

Employment Pathway

MMC Heat Preparedness Plan Heat Health Research Brief

Social determinants of health are the conditions in which people live that affect a wide range of health risks and outcomes. Our social context, economic situation, and built environment can buffer climate impacts by providing us a means to cope or adapt. They can also amplify climate impacts, especially among communities that have been subjected to structural racism and other inequities. MAPC identified six social determinant pathways through which people experience climate-driven extreme heat impacts. For each pathway, MAPC conducted a brief literature review and summarized the findings into a short memo.

Key Insights

- Exposure to extreme heat can cause a range of mild to deadly symptoms, from heat rashes and muscle cramps to heart attacks and heatstroke. Heat stress killed 815 U.S. workers and seriously injured more than 70,000 between 1992 and 2017. Five to ten million workers are exposed to outdoor heat beyond safe levels every year, which does not account for workers exposed to indoor heat.
- Beyond heat-illnesses, researchers have associated prolonged workplace heat exposure with fatigue, disorientation, deterioration of cognitive and fine motor skills, reduced worker productivity, and increased risk of serious work-related injuries and death.
- Workplace conditions that increase risks for heat health impacts include heavy physical activity, warm or hot environmental conditions, high humidity, clothing, and personal protective equipment that holds in body heat, and radiant heat sources, such as ovens, furnaces, and open fire. Hazardous heat exposure can occur in both outdoor and indoor work environments.
- Worker acclimatization to heat, job experience, pre-existing health status, and cumulative heat exposures (at work and at home) influence risk to occupational heat health impacts.
- The National Institute for Occupational Safety and Health (NIOSH) publishes criteria for a heat exposure standard and recommendations for employers about how to prevent heat-related illnesses. Currently, no federal occupational heat exposure standard exists.

Recommendations

- Enhance occupational health and safety surveillance programs to improve tracking of occupational exposures and patterns of injury and illness in relation to changes in climate and occupational sector.¹

¹ The Occupational Safety and Health Administration (OSHA) requires employers with more than 10 employees to keep a record of serious work-related injuries and illnesses.

- Educate workers and employers on occupational heat health risks and prevention measures, emphasizing connections between heat risks and hydration, rest breaks, worker acclimatization, uniforms, and personal protective equipment.
- Adopt specific heat exposure occupational health and safety standards at the federal (OSHA) and state level to enhance enforcement and prevention planning capacity.

Research Summary

Connections Between Health and Employment

Multiple aspects of employment affect health, including income, job stability, working conditions, access to health insurance and social connections. A stable, good-paying job can make it easier for workers to afford good quality housing in a safe neighborhood, nutritious food, transportation – all of which can enhance individuals’ health and resilience to climate-driven hazards. A job can also negatively influence a person’s health. Workplace injuries and illnesses can occur because of exposure to hazards in the workplace, toxic chemicals, dangerous equipment, and violence at work. In 2019, there were approximately 86,000 work-related injuries and illnesses reported across Massachusetts. Shift work, long work hours, and jobs with high demand, low control and poor social support, impact health directly and can also indirectly affect health by influencing lifestyle behaviors – eating habits, leisure time, exercise, sleep, and ability to manage chronic disease.²

Occupational health risks are not borne equally. Low wage workers, including many immigrants and Black, Indigenous, and People of Color (BIPOC), are disproportionately employed in physical demanding, high risk jobs, with less predictable schedules, and high stress positions. These workers are also less likely to have access to employer provided healthcare, awareness of rights and resources, and more likely to experience workplace racism and violence.

Health Impacts of Workplace Exposure to Heat

Exposure to extreme heat can cause a range of mild to deadly symptoms and conditions, from heat rashes and muscle cramps to heart attacks and heatstroke. Multiple days of exposure can have a cumulative effect on workers by reducing the effectiveness of the human body’s natural cooling mechanisms, particularly among older workers. Even small changes in temperature can significantly affect the health of workers, especially when doing physical labor. Exertional heat illness, which is associated with increased production of body heat due to strenuous activity, can happen under cooler conditions than those that trigger heat illness among more sedentary

² MA Department of Public Health (2016). Putting Data to Work: 23 Health Indicators by Occupation and Industry: Findings from the Massachusetts Behavioral Risk Factor Surveillance System, 2012-2013. MDPH Bureau of Community Health and Prevention Occupational Health Surveillance Program Office of Data Management and Outcomes Assessment Health Survey Program. <https://www.mass.gov/doc/putting-data-to-work-23-health-indicators-by-occupation-and-industry-findings-from-the-1/download>

individuals.³ According to the Occupational Safety and Health Administration (OSHA), heat stress killed 815 U.S. workers and seriously injured more than 70,000 between 1992 and 2017.⁴ Other sources estimate that five to ten million workers are exposed to outdoor heat beyond safe levels every year, in addition to workers exposed to indoor heat of which no estimate was reported in the research⁵. Efforts to address occupational heat exposures have mostly focused on outdoor exposure, which may explain the gap in data on indoor heat exposures. OSHA reporting on workplace heat-related fatalities and illnesses likely underestimates occupational heat health impacts, given the limitations of surveillance programs.⁶

Beyond heat-illnesses, researchers have associated prolonged workplace heat exposure with fatigue, disorientation, impaired judgement, loss of concentration, reduced vigilance, deterioration of cognitive and fine motor skills, reduced worker productivity, and increased risk of serious work-related injuries and death.⁷ Occupational injuries including both serious and traumatic injuries arising from slips, trips and falls, exposure to harmful objects, wounds, lacerations, and amputations, burns and minor cuts have been reported to increase in hot weather conditions. Heat-related fatigue and deterioration of cognitive and fine motor skills – and removal of personal protective equipment to cope with heat - are thought to contribute to the risk of occupational injury in hot environments. Heat exposure may also increase workers' exposure to toxic chemicals. There is some evidence that high temperatures accelerate the movement of chemicals such as polychlorinated biphenyls (PCBs) in the air and increase chemical uptake by human lungs and skin.⁸ The temperature threshold at which heat increases risks of occupational injuries varies from region to region because of different levels of acclimatization in the population across different climates.⁹ The economic cost of occupational injuries and deaths is as

³ Lundgren, K., Kuklane, K., Gao, C., Holmer, I. (2013). Effects of heat stress on working populations when facing climate change. *Industrial Health*. 51: 3-15.

⁴ Miranda, L. (2021). Why are workers in the U.S. still dying from heat exhaustion? NBC News. <https://www.nbcnews.com/business/business-news/why-are-workers-u-s-still-dying-heat-exhaustion-n1270417>

⁵ Applebaum, K.M., Graham, J., Gray, G.M., LaPuma, P., McCormick, S.A., Northcross, A., Perry, M.J. (2016). An Overview of Occupational Risks from Climate Change. *Current Environmental Health Reports*. 3:13-22.

⁶ Gubernot, D.M., Anderson, G.B., Hunting, K.L. (2014). The epidemiology of occupational heat-related morbidity and mortality in the United States: a review of the literature and assessment of research needs in a changing climate. *International Journal of Biometeorology*. 58, 8: 1779-1788.

⁷ Applebaum, K.M., Graham, J., Gray, G.M., LaPuma, P., McCormick, S.A., Northcross, A., Perry, M.J. (2016). An Overview of Occupational Risks from Climate Change. *Current Environmental Health Reports*. 3:13-22.

⁸ Constible, J., Chang, B., Morganelli, C., Blandon, N. (2020). On the Front Lines: Climate Change Threatens the Health of America's Workers. Natural Resources Defense Council.

⁹ Fatima, S.H., Rothmore, P., Giles, L.C., Varghese, B.M., Bi, P. (2021). Extreme heat and occupational injuries in different climate zones: A systematic review and meta-analysis of epidemiological evidence. *Environment International*. 148: 106384.

high as some major diseases, yet the investment in prevention of occupational injuries is miniscule compared to resources spent on disease research.¹⁰

Heat may also play a role in workers' development of chronic conditions. For example, in Central America repeat exposure to high temperatures has been identified as an underlying cause of the elevated prevalence of chronic kidney disease among agricultural workers¹¹. Other long-term health effects of prolonged heat exposure among workers includes mental health, skin, and respiratory conditions. Finally, heat can indirectly harm health by affecting productivity and causing workers to take extended absences from work, reducing take home pay and making it harder to afford medical care, food, and housing. According to a Natural Resources Defense Council report, "in 2018 fewer than half of farm and construction workers—the two groups most vulnerable to heat-related deaths—had paid sick leave, compared with 80 to 90 percent of workers in finance, insurance, real estate, and public administration. From 2013 to 2018, private sector workers in the United States experienced an estimated 1,020 occupational cases of nonfatal heat stroke that required time away from work. About three-quarters of the cases resulted in one to five days of time away. The worst 10 percent of cases, however, resulted in lost-work time of a month or longer."

Occupational fatalities and injuries attributable to heat are not always reported as such, so current assessments are likely an undercount¹². Moreover, it is well known that occupational health surveillance programs do not accurately capture the full scope of injuries and illnesses. Gubernot et al. outlined several reasons why occupational injuries are difficult to diagnose: 1) similarities in the clinical presentation and progression of illnesses resulting from occupational and non-occupational exposures; 2) the time between exposure and symptom onset; 3) the multiple causes of many diseases; and 4) doctors do not inquiring about work-related hazards. Employees may also be reluctant to report occupational injuries for reasons that include fear of retaliation, economic disincentives, and lack of awareness over diagnosis, rights, and resources. Collectively, these factors may explain the underreporting and under-diagnosis of heat disorders among workers.

Workplace Heat Exposure Risk Factors

Type of Employment

Workplace conditions that increase risks for heat health impacts include heavy physical activity, warm or hot environmental conditions, high humidity, clothing, and personal protective

¹⁰ Gubernot, D.M., Anderson, G.B., Hunting, K.L. (2014). The epidemiology of occupational heat-related morbidity and mortality in the United States: a review of the literature and assessment of research needs in a changing climate. *International Journal of Biometeorology*. 58, 8: 1779-1788.

¹¹ Applebaum, K.M., Graham, J., Gray, G.M., LaPuma, P., McCormick, S.A., Northcross, A., Perry, M.J. (2016). An Overview of Occupational Risks from Climate Change. *Current Environmental Health Reports*. 3:13-22.

¹² Applebaum, K.M., Graham, J., Gray, G.M., LaPuma, P., McCormick, S.A., Northcross, A., Perry, M.J. (2016). An Overview of Occupational Risks from Climate Change. *Current Environmental Health Reports*. 3:13-22.

equipment that holds in body heat, and radiant heat sources, such as ovens, furnaces, and open fire¹³.

Hazardous heat exposure can occur in both outdoor and indoor work environments. Outdoor industries that OSHA and other sources identified as high risk for heat-related illnesses include agriculture, construction, landscaping, mail and package delivery, oil and gas operations, transportation, firefighting, and emergency response operations. Indoor industries that OSHA and other sources identified as high risk for heat-related illnesses include commercial kitchens, laundries, electrical utilities, fire services, iron and steel mills and foundries, manufacturing with hot local heat sources, and warehousing. Most heat deaths have been reported in outdoor workplaces requiring heavy work, such as agriculture and construction sites. However, during heat waves, the risks may be higher in indoor industries.¹⁴ The effects on indoor workers are less clear and the impact more complex as industrial heat production and building characteristics, such as ventilation and presence of cooling systems, become important factors.

Uniforms and personal protective equipment may exacerbate the risk for heat stress by impeding heat loss from the body. PPE can contribute to heat-related injuries in conditions that are not considered excessively hot.¹⁵ Heat can also motivate workers to take off protective clothing due to discomfort, putting the worker at higher risk for dangerous exposure and injury.

Worker Acclimatization, Experience, and Underlying Health Status

According to OSHA, “most outdoor fatalities, 50% to 70%, occur in the first few days of working in warm or hot environments because the body needs to build a tolerance to the heat gradually over time. The process of building tolerance is called heat acclimatization. Lack of acclimatization represents a major risk factor for fatal outcomes¹⁶ (OSHA).” The CDC’s National Institute for Occupational Safety and Health (NIOSH) publishes recommended occupational heat exposure limits (OSHA). Recommended exposure limits are lower for workers who are unacclimatized to heat, who wear work clothing that inhibits heat dissipation, and who have predisposing personal risk factors. NIOSH also recommends an acclimatization schedule for newly hired workers and unacclimatized long-term workers (e.g., during early season heat waves). Workers are considered unacclimatized if they had started a new job within the

¹³ Occupational Safety and Health Administration. (2020). Heat. United States Department of Labor. <https://www.osha.gov/heat-exposure>

¹⁴ Fatima, S.H., Rothmore, P., Giles, L.C., Varghese, B.M., Bi, P. (2021). Extreme heat and occupational injuries in different climate zones: A systematic review and meta-analysis of epidemiological evidence. *Environment International*. 148: 106384.

¹⁵ OSHA published COVID-19 guidance on the use of cloth face coverings while working in hot and humid environments.

¹⁶ Occupational Safety and Health Administration. (2020). Heat. United States Department of Labor. <https://www.osha.gov/heat-exposure>

preceding 2 weeks or if they had recently returned from an absence of greater than one week.¹⁷ Poor acclimatization, insufficient training, failure to adopt preventive measures, and the strenuous nature of jobs are important factors contributing towards the risk of occupational injury in newer workers.

Closely associated with acclimatization, age and pre-existing health status can put certain workers at greater risk for occupational heat health risks. The risk of heat stress during hot weather conditions is higher among older workers particularly because of pre-existing health conditions and compromised ability to regulate body heat. A 2012-2013 survey of Massachusetts workers found that workers in building and grounds maintenance, accommodation and food service workers, and transportation and materials moving workers reported a higher prevalence of poor self-reported overall health. Most of these occupations are listed among those with greater heat exposure.

Cumulative Exposures to Heat at Work and Home

Continuous exposure to high temperatures, at work, home, or other non-workplace environments, can worsen health risks because workers are unable to cool down in between shifts. Many workers with the most hazardous jobs and socioeconomic disadvantage, including migrant workers and day workers, are also most likely to live in homes without adequate indoor cooling. Home-related extreme heat exposures are covered within the Housing Pathway Research Brief.

Lack of Workplace Heat Standards

OSHA sets and enforces safety standards and conducts inspections of workplaces to assess compliance with these standards. Under the General Duty Clause of the Occupational Safety and Health Act, employers are responsible for providing workplaces “free from recognized hazards that are causing or are likely to cause death or serious physical harm to employees.” OSHA has interpreted this to include heat-related hazards that are likely to cause death or serious bodily harm and has cited employers for heat-related illnesses and fatalities under the General Duty Clause.

However, no specific federal heat exposure standards or regulations exists.¹⁸ OSHA launched a heat illness prevention campaign in 2011 to educate both employers and employees on recognition and prevention of heat illness, and the agency recommends, but does not require, that employers with workers exposed to high temperatures develop a written plan to prevent heat-

¹⁷ Tustin, A.W., Lamson, G.E., Jacklitsch, B.L., Thomas, R.J., Arbury, S.B., Cannon, D.L., Gonzales, R.G., Hodgson, M.J. (2018). Evaluation of occupational exposure limits for heat stress in outdoor workers – United States, 2011-2016. Centers for Disease Control and Prevention Morbidity and Mortality Weekly Report. 67, 26.

¹⁸ Sparkman, D. (2019). Public Citizen, Labor Groups Seek OSHA Heat Standard. EHS Today. <https://www.ehstoday.com/environment/article/21920164/public-citizen-labor-groups-seek-osh-heat-standard>

related illnesses. Only Washington, Minnesota, and California have specific laws governing occupational heat exposure. Washington and California's heat exposure standards apply to outdoor workplaces, while Minnesota's apply to indoor places of employment (OSHA).

Climate scientists and labor groups have advocated for enhanced worker protections to both OSHA and individual states, arguing that the lack of specific standards undermines prevention and enforcement efforts.¹⁹ Federal lawmakers are currently considering two new bills that would create measures such as paid breaks in cool spaces, access to water and limitations on time workers are exposed to heat as temperatures hike to daily record levels.²⁰ The National Institute for Occupational Safety and Health (NIOSH), an occupational health and safety research agency housed within the CDC, first developed criteria for a recommended heat exposure standard and recommendations for employers about how to prevent heat-related illnesses in 1972 (OSHA). NIOSH has since revised these recommendations in 1986 and 2016. Each time, NIOSH recommended a heat exposure standard to OSHA. According to a Department of Labor representative, OSHA is currently considering a possible new rule on heat exposures.

Other Workplace Heat-Related Climate Hazards

A warming climate and shifting rainfall conditions can affect the prevalence and distribution of insect- and water-borne vectors, pathogens, and allergens. These changes are anticipated to heighten occupational exposures to infectious disease, primarily affecting workers in forestry, landscaping, agriculture, fisheries, animal husbandry, and meat processing industries. Risks include tick-borne encephalitis, tularemia, brucellosis, leptospirosis, rabies, and anthrax. Pollen may increase from earlier flowering and longer growing seasons.²¹

Research Gaps

- Improved occupational injury and illness surveillance protocols and programs are needed to track changes in exposures and patterns of injury and illness in relation to changes in climate, including heat, by an occupational sector.
- Better surveillance data can help guide additional research on appropriate interventions for different workers and employment settings.

¹⁹ Miranda, L. (2021). Why are workers in the U.S. still dying from heat exhaustion? NBC News.

<https://www.nbcnews.com/business/business-news/why-are-workers-u-s-still-dying-heat-exhaustion-n1270417>

²⁰ Miranda, L. (2021). Why are workers in the U.S. still dying from heat exhaustion? NBC News.

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²¹ Applebaum, K.M., Graham, J., Gray, G.M., LaPuma, P., McCormick, S.A., Northcross, A., Perry, M.J. (2016). An Overview of Occupational Risks from Climate Change. *Current Environmental Health Reports*. 3:13-22.