent. When these conditions are met, heat loss by radiation and evaporation fail and the body's temperature will increase. The Fifth National Climate Assessment warns us that these conditions will occur with an increasing frequency as the climate crisis deepens.[4] Weather, age and social and economic factors combine with a variety of medical conditions, medications, and other factors to determine an individual's risk for developing a serious heat-related illness.

Lessons learned from heat waves

On July 12, 1995, Chicago was unprepared when the official temperature at O'Hare and Midway Airports rose to 97˚F. The weather forecast that predicted this heat did not receive the attention that is garnered by current predictions. In the ensuing week there were over a thousand excess admissions to the 47 hospitals in Cook County (excluding Department of Veterans Affairs hospitals).[5] Those over 65 years accounted for 38 percent of the excess admissions. Approximately 700 deaths were recorded.

Death certificate data from 608 adults listed heat, with or without cardiovascular disease as the primary cause of death.[6] The heat burden fell heavily on the elderly. The median age of those who died was 76 years. Diagnoses among those hospitalized included dehydration, heat stroke and heat exhaustion, renal failure, emphysema, and epilepsy. Comorbid conditions included pre-existing cardiovascular disease, diabetes, renal disease, and other unspecified nervous system disorders.

The heat wave became the focus of many studies as epidemiologists worked to learn why people died. In one of the first of these investigations researchers interviewed an age-matched sample of relatives, friends, or neighbors of those who died.[6] Factors that were linked to an increase in the risk for death were found. These included confinement to bed because of a medical problem; the inability to perform self-care activities; living alone, like Petar and Monique; not leaving home each day; and like Petar, living on the top floor of a building. The dark roof of his building created additional risk. Not surprisingly, access to air conditioning was protective along with the presence of social contacts and activities.

Petar's social isolation was particularly notable. His body was not discovered until about two weeks after his death. The circumstances of his death, and undoubtedly that of too many others, were captured in the title of Richard Keller's book, Fatal Isolation.[2]

The Chicago Heat Wave in Context

The Chicago event was one of many more recent heat waves in the U.S. In the summer of 2021 record-breaking heat affected much of the country. In late June the temperatures reached 108 F° in Seattle, WA.[7] Portland, OR, was even more severely affected, with temperatures reaching 116 F°, 42 F° higher than the mean daily high temperature for late June.[8] Over 200 million Americans were under heat watches and warnings during that wave. Heat waves are invariably associated with heat-related illnesses and deaths. The National Syndromic Surveillance Program, a CDC initiative designed to detect and respond to potential health threats, reported that in Washington state, Oregon, Idaho and Alaska there were 3,504 heat-related emergency room visits in the interval between May 1 and June 30 .[8] Approximately 79% of those occurred between June 25 and June 30. Deaths rose accordingly. On June 28 there were 1,038 heat related emergency room visits in Washington and Oregon, compared with nine on the same date in 2019. In June, 2021, there were approximately 600 unexpected deaths in Washington and Oregon.[9] In Washington state, the weekly number of excess deaths exceeded the number recorded during the winter COVID-19 surge.[9]

A CDC group evaluated data from the National Vital Statistics System and concluded that, on average,

there were 702 heat-related deaths each year in the interval between 2004 and 2018. Deaths were the highest among males, individuals 65 years of age or older, non-Hispanic American Indian/Alaska Natives and among those who lived in what the CDC termed "noncore nonmetropolitan and large central metropolitan areas."[10] The CDC Quikstats feature reported that in 2021 there were 1,600 heat-related deaths in the US.[11] The deaths were not distributed evenly among states. Nine states with 20 or more deaths included Arizona (426), Washington (171), Oregon (133), Nevada (166), California (143), Oregon (133), Texas (93), Louisiana (38), Florida (30), and Pennsylvania (26).

An estimate of the number of heat-related deaths, based on epidemiological data, was modeled by Shindell and colleagues.[12] They concluded that there were 12,000 premature heat-related deaths per year in the U.S. during the decade ending in 2019. They predicted that this number will increase to 97,000 per year during the last decade of the 2000s, assuming that a high rate of greenhouse gas emissions continues (the RCP8.5 scenario). Reducing emissions substantially reduces the number of premature deaths by about half (the RCP4.5 scenario). Their model also predicts that the greatest number of premature deaths will occur in northern states where poor preparation for heat is relatively common, compared to southern states where adequate air conditioning is more widespread.

In a 2014 publication, the World Health Organization (WHO) reported that heat-related deaths for those over 65 years of age rose by about 70 percent in the preceding twenty years.[13] The outlook for the future seems grim, according to the most recent Lancet Countdown on health and the environment that leads with a statement that we live in a "world that is accelerating in the wrong direction."[14] An accompanying commentator writes "Every health dimension tracked by the Lancet Countdown is worsening as the climate changes."[15] The report backs this up with projections for the future. By the interval between 2041 and 2060 they estimate that there will be a 1120 percent increase in heat wave exposure for those over 65, compared to a baseline between1995 and 2014. This increases to 2510 percent during the last two decades of the century, even if the global temperature increases can be limited to 2°C. If there is no further climate mitigation, these increases rise to 1670 percent by the middle of the century and to 6311percent by the century's end. There will be parallel increases in heat-related morality for those 65 and older. If no further mitigation occurs these rise to 433 and 1537 percent for the two intervals, respectively.

Although air conditioning reduces the morbidity and mortality associated with heat waves, there is a price to pay. Air conditioning requires the use of electricity. High-efficiency heat pumps and better insulation help. However, unless the increase in demand for electricity is met with increases in electricity generation from renewable sources, greenhouse gas emissions from fossil fuel use will increase. A 2023 report from the United Nations Environment Programme estimates that this increase will be about 10 percent by 2050.[16]

Heat Where You Live

You can find your own heat-associated risk, particularly if you are elderly or a member of another vulnerable population. Consider Cleveland, Ohio, as a typical example. Very hot weather is uncommon in Cleveland. So when the temperature reached 90˚F two days in a row on September 10, in 2019, a brief note in the newspaper stated that "There have been only 38 days in the 90s on

September 10 or later since ... 1938."[17] Cleveland.com maintains an historical weather database. Between 1871 and 2020 there were only 4 days when the temperature reached 95˚F on the Fourth of July. As shown in the Table on page 6, it is likely that by 2050 that there will be 10 more days each year when the Cleveland temperature exceeds 95˚F compared with 2020. For Phoenix, AZ, the prediction for 2050 is that there will be 171 days each year when temperatures exceed 95˚. Use the National Oceanographic and Atmospheric Administration interactive map to find similar data for many U.S. and other cities.

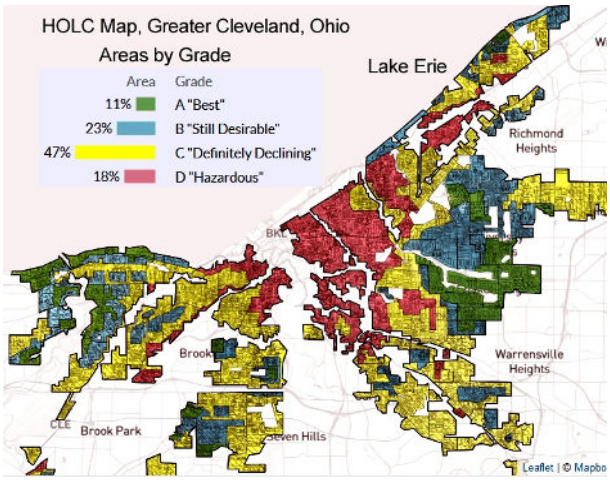

Figure 2: Greater Cleveland, Ohio. Home Owners' Loan Corporation (HOLC) boundaries are shown along with the percent of the city in each area. Best mortgage risk areas are green, still desirable areas in blue, definitely declining areas in yellow, and hazardous areas in red.[18] Reproduced under terms granted by the Creative Commons International License 4.0 Accessed April 13, 2021

The heat burden is not evenly distributed among all residents of Cleveland. Hoffman and colleagues extracted land surface temperature data from satellite records for Cleveland and 107 other American cities.[19] They then subdivided each city's surface temperature record into regions defined by the Home Owners' Land Corporation (HOLC), a New Deal effort ostensibly designed to prevent mortgage foreclosures. There were four HOLC-defined regions, one of which was the so-called redlined area that primarily housed racial and ethnic minorities and low-income individuals. This is now recognized as a racist practice that contributed to the current racial wealth gap. These investigators found that the temperatures in redlined areas in the cities were approximately 2.6˚C or 4.7˚F hotter than in the green or so-called best mortgage risk areas. Cleveland is a typical city in this regard. Its HOLC-defined boundaries are shown in Figure 2.[18] The temperature differential in Cleveland was 2.55˚C or 4.59˚F. The built environment and the extent of tree cover were important factors that contributed to this difference in Cleveland and other cities.[19] Higher temperatures in previously redlined areas place these residents at a higher risk for the development of heat-related illnesses. In addition, those residents are undoubtedly more likely to live in poorly insulated homes that do not have air conditioning. Those with air conditioning will be confronted by higher electrical bills as they struggle to keep cool.

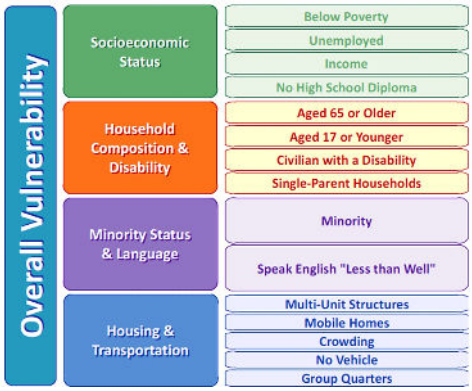

Figure 3: The Social Vulnerability Index, Source, CDC.

To aid in the formulation of plans for disasters it is important to have information about the vulnerability of the individuals who live in the area. To help address this need, the CDC created and maintains a Social Vulnerability Index (SVI) website in collaboration with the Agency for Toxic Substances and Disease Registry.[20] The SVI is designed to predict "a community's ability to prevent suffering" in the event of a disaster. This would include heat waves. The overall SVI is made up of 4 categories, each of which has its own SVI as shown in Figure 3. Each category is determined by grouped factors. SVIs range from 0.0, the least

vulnerable, to 1.0, the most vulnerable. Thus, there is an overall SVI and additional SVIs for Socioeconomic status, Household Composition & Disability, etc. The overall SVIs and measures of Household Composition & Disability for 8 U.S. cities are shown in the Table. Links in the Table footnotes provide access to county and census tract data in the U.S. for each of the SVIs and the 15 factors. Cleveland has an overall SVI of 0.7333, placing it in the CDC's medium-to-high vulnerability category. These data help identify populations where focused public health and other measures can mitigate the effects of a disaster, such as a heat wave, as shown in the Table and its legends. These factors might include the percentage of the population in a county or census tract that is 65 or older, the percentage living in poverty and the percentage who are disabled. Many Cleveland residents live in poverty (25.9 percent) and 18.2 percent are 65 or older. Data for other American cities and how to access similar information for others are shown in the Table and its footnotes.

A Prescription for Survival

The year 2024 is certain to be the hottest on record. The recent analysis performed by the Rhodium Group predicts that by the end of the century the global temperature will increase by 2.8°C.[21] This is an improvement over prior predictions but it is disastrously short the goal of 1.5˚C called for by the Intergovernmental Panel on Climate Change.[22] The statement in United Nations COP28 document was hailed for including the goal of "transitioning away from fossil fuels in energy systems" however loopholes place this goal in doubt.[23]

Top-down efforts must be matched by bottom-up efforts. The Centers for Disease Control and Prevention exhorts us to "stay cool, stay hydrated, stay informed." The CDC urges individuals to perform a heat wave preparedness assessment. Factors to consider are: age; presence of medical conditions that increase susceptibility to heat, including needed medications; and the availability of an adequate supply of drinking water. Other items include: the presence or absence of social support networks, something that is particularly important for individuals living alone; whether there is a plan to move to a cooling shelter if needed; and the identification of measures needed to make homes more energy efficient. This includes a search for help from community and other sources designed to aid vulnerable populations. Advice from healthcare professionals should be helpful in making individual plans. It is important to stay tuned to media warnings that predict heat waves and to act accordingly. Subscribe to your community's emergency warning service if available. Communities should develop climate action plans that include public health resources needed to help vulnerable individuals. Create cooling shelters and provide a way to move vulnerable individuals into air conditioned spaces. Local, state and federal programs are needed to avoid the disasters associated with the Chicago, European, and other heat waves. Temperatures are rising and heat waves will become more prevalent even if greenhouse gas emissions are curtailed and adaptive measures become standard.

Epilog

Monique Taupin and Petar, her fellow Parisian, were vulnerable. Hard work is needed we are to be judged favorably by how well we treat those who are vulnerable. Do not become a victims of heat and do not let this happen to others. Many heat-related deaths are preventable; fortunately individuals can minimize this risk. The solution is to halt the climate emergency; mitigate greenhouse gas emissions and adapt to the threats posed by this crisis. Herculean tasks require herculean efforts. The forces of ignorance and greed propelled by disinformation are powerful but not insurmountable. There is very little time to act. But act we must if the legacy we leave behind is to be one of triumph and pride

City, County, State	T˚C, redline minus best[a]	Days above 95˚F 2020 and 2050[b]	Percent County Population older than 65[c]	Percent county Population below 150 % poverty level[c]	Percent County Population with Disability among non-institutionalized civilians[c]	Overall SVI for county, 2020 data[c]
Los Angeles CA	4.21	14 vs 30	13.6	23.7	10.7	0.8584 High
Phoenix, Maricopa, AZ	N.A. 36% of city redlined	155 vs 171	15.2	20.8	11.4	0.7397 Medium to High
Portland, Multnomah, OR	7.07	5 vs. 12	13.5	20.7	12.3	0.577 Medium to High
Denver, CO Denver	6.68	19 vs 38	11.8	19.4	9.7	0.5821 Medium to High
Cleveland, Cuyahoga, OH	2.55	4 vs 14	18.2	25.9	14.7	0.7333 Medium to High
St. Louis, St. Louis, MO	-1.47	26 vs 49	18.1	15.2	11.7	0.3199 Low to Medium
Miami, Miami-Dade FL	5.34	4 vs 27	16.3	27.8	10.2	0.9007 High
Baltimore City, MD	5.15	25 vs 35	14.0	29.5	15.5	0.8682 High
Greater NY City, NY	-0.83	6 vs 13	16.6	22.3	10.3	0.6668 Medium to High

a = Summer temperature in redlined HOLC area minus temperature in best mortgage risk area.[19]

b = From NOAA future heat events from 1950 to 2099. Accessed 11/20/23.

c = CDC/ATSDR 2020 Social Vulnerability Index (SVI) 2020 data for states, counties or census tracts. When the geographic comparison switch on the site is set to Nationwide, the SVI for the selection is compared to national data; when set to Statewide, the selection is compared to within-state data. Accessed 11/20/23.

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