Hot Pursuit: New Efforts to Prevent Heat-Related Illness on the Job

Charles W. Schmidt

https://doi.org/10.1289/EHP11954

A few months after arriving in Las Vegas, Nevada, in the winter of 2015, Erick Bandala began to struggle with the heat. Bandala, an environmental engineer, had come from Mexico to take a job with the Desert Research Institute. He recalls that the weather was pleasant at first. But as summer rolled around, the temperatures became suffocating, often soaring well over 40.5°C (105°F).

Prompted by complaints from local residents that summer heat waves seemed to be getting worse every year, Bandala started studying climatic trends in the area. His research team has since published evidence showing that extreme heat is a worsening problem for residents of Las Vegas and surrounding states, especially for workers who spent their days toiling in the heat. Bandala’s team reported in May 2022 that heat-related illnesses and injuries have increased steadily among the regional labor force for the past decade. In some cases, affected individuals have taken weeks to recover.

Bandala’s findings line up with growing evidence that workers worldwide, including indoor workers in settings without climate control, are hit hard by heat waves that are steadily increasing in number, duration, and intensity. In the United States, approximately 31,600 workers suffered heat-related illnesses or injuries and 344 died of such causes between 2011 and 2019.

But Jennifer Vanos, an associate professor at Arizona State University in Tempe, says the true number of deaths is almost certainly higher. A heat-caused death, such as heatstroke, is generally reported as such, Vanos says. However, that might not be true for a heat-related death if, for example, an overheated worker died from a heart attack or got dizzy and then suffered a lethal fall. In such cases, heat might be reported as the secondary cause of death, but it also might not be reported at all.

The International Labor Organization (ILO) recently estimated that if the mean global temperature increases 1.5°C (2.7°F)
Heat-related illnesses are especially likely in poorly acclimatized workers with any of numerous underlying risk factors. Some risk factors, such as advanced age or certain health conditions, are inherent to the worker. Others, such as limited air movement and high humidity, are part of the jobsite.

Images: figure courtesy Jacklisch et al.30; photo courtesy Andreas D. Flouris, Leonidas G. Ioannou, and FAME Laboratory.
Occupational Safety and Health Administration (OSHA) launched a National Emphasis Program (NEP)\(^9\) that, for the first time, makes high-risk industries a priority for inspections during hot weather. Inspectors will determine whether workers are provided with water, shade, cool areas, and other protective measures. Employers are also expected to provide all employees with heat hazard training, as well as time to acclimatize, or gradually increase their workloads and heat exposures to build up resilience.

“Lower-wage workers in underserved communities are more likely to live and work in areas facing greater exposure to hazardous heat, to work in dangerous occupations, and to have limited access to air conditioning,” says OSHA spokesperson Kimberly Darby. “The agency is placing special emphasis on our outreach efforts to focus on underserved workers in the highest-risk industries like construction, warehousing, and agriculture.”

The NEP is not a legally enforceable standard. However, four U.S. states—Minnesota, Washington, Oregon, and California—recently enacted regulations for the jobsite,\(^{10}\) and other countries around the world are moving in similar directions.\(^{11}\) Maître says the ILO is monitoring progress toward national occupational heat standards and plans to release a status report in 2023. Such rules have been slow in coming, even in the face of growing pressure from occupational and environmental groups to do more. A recent investigation by POLITICO and E&E News concluded that OSHA’s “reluctance [to issue an enforceable occupational heat rule] has extended through nine administrations, with bureaucracy and lack of political will combining to continually kick the can down the road.”\(^{12}\) However, the Biden administration has begun efforts to develop a permanent national workplace standard,\(^{13}\) with OSHA issuing an advance notice of proposed rulemaking in October 2021.\(^{14}\)

The task of setting enforceable standards is complicated by the lack of consensus on when they should be applied in occupational settings, says Josh Foster, a postdoctoral fellow in physiology at the Institute for Exercise and Environmental Medicine in Dallas, Texas. Foster explains that workers respond to heat stress—the body’s net heat load—in highly variable ways, depending on their age, underlying health status, work, protective clothing, and level of acclimatization.\(^{15}\)

Workers’ resilience also depends on whether they can pace themselves, slowing down when heat stress reaches dangerous levels.\(^{16}\)”Often, external factors—payment conditions, incentives, the nature of the task, etc.—limit this ability to self-pace and therefore place people at a higher heat stress risk,” says Ollie Jay, a professor of heat and health at the University of Sydney in Australia.

Kristie Ebi, a professor of global health at the University of Washington in Seattle, says investigators have only recently begun pursuing the multidisciplinary studies needed to learn how workers in different job categories and geographical regions respond to heat stress. “The research is new, and the questions are complicated,” she says. “But there is growing awareness among regulators that workers are an important population to consider as temperatures continue to rise and heat waves become more extreme.”

### Measuring Heat Exposure
Heat stress reflects a person’s load of metabolic heat (generated inside the body through physical exertion) and environmental heat (coming from the worker’s surroundings), minus the heat dissipated through sweating and other cooling mechanisms. Environmental heat is a function of four atmospheric characteristics: ambient temperature, humidity, wind, and thermal radiation, such as from sunlight or hot machinery. Discrepancies in how

| Adjusted Temperature (°F) | Light Work | Moderate Work | Heavy Work |
|---------------------------|------------|---------------|------------|
|                           | Minutes Work/Rest | Minutes Work/Rest | Minutes Work/Rest |
| 90                        | Normal     | Normal        | Normal     |
| 91                        | Normal     | Normal        | Normal     |
| 92                        | Normal     | Normal        | Normal     |
| 93                        | Normal     | Normal        | Normal     |
| 94                        | Normal     | Normal        | Normal     |
| 95                        | Normal     | Normal        | 45/15      |
| 96                        | Normal     | Normal        | 45/15      |
| 97                        | Normal     | Normal        | 40/20      |
| 98                        | Normal     | Normal        | 35/25      |
| 99                        | Normal     | Normal        | 35/25      |
| 100                       | Normal     | 45/15         | 30/30      |
| 101                       | Normal     | 40/20         | 30/30      |
| 102                       | Normal     | 35/25         | 25/35      |
| 103                       | Normal     | 30/30         | 20/40      |
| 104                       | Normal     | 30/30         | 20/40      |
| 105                       | Normal     | 25/35         | 15/45      |
| 106                       | 45/15      | 20/40         | Caution    |
| 107                       | 40/20      | 15/45         | Caution    |
| 108                       | 35/25      | Caution       | Caution    |
| 109                       | 30/30      | Caution       | Caution    |
| 110                       | 15/45      | Caution       | Caution    |
| 111                       | Caution    | Caution       | Caution    |
| 112                       | Caution    | Caution       | Caution    |

NIOSH based these work/rest schedules on the level of work, along with certain assumptions about worker health and age. “Adjusted temperature” refers to the sum of air temperature plus considerations for relative humidity and whether there is full sun or cloud cover.

by the end of the century—a conservative projection\(^8\)—the economic losses could be profound. Worldwide, 2.2% of all work hours (the equivalent of 80 million full-time jobs) would be lost to heat-related impacts in 2030. That estimate assumes agricultural and construction work would be carried out in the shade; if carried out in the sun, the estimated loss would be 3.8% of all work hours, or 136 million full-time jobs. Most of this loss would be in low- and middle-income countries.

Those lost hours are a sharp increase over the estimates of 1.4% of hours in the shade and 2.9% of hours in the sun lost to heat-related impacts in 1995.\(^4\) “Such losses would represent a huge decrease in productivity, which is an obstacle to economic development and a threat to workers’ health and working conditions,” says Nicolas Maître, an ILO economist based in Geneva, Switzerland.

### Complicated Questions
Employers and workers alike are taking steps to prevent heat-related illnesses, such as shifting work schedules to earlier in the morning, when the air is cooler. In April 2022, the U.S.
environmental heat is measured further complicate efforts to set labor standards. Such measures are based on different parameters, with varied levels of relevancy in a given local climate.

A familiar example is the heat index that often appears on local weather reports. The heat index reflects both air temperature and relative humidity, because as air becomes more saturated with water vapor, sweat is less able to evaporate and cool the body. At lower levels of relative humidity, the air temperature and heat index will be roughly the same. But as relative humidity climbs, the heat index begins to exceed air temperature. For example, at a relative humidity level of 60% and an air temperature of 32.2°C (90°F), the heat index equivalent is an air temperature of 37.8°C (100°F).

The heat index does not always reflect a person’s experience of heat. It excludes wind and thermal radiation, both of which significantly affect stamina. Moreover, the equations underlying the heat index “assume that someone is walking slowly in the shade, with a low metabolic rate, wearing light clothing,” Vanos says.

Other heat indicators are more suitable for high-intensity labor. One example is the wet bulb globe temperature (WBGT), a metric developed by the U.S. military in the 1950s to protect against heat-related illnesses during basic training. The WBGT accounts for the influence of all four environmental heat parameters. It is used routinely for monitoring risk of heat stress in athletes and has proven useful in occupational settings.

However, the WBGT also has drawbacks: It emerged from work seeking to protect healthy young men, which limits its applicability for predicting heat stress risk in other categories of workers, such as pregnant women or older laborers with underlying health problems, Jay explains. “Critical WBGT thresholds for safe work can be lowered to better protect these populations,” he says, “but what these altered thresholds should be is not well established.” Like the heat index, the WBGT does not fully account for the body’s effort to cool itself by sweating. In hot, arid areas, sweat may evaporate so quickly that the sweat glands “can’t keep up,” Jay cautions—a phenomenon that is not captured by the WBGT value. “If calculated properly, then WBGT is a good tool, especially when compared with other methods,” he says. “It just needs to be handled with care.”

Oregon’s Experience

Regulators in Oregon heeded the recommendation to protect workers with an occupational heat rule that took effect on 15 June 2022. Described by Oregon state officials as the most
protective such rule in the United States, it sets an initial threshold that requires employers to provide workers with access to shade and water when the heat index reaches 26.7°C (80°F). At a heat index of 32.2°C (90°F) or above, workers must be provided with paid rest breaks on a schedule set by the employer according to one of three options.

Option A bases the schedule on several considerations: the intensity of the work, the heat added by personal protective equipment or other work clothing, whether the work is performed indoors or outdoors, and whether the work occurs in direct sunlight. Under option B, employers determine each employee’s schedule according to a work/rest chart developed by the National Institute for Occupational Safety (NIOSH), which incorporates the intensity of the workload, environmental heat, and certain worker characteristics (see chart above). Option C simply defaults to the “heaviest workload” provisions of the NIOSH work/rest schedule.

In all cases, employers must provide a minimum 10-minute rest break every two hours when the heat index reaches 32.2°C (90°F), with increasingly longer and more frequent breaks as the heat index rises. Individuals must have access to enough water so they can drink a quart per hour. And because people need lower temperatures at night to recover from daytime heat exposures, employers who house agricultural workers must ensure they have access to a cooling area.

Immediately after the rule went into effect, a coalition of forestry and manufacturing trade groups sued the state. The plaintiffs asserted the agency had exceeded its statutory authority and failed to provide “fair notice of what conduct is required or proscribed,” a violation of their 14th Amendment rights. Mary Anne Cooper, vice president of government and legal affairs with the Oregon Farm Bureau, rejects what she describes as the rule’s prescriptive, top-down approach, contending that agricultural workers already pace themselves to keep from overheating. Cooper also criticizes a provision requiring employers to consider the health of individual workers when determining how much protection they need from heat. “We don’t want to ask our workers ‘How old are you? Did you go partying last night? Do you have preexisting conditions?’” she says. Aside from privacy issues, she adds, employers could open themselves to litigation if they base any employment decisions—such as when to send a worker home for safety reasons—on medical history.

Aaron Corvin, a spokesperson for Oregon Occupational Safety and Health, responds that the policy is “based on what we believe is appropriate to protect the health and safety of employees from heat-related illnesses.” He also acknowledges the expense. “While the costs of complying with the rules are likely to be meaningful, the agency has determined that they are also manageable and that the rules provide more than sufficient value [in terms of avoided illness] to justify those costs,” he says.

**Interim Measures**

Nevada is in the process of developing its own heat protection regulations. In the meantime, state officials on 15 June 2022 adopted a modified version of the NEP that calls for preplanned inspections in 70 high-risk industries on days when the National Weather Service issues a heat warning or advisory for a local area. Unlike the heat index–based trigger of 26.7°C (80°F) set by the federal NEP, the Nevada program—owing to the state’s arid climate—will initiate site inspections when local air temperatures reach or exceed 32.2°C (90°F).

In parts of southern Nevada, heat indices over 37.8°C (100°F) were documented up to 45 days per year on average between 1991 and 2020, according to data analyzed by Oregon state
climatologist Larry O’Neill in advance of the forthcoming Sixth Oregon Climate Assessment. Furthermore, the gap between mean and maximum temperatures in the southwestern United States is steadily narrowing, Bandala says. “The temperatures here in the [Las Vegas] Valley are going up,” he explains, “but most importantly, even the low temperatures are getting higher.” That is especially true near Las Vegas, where—as in other cities worldwide—paved surfaces and concrete buildings create urban heat islands that absorb solar radiation and release it at night, keeping temperatures elevated.

The federal and Nevada programs enable inspectors to impose penalties for infractions under the broad “General Duty Clause” of the Occupational Safety and Health Act of 1970. Under this clause, the inspector must prove the employer failed to keep its workplace free of “recognized hazards” that could cause death or serious harm. Darby explains that the clause applies only when there is no standard that applies to a particular hazard—as is the case with heat. Former OSHA director David Michaels, now an epidemiologist and professor at George Washington University, says, “The problem is that the General Duty Clause does not provide guidance to industries as a whole, so any penalties imposed on individual worksites have little impact on other employers.”

The NEP is temporary—it will expire in 2025 unless cancelled or extended. Under the Biden administration, according to Darby, setting a permanent standard to protect against heat-related illnesses is one of OSHA’s top priorities. But Michaels notes that setting standards “is a very slow multiyear process” that can be derailed when administrations change.

Experts interviewed for this story say that more research is needed to supply policy makers with the data they require to develop evidence-based guidelines. Priority research areas include better ways to define heat waves, as well as more specifics on the meteorological conditions that cause spikes in the number of heat-related illnesses and injuries. Along those lines, more than a dozen research groups across the European Union are now collaborating on a program called HEAT-SHIELD that was created to assess how heat affects worker health and productivity. A takeaway lesson from the program so far, says Andreas Flouris, an associate professor of exercise science at the University of Thessaly in Volos, Greece, is that variation in how workers respond to heat stress complicates one-size-fits-all solutions.

Still, as temperatures escalate further with climate change, Flouris adds, the need for additional protections is growing. “Workers are hurting badly,” he says. “Not everyone is affected the same way, but everyone we speak with during our research agrees the heat never used to be like this. I think in the next 5 years, we’re going to see a lot of new legislation around the world.”

Charles W. Schmidt is a freelance writer based in Portland, Maine.

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