FARMWORKERS AND HEAT STRESS IN THE UNITED STATES

A future proofing in U.S. agriculture report

Environmental Defense Fund

la isla network

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La Isla Network (laislanetwork.org) is the leading global occupational health research organization and consultancy dedicated to protecting workers in a warming world. La Isla Network is generating, supporting, and executing evidence-driven solutions to protect workers from heat and other occupationally acquired injuries and illnesses, especially those driven by climate change.

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1. INTRODUCTION

1.1 Scope of the problem

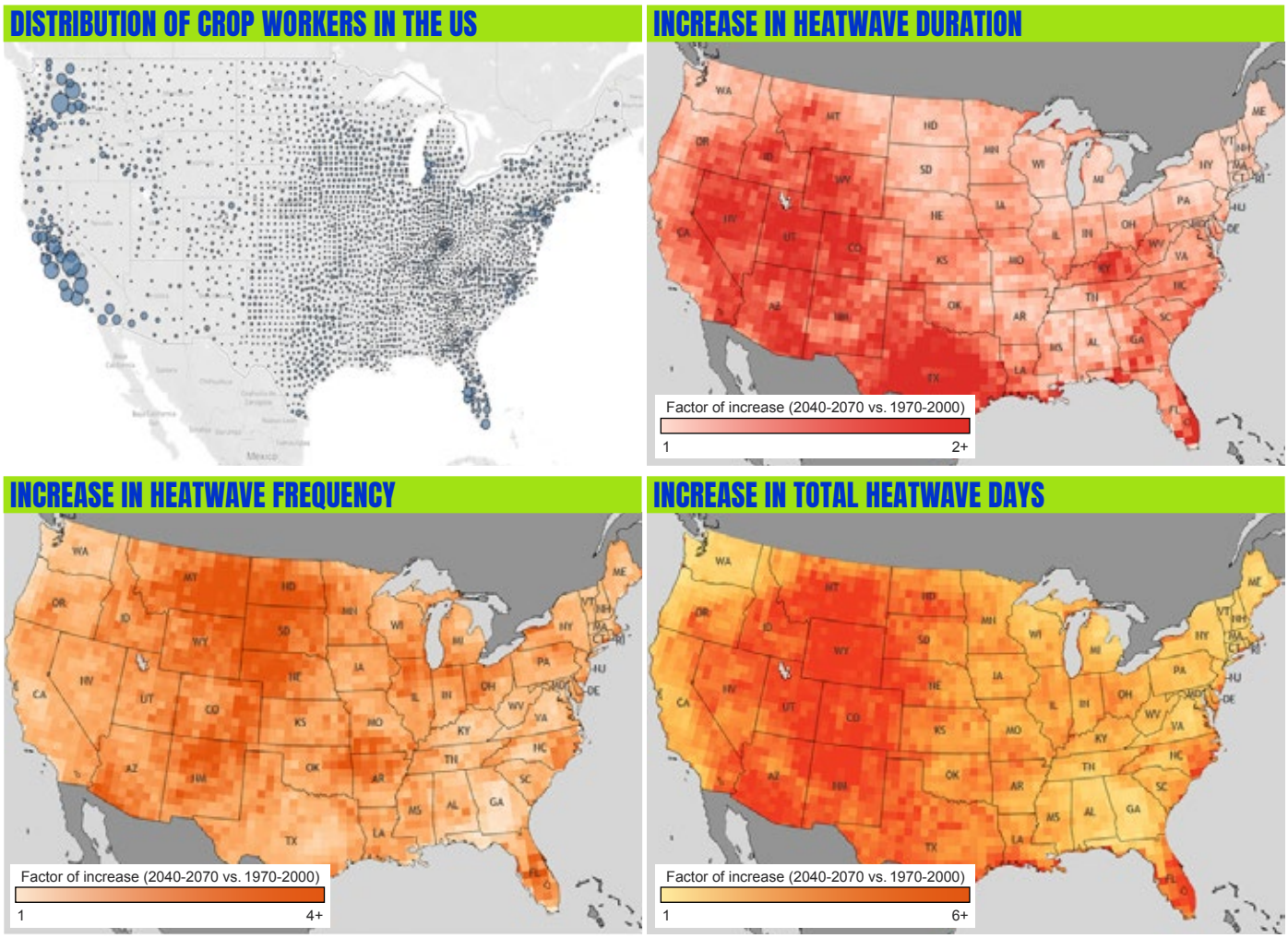


FIGURE 1.

Top left: *This map shows 2017 estimates of the number of contracts and directly hired crop workers by county in the U.S. (National Center for Farmworker Health 2017).*

Top right: *This map shows the modeled increase in heat wave duration (days) from the end of the 20th century to the mid-21st century (Climate.gov, 2012).*

Bottom left: *This map shows the modeled increase in heatwave frequency (episodes per summer) from the end of the 20th century to the mid-21st century (Climate.gov, 2012).*

Bottom right: *This map shows the modeled increase in total heatwave days per summer (frequency times duration) from the end of the 20th century to the mid-21st century (Climate.gov, 2012).*

INCREASING TEMPERATURES, EXACERBATED BY INCREASED INCIDENCE AND INTENSITY OF HEAT WAVES, POSE A SIGNIFICANT RISK TO HUMAN HEALTH.

Average global temperatures have increased by about 1.98°F (1.1°C) since 1901, with 19 of the 20 warmest years on record occurring since 2000.[1,2] July 2021 was the hottest month ever recorded globally, with parts of the U.S. setting record-breaking highs of 130°F or more.[3] One dangerous consequence of increasing average global temperatures is the intensification of extreme events, including heat waves. Rising temperatures have resulted in increased heat wave intensity, frequency and duration across the globe.[4] In the U.S., heat wave incidence has also increased, from an average of two heat waves per year during the 1960s to six per year during the 2010s.[5] According to the most recent Intergovernmental Panel on Climate Change report, as the climate continues to warm, heat waves are expected to become more frequent and intense.[1]

Increasing temperatures, exacerbated by increased incidence and intensity of heat waves, pose a significant risk to human health. High temperatures can lead to a wide variety of adverse health outcomes, including heat-related illnesses such as heat stroke, kidney disease, and exacerbation of cardiovascular, cerebrovascular and respiratory disease and preterm birth.[6, 7, 8, 9] This risk does not affect all populations equally, with a higher risk for low-income populations. In 2020, over one-quarter of the U.S. population reported experiencing heat-related symptoms, with low-income individuals among the hardest-hit demographics.[10] Farmworkers are at exceptionally high risk. With one-third of farmworkers living with a family income below the federal poverty line and fewer than half covered by health insurance, U.S. crop workers are 20 times more likely to die from heat-stress-related illness than civilian workers in the U.S. Between 2001 and 2020, the U.S. is estimated to have lost more than 100 hours of labor per outdoor worker per year due to humid heat exposure.[11] Those labor losses translate to significant economic costs; the same study estimated heat-induced labor productivity losses in the U.S., costing over 90 billion annually from 2001-2020.[9]

1.2 Solutions

Climate change will likely increase the incidence of climate-influenced natural disasters like floods, hurricanes and fires, which we will have little chance to prevent. Although temperatures have been rising and are expected to continue to increase, occupational heat illness among farmworkers is one climate change-driven problem that is preventable and can be mitigated by implementing common-sense best practices.

Implementing these practices will involve costs and lost productivity during the hottest days, a potential challenge for farm businesses operating in competitive and low-margin environments. Some profitable farm businesses are already implementing mitigation programs to adapt to the growing number of hot days centered around the following basic principles: shade, water, rest and timing.

A growing body of applied research in hot climates globally demonstrates that the rigorous implementation of these best practices by farming businesses, field supervisors, and farmworkers can virtually eliminate heat-induced illnesses and deaths.[12, 13] For example, one study in California illustrates the success of such interventions; there have been fewer heat-related workplace injuries after the implementation of statewide regulations.[14] This evidence suggests that the most successful and resilient farm businesses, those with the highest employee satisfaction and retention rates, will be those that aggressively confront the "new normal" concerning heat exposure and are ready to implement heat mitigation measures immediately.

This report explores the growing health threat of heat stress on agricultural workers and promising pathways for prevention. It describes the physiological effects and growing risk of extreme heat exposure, the particular vulnerabilities of the farmworker population in the U.S., and prevention measures against the health impacts of heat stress. Finally, it explores a case study of heat health impacts in the tropics with important implications for the U.S., and examines the need for national worker protections looking forward.

2. HEAT STRESS AND HEAT-RELATED ILLNESS

2.1 Health risks

To appreciate why rising temperatures pose such a considerable health risk to farmworkers, it is important to understand the effect that heat has on the body. When an individual's core body temperature rises in response to higher environmental temperatures (external heat) and/or an increase in physical activity (internal metabolic heat), the body responds through innate mechanisms of thermoregulation, such as sweating or sending blood flow away from central organs to the skin.[15] Usually, those steps would help to cool down one's body temperature, keeping it within a safe and healthy range. However, in situations that consistently raise an individual's core body temperature, such as performing strenuous work in hot environments, the body's physiological response mechanisms lose efficacy.[16]

In addition to temperature, humidity is a compounding stressor that reduces sweat evaporation and thereby limits the human ability to maintain a safe core body temperature.[16] The inability of a body to maintain a safe core temperature is a condition known as hyperthermia. Failure to reduce core body temperature below critical thresholds through rest in the shade or in an air-conditioned space and drinking adequate water can result in a cascading set of increasingly severe conditions.

When an individual becomes physically sick from heat stress, they are experiencing a heat-related illness, also known as HRI.[17] This can be understood in stages of severity, from mild symptoms to life-threatening illnesses. Milder forms of heat-related illness include heat rash and heat cramps (muscle spasms), and heat syncope (dizziness, light-headedness or fainting) and can occur without an elevation in core temperature. Heat exhaustion is coincident with elevated core body

temperature (>101.3 °F), and symptoms can include headache, irritability, loss of coordination, nausea/vomiting, weakness, and edema (swelling of hands and legs), although often symptoms are not readily noticeable.[18, 19] If heat stressors are not mitigated, the illness may progress to life-threatening heat stroke as the core temperature keeps rising and can result in seizures, organ and tissue damage (e.g., kidney, liver, gut, muscle) and multi-organ failure, which can lead to coma, and ultimately, death.[20, 21] While these heat-related illnesses describe the acute health outcomes associated with heat exposure with or without an exertional component, additional longer-term impacts of chronic exposure to heat are also well-characterized. For example, cardiovascular disease, acute kidney injury, and chronic kidney disease are associated with hot work conditions.[20, 21, 22]

2.2. Body temperature threshold

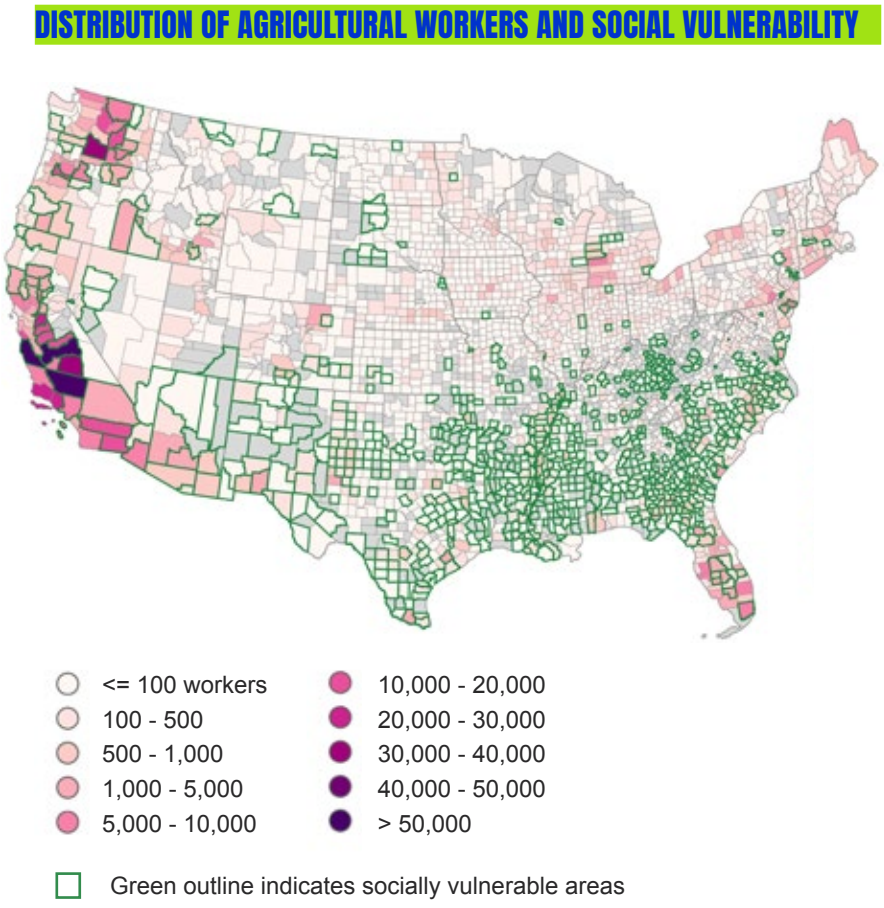
According to physiological standards recommended by the National Institute for Occupational Safety and Health, the World Health Organization, and the American Conference of Governmental Industrial Hygienists, also known as ACGIH, heat-related illness can be prevented by maintaining workers' core body temperatures below 100.4 °F (38 °C).[23] Unfortunately, farmworkers' core body temperatures (CBTs) regularly surpass that limit. Current literature is rife with examples. In one study of Florida fernery workers, farmworkers' core body temperatures exceeded the safe limit of 100.4 °F on 57% of workdays.[24] In another study, 49% of farmworkers' CBTs exceeded 100.4 °F, with most hitting this point by 10:30 a.m., even though morning is the assumed safest time when breaks and shade measures are less likely to be implemented.[25] In California, a state that has some of the strongest occupational heat standards for farmworkers, 8.3% of farmworkers experienced CBTs above 101.3 °F.[26]

HRI is frequently reported among farmworkers, who are at risk from both their strenuous workloads and the high temperatures they work in. One study in Florida found that 84% of farmworkers reported at least one symptom of HRI during a week, while 40% reported three or more symptoms.[27] In North Carolina, 94% of farmworkers self-reported working in extreme heat conditions, while 40% reported symptoms of HRI.[28] In Georgia, one-third of farmworkers reported at least three HRI symptoms within a week.[29]

HEAT-RELATED ILLNESS IS FREQUENTLY REPORTED AMONG FARMWORKERS, WHO ARE AT RISK FROM BOTH THEIR STRENUOUS WORKLOADS AND THE HIGH TEMPERATURES THEY WORK IN.

3. WHAT IS KNOWN ABOUT HEAT EXPOSURE TO DATE, AND WHAT ARE THE LIKELY FUTURE TRENDS?

3.1 Current unsafe conditions



Using the ACGIH Threshold Limit Value approach that incorporates temperature, humidity, clothing and exertion level, it is estimated that the average U.S. agricultural worker is currently exposed to 21 unsafe working days due to heat each May through September, a loose approximation of the average worker's summer growing season.[12] Different areas across the U.S. vary in resilience to heat stress, depending on the number of agricultural workers and regional temperature, as well as local social vulnerability, measured using a Center for Disease Control metric that identifies areas especially at risk during public health emergencies (Figures 2 and 3). For example, in Riverside, California, home to an estimated 15,700 agricultural workers, the number of unsafe working days that agricultural laborers are exposed to each summer is 42; in Hillsborough, Florida, home to almost 10,000 agricultural workers, the number is 113 (out of a possible total of 153 days).[31]

FIGURE 2.

This map shows the spatial distribution of agricultural workers and social vulnerability, demonstrating areas with the least resilience to heat stress. Color scale represents the number of summertime hired agricultural workers as reported by the Bureau of Labor Statistics Quarterly Census of Employment and Wages. Counties outlined in dark green are in the upper quartile of the Center for Disease Control's Social Vulnerability Index, highlighting areas especially at risk during public health emergencies. This social vulnerability measure includes 16 U.S. census variables aggregated into the themes of socioeconomic status, household characteristics, racial and ethnic minority status, and housing type and transportation. (From Tigchelaar et al., 2020)

SPATIAL VARIABILITY IN PRESENT-DAY HEAT INDEX EXTREMES

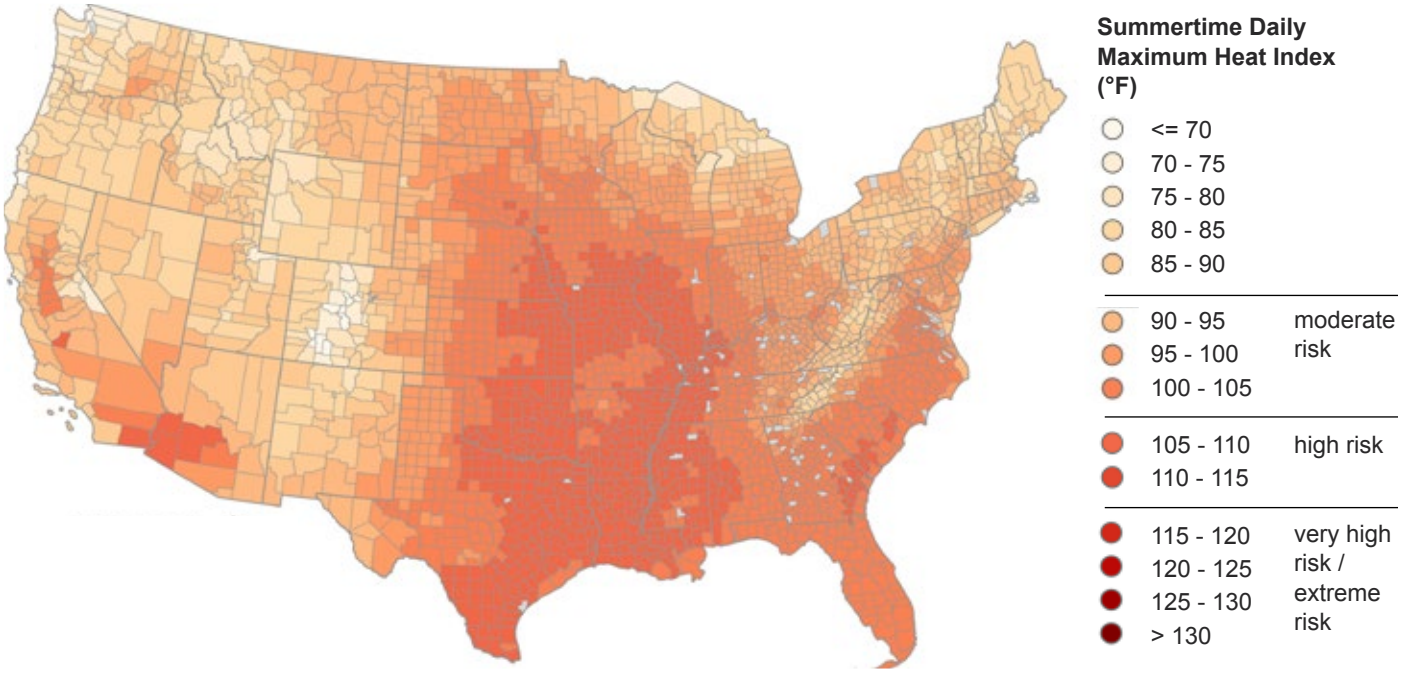


FIGURE 3.

This map shows the spatial variability in present-day heat index extremes. Extreme heat is most severe in the South, southern Midwest, central California, and the coastal Southwest. The heat index measures temperature and relative humidity, and heat index extremes are measured in the 95th percentile of summertime daily maximum Heat Index (°F). (From Tigchelaar et al., 2020)

3.2 Future risk

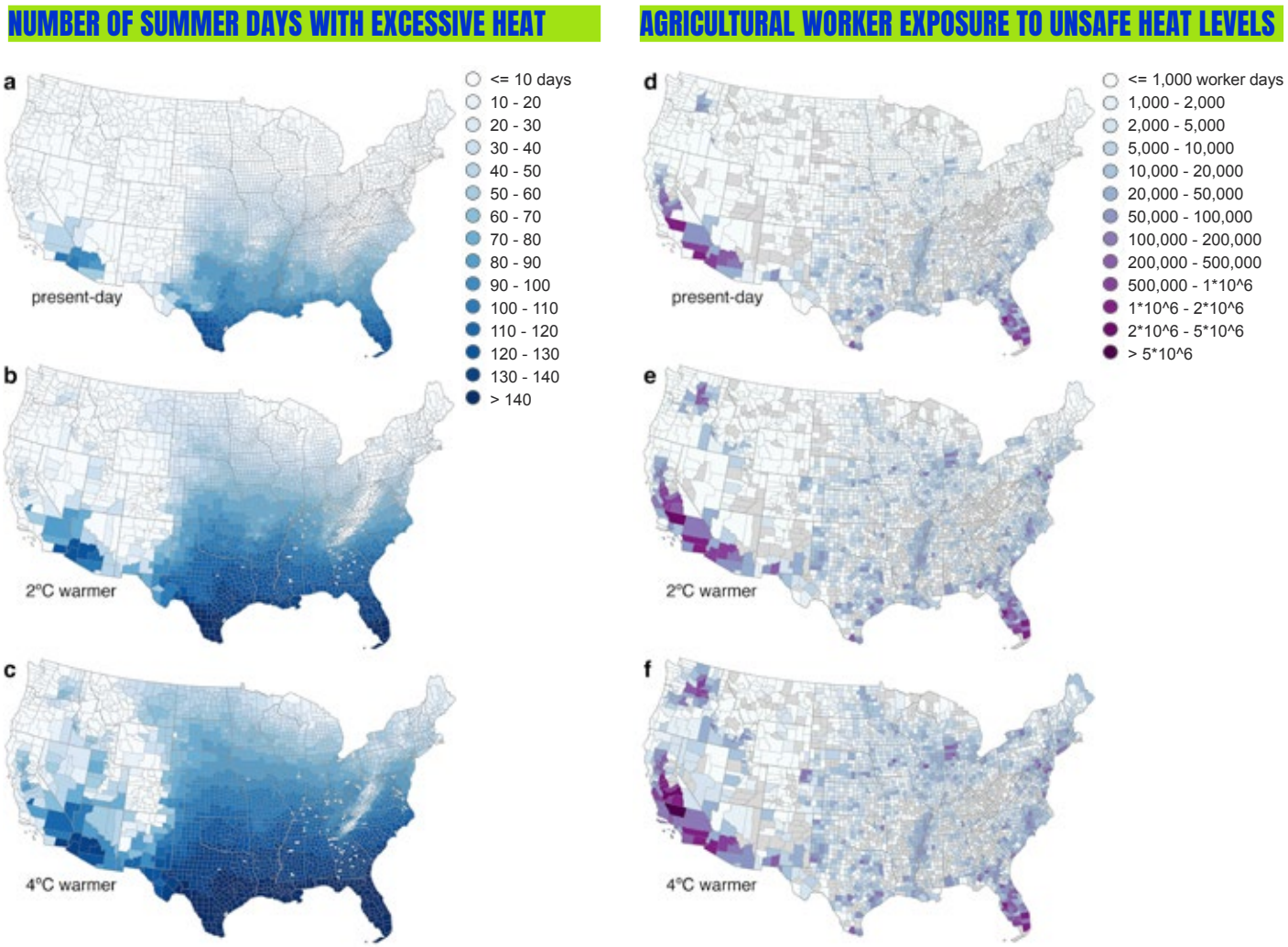


FIGURE 4.

This image shows the present and future (under 2◦C and 4◦C warming scenarios) and projected agricultural worker exposure to unsafe heat levels. Maps a-c shows the number of days each summer that the daily mean Heat Index exceeds the baseline Threshold Limit Value of 83.4 ◦F. Maps d-f shows the same exposure in several working days, based on present-day agricultural worker employment levels. (From Tigchelaar et al., 2020)

While these current numbers are worrying, climate models predict increased warming and therefore the problem is likely to get worse.[7] The frequency of exposure of outdoor workers to extreme heat index conditions in the U.S. is projected to increase substantially in the next 30 years.[30, 31] Regardless of the emission and population change scenario, the annual numbers of days in 2036–2065 with heat indices exceeding 100°F and 105°F are projected to double and triple, respectively, compared to a 1971–2000 baseline.[32] Seldom-crossed heat thresholds of unsafe working conditions will become frequently surpassed over this century, putting millions of people at risk.

At 2°C (or about 3.6°F) of warming above the pre-industrial baseline, which multiple IPCC models project could occur within the next 6-11 years, the average U.S. agricultural worker would experience 39 days of work above safe heat levels.[1,12] At this level of warming, half of U.S. agricultural counties would experience heat extremes above 105°F (what the Occupational Safety and Health Administration, or OSHA, characterizes as "high risk" working conditions), and multi-day heat events would occur five times more often.[12] The growing season in the Southeast could be considered unsafe based on present-day work practices.[12] Should we hit 4°C of global warming, as multiple IPCC models project could occur within 21-30 years, the average U.S. agricultural worker would labor 62 days in unsafe conditions every season, and many of the most important agricultural regions in the U.S. would not have a single day of occupationally safe temperatures (Figure 4).[1,12] While there is still a range of possible outcomes depending on the trajectory of emissions, warming is already occurring, and thus the need for addressing farmworker heat exposure is a critical need for farm businesses that hope to thrive in a warmer climate.

4. SPECIFIC VULNERABILITIES OF U.S. FARMWORKERS

Farmworkers are members of an essential group of American workers who spend most of their working hours outdoors. This group includes postal workers, construction workers, landscapers, and oil and gas well operators. Among these, the farmworker community faces unique vulnerabilities that, in turn, create compounding complexities in preventing and treating heat stress and other health challenges, especially when compared to the average U.S. worker. These factors, summarized in this section, include geography and seasonality of work (i.e., where and when farm work occurs); low wages and compensation incentive structures; social and cultural isolation due to national origin, language, ethnicity, and legal status; poor access to medical care; and inadequate regulatory standards.

THE FARMWORKER COMMUNITY FACES UNIQUE VULNERABILITIES THAT, IN TURN, CREATE COMPOUNDING COMPLEXITIES IN PREVENTING AND TREATING HEAT STRESS.

4.1 Compensation level and method

Farmworkers are among the lowest-paid workers in the U.S. economy. In 2020, the United States Department of Agriculture reported that nonsupervisory farmworkers in the U.S. earned an average of $14.62 per hour - about half of the hourly wage of nonsupervisory non-farmworkers, which averages $24.68.[33,34] In addition to low pay, farmworkers often lack access to protections afforded to non-farmworkers, such as minimum wage, overtime pay, and health insurance.[35,36] One recent study estimated that a third of farmworker families have incomes below the poverty level,[37] which is associated with lower physical and mental health outcomes.[38,39]

In addition to low wages, the structure of farmworkers' compensation can increase risks. Some farmworkers, particularly those involved in fruit and vegetable harvesting, are more likely to be paid based on a *piece rate* or unit of productivity instead of an hourly rate. Some farmworkers prefer this compensation method because it rewards the most productive workers. However, studies have shown that this approach can lead to overwork and lack of adequate rest, which becomes particularly dangerous on high-heat days when rest, water, and shade are essential.[40] In one study, farmworkers paid by piece rate were 4.52 times more likely to have acute kidney injury (AKI) than hourly workers.[41] Another study found that men paid by piece rate had higher recorded activity levels (i.e., they worked harder to earn more money), putting them at greater risk for heat-related illness.[42]

4.2 Poor access to medical care and health insurance

Farmworkers who experience heat stress are at risk of not receiving appropriate medical treatment. Low-wage workers are incentivized to work longer hours and, because most do not receive paid sick leave benefits, are less likely to take time away from work to address health concerns.[43] In addition, fewer than half of farmworkers have access to health insurance, a major barrier to receiving appropriate care. The cost of medical care is the most cited reason why farmworkers avoid seeking medical help.[35] Additionally, many workers who have health insurance, like those on the H2-A program for temporary agricultural workers, are unaware of their benefits.[44]

4.3 Factors related to national origin, language barriers, and immigration status

An estimated **64% of agricultural workers** in the United States are immigrants: nearly half of whom have no legal work authorization, and of which 63% are born in Mexico. Most farmworkers (62%) are primarily Spanish speakers, and 29% cannot speak English at all.[36,39] Each of these factors creates vulnerability for farmworkers and their families, can make navigating U.S. systems more challenging, and can reduce the likelihood of receiving adequate training and medical treatment.

These challenges can take the form of farmworkers and their family members simply not knowing how to take advantage of available services, which may be masked by cultural differences and language or reading barriers. They can also take the form of a high sense of risk aversion, especially during a period of high social tension around issues of race and immigration status in America - as is the case now. These factors can lead to individuals making choices to avoid interactions that increase their sense of vulnerability; require revealing personal information, and increase the risk of interaction with law enforcement or immigration officials. In short, there is evidence that many farmworkers avoid or delay medical treatment at times, not only for reasons related to cost and lost wages but also to *stay off the radar* and avoid issues that might complicate their lives.

Language barriers are diminished in communities where Spanish, the most common native tongue among farmworkers, is commonly spoken by field supervisors and among medical personnel. When supervisors and field supervisors speak Spanish, they can better provide proper training in heat exposure to Spanish-speaking workers. However, when supervisors do not speak the same language as their field crew, the risk of occupational injury can increase.[45]

Farmworkers lacking secure legal status face additional barriers. Many farmworkers that lack secure legal status fear that accepting medical treatment might result in deportation or threaten their ability to receive a green card someday in the future.[46] This fear was exacerbated by a 2019 Department of Homeland Security policy, the Public Charge rule, that allowed denying a green card based on evidence that the applicant might rely on public benefits.[47] This rule perversely caused some farmworkers to avoid medical treatment and, despite the rule being reversed in 2021, continues to have an effect because many are unaware that it is no longer in effect.[48] For example, researchers at Harvard University and Beth Israel Deaconess Medical Center partially attribute disproportionately high COVID-19 rates among foreign-born Latinos to the 2020 Public Charge rule, despite the rule being paused during the pandemic.[49]

4.4 Housing

Many farmworkers return from intense workdays in the field to substandard and crowded housing conditions. Thirty percent of farmworkers live in crowded accommodations, defined by the U.S. Census Bureau as housing units in which the number of persons per room exceeds one.[39] Operations that employ temporary agricultural workers are required to provide housing, but this housing is often of poor quality, characterized by mold, mildew, pesticides, and structural deficiencies.[50] Substandard and crowded housing has been linked to both negative mental and physical health for farmworkers.[54] Farmworkers who lack the housing conditions to properly recover from heat exposure may return to work the following morning, already dehydrated and suffering from symptoms of heat stress from the previous day.[51]

4.5 Compounding stressors

Exposure to environmental and occupational factors can exacerbate heat-related stressors. Farmworkers have the unique predicament of heat stress exposure in a particularly risky environment. These environments include risks such as exposure to toxic pesticides and wildfire smoke.[52,53] Additionally, occupational hazards, including machinery and sharp objects, are greater risks when combined with the confusion and impaired coordination that heat stress can cause.[54,55]

5. PREVENTION BEST PRACTICES

Despite the growing heat-related risks and vulnerabilities of farmworkers, most elements of heat illness are well understood and almost entirely preventable if best practices are followed. The simple principle is this: maintain healthy core body temperature through hydration, rest, and shade. These essential practices can be augmented through additional measures that include acclimatization, adjustment of work hours, and the use of wearable technology.

5.1 Water, rest and shade

Water, rest and shade are currently the most strongly advocated occupational protocols for protecting farmworkers from heat. When implemented correctly, providing water, rest and shade in sufficient quantities during work hours is shown to be effective at mitigating heat exposure and heat-related illness.[31,56] These three essential practices form the basis of OSHA's approach to occupational safety in high-heat environments and are central to all state-level enforceable heat standards.[57] They are additionally advocated by organizations like the National Institute for Occupational Safety and Health (NIOSH), ACGIH, and Migrant Clinicians Network as critical tools for helping to maintain workers' core body temperatures within a safe range and replenish lost fluid through strenuous work.[25] Collectively, water, rest, and shade are not only some of the most accessible occupational practices to legislate and enforce but are also practices that employers can immediately implement, even in the absence of enforceable standards.

Different organizations have different specific best practices for water, rest, and shade, but most pull from the OSHA recommendations. OSHA suggests workers drink at least 8 ounces of cooled water every 20 minutes but should switch to electrolyte beverages (like sports drinks) for jobs lasting longer than 2 hours. All beverages should be easy to access, and workers should be prompted to drink frequently rather than relying on feelings of thirst.[60] Generally, OSHA recommends that workers rest hourly in temperatures above 77°F and prioritize rest in shaded areas.[58,60]

The Division of Occupational Safety and Health of California, also known as Cal/OSHA, defines shade as blockage of direct sunlight that allows the body to cool, meaning that, for example, a car sitting in the sun does not provide acceptable shade unless the car is running with air conditioning.[59]

Implementing the Water-Rest-Shade protocol involves some costs to employers and farmworkers. These include *de minimus* costs associated with equipment, but the more significant costs are those associated with lost productivity and wages. Piece-rate compensation can push workers to forgo water, rest, and shade breaks in order to maximize daily compensation. As a result, piece-rate compensation can be popular with employers who benefit from the additional labor gained from their workers.[60] In California, piece-rate compensation is supplemented with paid breaks, which can encourage workers to take necessary water, rest, and shade breaks, but this is not a federal standard.[61] Hourly compensation, with the current federal standard of mandated paid breaks, also avoids some dangerous incentives of piece-rate compensation by encouraging water, rest, and shade breaks.[62] Ultimately, practices that put workers at greater risk of heat-related illness also result in lost productivity and wages, alongside the direct impacts on workers' health and safety.[63]

5.2 Acclimatization

Heat adaptation or acclimatization is the process by which individuals undergo physiological adaptations in response to recurrent elevations in core and skin temperatures from either exercise or high ambient temperatures. Some examples of physiological adaptations include increases in sweating, reduced core and skin temperatures, improved fluid balance, and improved cardiovascular stability. Acclimatization is known to reduce the risk of heat illness in hot environments by improving the ability to withstand strain placed on the body by heat.[64]

Farmworkers are at higher risk of heat-related illness if they are not acclimatized. In 2005, Cal/OSHA found that almost half of the reported incidences of heat illness and deaths were in unacclimatized workers.[65] Forty-six percent of those reported cases of heat illness occurred on the employee's first day on the job, and 80% were within the first four days.[66]

5.3 Adjusting the time of day

Some employers in agricultural regions are adjusting the time of day for major outdoor farming operations, including working at night and early morning, to avoid the hottest temperatures.

This practice involves tradeoffs for both the employer and farmworkers. Care must be taken to ensure that working in the dark or low light conditions does not exacerbate other occupational health concerns, including a higher incidence of injuries.[67] This practice also requires an investment in lighting and other technology to maintain productivity. Night harvesting or other temporal adjustment is still an active area of research but seems to require large-scale social buy-in, bolstered by a policy that protects workers.[68]

5.4 Clothing and cooling wearables

Proper clothing and headwear are critical elements of best practices in high-heat environments. Experts currently recommend that farmworkers exposed to high heat and sun should wear the following: loose-fitting clothing made of breathable fabric to encourage cooling airflow, light-colored clothing to reflect the sun, long sleeves to avoid sunburn, and a wide-brim hat to shade the head.[69] While clothing choice has been shown to be an important component in reducing occupational heat stress, it is most effective when used in conjunction with adequate cycles of rest.[12,70]

In addition to recommended clothing, farmworkers can further reduce their heat exposure with cooling wearables, such as specially engineered cooling vests or jackets, bandanas (sometimes dipped in water) or head-cooling gel packs.[71] In one of the first pilot studies on cooling interventions for farmworkers in the U.S., researchers found that, though cooling vests have shown great promise in industries like construction, they actually increased farmworkers' risk for heat-related illness, possibly due to the increased weight load, which increased farmworkers' exertion.[72] In fact, the low-tech, lower-cost intervention of using a bandana soaked in cool water was shown to be the most effective option to reduce heat-related illness.[75] Cooling vests have the additional complication of requiring employer buy-in, both in maintaining the gel packs at a cool temperature and in ensuring that provided vests are in good condition.[53] When asked which cooling wearable they prefer, one study found that farmworkers found bandanas practical and effective, while cooling vests (even when assumed to be effective) were met with mixed reviews.[75] Ultimately, any cooling wearable must be appropriate for the work being performed and accommodate the cultural practices and individual levels of comfort of the user to ensure the wearable is used effectively.[75]

Using pesticides in farm labor complicates any attempt to rely solely on wearables as a heat stress mitigation tool. Farmworkers who apply pesticides often wear specialized protective equipment that increases their risk for heat stress.[73] Some farmworkers wear double-layered clothing when applying pesticides, potentially protecting them from the serious health consequences of pesticide exposure but exacerbating the threat to their health from heat.[40,74,75]

6. ARE CURRENT HEAT STANDARDS ADEQUATE TO PROTECT FARMWORKERS IN THE U.S.?

No U.S. federal occupational standards currently protect workers specifically from the dangers of heat exposure. OSHA has implemented a series of awareness-building and enforcement measures since the passage of the Occupational Safety and Health Act in 1970. As of the publication of this report, five states—California, Oregon, Washington, Colorado, and Minnesota—have adopted some level of heat standard with enforceable risk mitigation measures, and several other states are in the process of developing standards. However, heat illness in occupational settings, particularly among farmworkers, continues to be a growing problem. Therefore, in October 2021, OSHA flagged its intent to begin developing rules to protect workers nationwide from heat exposure and invited input from stakeholders and experts.

6.1 Federal programs

The Occupational Safety and Health Act of 1970 governs protection of workers in America. The Act created OSHA, the agency that is responsible for developing occupational safety and health regulations and enforcing those regulations, among other functions. Previously, OSHA has used a combination of awareness-building programs (e.g., **www.osha.gov/heat** and **www.osha.gov/heat-exposure**) and enforcement under the law's *General Duty Clause* to address heat stress among farmworkers. The General Duty Clause requires employers to provide a workplace free from recognized hazards, including heat-related hazards. Based on this provision, OSHA has cited individual employers for failure to protect against heat-related hazards on a case-by-case basis and has issued various guidance documents on protecting workers from heat. For example, OSHA's Region 6 office (covering Texas, New Mexico, Oklahoma, Arkansas, and Louisiana) has established a *Regional Emphasis Program*, using General Duty Clause authority, designed to address substantial heat-related illness occurrences in the region.[76] Through this program, regional enforcement officers can conduct inspections on days when forecasts call for temperatures above 80 degrees to ensure that working conditions are safe. However, as OSHA acknowledges, enforcement under the General Duty Clause in the absence of a specific heat hazard standard presents challenges—both for the agency, which has had to establish separately in each case that heat-related dangers were a recognized hazard and for employers, who could benefit from more explicit guidance on the agency's heat-related expectations.[77]

OSHA's sister non-regulatory agency, NIOSH, a branch of the Centers for Disease Control, has weighed in with recommendations on specific occupational heat exposure limits and measurement recommendations.[73] The NIOSH recommendations seek to provide science-based thresholds for heat exposure and, importantly, practical methods for assessing both environmental heat and metabolic heat (i.e., body temperature). However, employers are not bound to follow the NIOSH recommendations.

In response to the high heat of the summer of 2021, the hottest summer in recorded history for the U.S., President Biden launched a series of efforts to address heat exposure and the growing incidence of heat illness in the U.S.[74] Alongside other initiatives, the administration announced that OSHA would launch a rulemaking process on workplace heat risks. In October 2021, OSHA published an Advance Notice of Proposed Rulemaking, also known as ANOPR, as a standard to protect indoor and outdoor workers from heat illness and injury. There is strong support for such a standard among occupational safety and health experts, farmworkers and other labor advocates, and environmental and health advocates; see EDF and La Isla comments below. OSHA is now analyzing the input received on the ANOPR to inform its development of a heat standard. While that rulemaking process unfolds, OSHA is pursuing other worker protection efforts, including a National Emphasis Program on heat hazard inspections.[78]

EDF public comments to OSHA on ANOPR are available here: **https://www.regulations.gov/comment/OSHA-2021-0009-0706.**

La Isla comments to OSHA on ANOPR are available here: **https://www.regulations.gov/comment/OSHA-2021-0009-0526.**

6.2 State programs

In the absence of a federal heat standard, four states so far—California, Oregon, Washington, and Colorado—have adopted standards covering outdoor workers generally or farmworkers specifically (Minnesota has standards for indoor workers). Additional states—like Maryland and Nevada—have passed legislation that requires the development of occupational heat rules by state agencies. State action is accelerating, with many of these developments occurring in the last few years.

The characteristics of each state program vary but generally include an ambient temperature heat threshold, generally around 80°F, that triggers mitigation measures. California, Oregon, and Washington have each established additional mitigation measures in extreme heat circumstances (e.g., between 95°F and 100°F).

STATE RULES ON HAZARDOUS HEAT AS OF AUGUST 2021

STANDARD REQUIREMENTS	CALIFORNIA	MINNESOTA	OREGON	WASHINGTON *(Emergency rule additions in italics)*
Worksite coverage	Outdoor, year-round	Indoor, year-round	Indoor and outdoor, emergency rule	Outdoor, May 1 - Sept. 30
Threshholds triggering protection requirements	80°F (ambient temp.)	Between 77°F-86°F (WGBT) based on workload	80°F (NOAA NWS Heat Index)	89°F (ambient temp.); lower if wearing heavy clothing/PPE
Add'l high heat protections	At 95°F (certain industries only)	No	At 90°F	*At 100°F*
Water/Hydration	1 qt./hr./worker	No	1 qt./hr./worker, cool or cold	1 qt./hr./worker (*suitably cool*)
Shade	Yes	N/A	Yes	Yes
Training	Yes (new hire)	Yes (new hire and annual)	Yes	Yes (new hire and annual)
Breaks	Yes (encouraged generally, mandatory if symptoms)	Yes (after two hours exposure at threshold)	Yes (mandatory if symptoms at any temp. every two hours for all at 90°F)	Yes (mandatory if exhibiting symptoms; mandatory at 100F; *encouraged preventively and must be paid*)
Acclimatization Plan	Yes	No	Yes (in practice at 90°F)	Yes (mandatory if exhibiting symptoms; mandatory at 100F; encouraged preventively and must be paid)
Heat Illness Prevention Plan	Yes	No	No	Yes (as part of accident prevention plan)
Emergency Medical Response Plan	Yes	No	Yes	Yes
Medical monitoring	Reactive, proactive when about 95 F	Reactive	Reactive	Reactive
Record-keeping requirements	Yes	No	No	Yes

TABLE 1.

From Federal Register / Vol. 86 / Proposed Rules 5, 2021, this table summarizes some of the features of each state program in effect as of August 2021. It does not include the Colorado agricultural heat standard that went into effect in 2022. Also note that the table reflects the Oregon emergency temporary standards put in place in 2021, which have been replaced with permanent standards in 2022.

6.3 Employer programs

Some employers have voluntarily developed practices and programs to protect their workers from heat-related illness and injury. OSHA recognized these efforts in its ANOPR and invited employers to provide details on these programs and their efficacy.[79]

The expertise employers provide will help inform the development of the federal heat standard, ensuring that it is effective in protecting workers and feasible for employers to implement. A federal standard would benefit responsible employers by leveling the playing field and preventing competitors from attempting to cut costs with risky practices.

7. CASE STUDY: THE TROPICS

Though farmworkers in the U.S. currently face dangerous working conditions due to heat, warming temperatures in the coming decades due to climate change threaten to make this reality considerably worse. Additional warming may mean that U.S. farmworkers will be required to labor in extreme heat conditions that mirror the current climates in more equatorial regions like Mesoamerica. In order to anticipate the consequences that this warming may produce for U.S. farmworkers, it may be instructive to examine the growing epidemic of chronic kidney disease presently facing agricultural workers laboring in these climates.

7.1 The chronic kidney disease of non-traditional causes epidemic

In recent decades, an increasingly global epidemic of chronic kidney disease of non-traditional causes, or CKDnt, has been identified among agricultural and other outdoor laborers in hot climates.[80,81,82,83,84,85] Unlike traditional chronic kidney disease, CKDnt is not caused by known risk factors such as diabetes, obesity, and hypertension but occurs in often much younger individuals who perform strenuous physical labor in high temperatures without rest and adequate hydration.[86,87] CKDnt is a progressive loss of kidney function that ultimately leads to painful kidney failure and death. The progression of CKDnt can be slowed with proper medical attention, but symptoms present late in the course of the disease, and CKDnt can present significant problems for afflicted patients. The only treatments available for individuals with end-stage kidney disease are dialysis or transplantation which are expensive options, require considerable resources from health systems, and are often unavailable in low-resource settings.[88] As a result, many patients do not survive long after diagnosis.

Though multiple factors have been proposed to explain why agricultural workers are particularly susceptible to CKDnt, such as their exposure to agricultural chemicals like pesticides and heavy metals or their use of certain pain medications, the leading hypothesis is that CKDnt is an occupational illness primarily driven by high exertion and recurrent physical labor performed in extreme temperatures.[88,89,90] This has led some to suggest that CKDnt may represent one of the first climate change-induced epidemics.[91]

CKDnt is an emerging illness, so the exact number of individuals affected remains unknown, partly due to health system reporting not distinguishing CKDnt from CKD due to traditional causes (i.e., diabetes, hypertension).[92] However, what is clear is that throughout hot regions like Mesoamerica, where CKDnt has been most readily identified, the burden of CKD overall is consistently highest in the hottest areas with the most strenuous forms of manual labor, and the disease concentrates in worker populations at high risk of occupational heat exposure.[93] It has been estimated that over 20,000 have died of this disease within a decade in Central America alone, with many more sick and injured and therefore unable to work and provide for their families.[94]

7.2 Warning signs in the U.S

There is a growing concern that workers exposed to heat in the U.S., especially farmworkers, may currently suffer from CKDnt.[95] While recent studies have sought to explore the risks of CKDnt facing this group, those explorations have been troubled by the dearth of evidence characterizing U.S. occupational heat stress. Additionally, undocumented workers, who comprise nearly half of the U.S. farmworker population, are unlikely to be registered in the United States Renal Data System, where data on kidney injury and disease is collected.[96] Even still, incidences of CKD among agricultural workers globally (including in the U.S.) are on the rise and there are currently unexplained "hot spots" of CKD throughout some of the hottest U.S. agricultural regions like the San Joaquin Valley and the Rio Grande Valley, suggesting an urgent need for more research.[97,98,99,100]

While more research is needed to assess the present risk that CKDnt poses to U.S. farmworkers, several studies have investigated the prevalence of acute kidney injury, or AKI, among this group. AKI is characterized by the sudden damage or failure of the kidneys and can be triggered by various factors, such as recurrent exposure to heat, dehydration, or pesticides.[85,100] Recurrent incidences of AKI are a known risk factor for CKD.[101,102]

Farmworkers are an especially at-risk population for AKI. One study from California assessed the kidney function of 295 farmworkers over one work shift and identified AKI in 12% of participants,an extremely troubling finding considering that California has some of the strongest heat stress regulations currently on record.[107] Workers who were paid by piece rate (i.e., paid by the amount harvested rather than an hourly wage) were over four times likelier to have AKI.[107] Another study assessing 29 farms in California was similarly troubling, identifying AKI in 15% of farmworkers after one day of harvest.[103] As expected, workers in roles that required a higher workload, and those being paid by piece rate, were most likely to have AKI.[107] These studies are especially alarming when one considers that the findings reflect only one day of harvest and that recurrent episodes of AKI may eventually lead to CKDnt.[85]

In Florida, where, unlike California, no enforceable heat standard exists for farmworkers, researchers have identified a strikingly high prevalence of AKI and dehydration among farmworkers. In one analysis of the kidney health of a group of 192 farmworkers over 555 days across 2015-2016, 33% of participants had AKI on at least one working day.[104] Further, approximately 53% of farmworkers arrived to their shifts already dehydrated, and 81% finished their shifts dehydrated on at least one working day, putting them at high risk for heat stress and AKI.[108] Many farmworkers must contend with substandard housing that can be both overcrowded and inadequately cooled, leading some farmworkers to arrive to their shifts already dehydrated and experiencing symptoms of heat stress.[54,105]

7.3 Looking ahead

As climate change continues to raise the ambient temperatures that farmworkers labor in, the risks to their kidneys will increase.[106] One study found that for every 5°F increase in ambient temperature, the odds of farmworkers having AKI increased 47%.[108] Climate change is also likely to increase the number of pesticides required on non-organic farms, and pesticide exposure may possibly exacerbate already decreased kidney function in workers exposed to high heat.[107,108]

One of the critical hurdles to understanding precisely how dire the AKI and CKDnt situation currently is for farmworkers is the documented underreporting of occupationally acquired AKI incidents in the U.S. by employers.[109] Workers may also be reluctant to seek medical help for heat-related incidents, which could otherwise alert clinicians to issues in kidney function and allow those issues to be formally documented as AKI events.[46,110]

AKI and CKDnt represent two of the direst outcomes of occupational heat stress, as well as two of the most significant warning shots regarding the health risks of climate change. CKDnt is now such a recognized crisis among Central American agricultural workers that the U.S. Department of Labor (DOL) is investing millions in the region as a part of the Biden-Harris administration's Root Causes of Migration Strategy to improve labor practices for those most at risk.[111] As temperatures in the U.S. continue to increase due to climate change, the established prevalence of CKDnt globally in areas with extreme temperatures and strenuous manual outdoor labor point to a needed focus for the U.S. agricultural industry.

LESSONS FROM ABROAD PAINT A GRIM PICTURE OF THE REALITY THAT COULD FACE MILLIONS OF FARMWORKERS IN THE U.S. IN THE COMING DECADES DUE TO CLIMATE CHANGE IF SOLID PROTECTIVE MEASURES ARE NOT TAKEN.

8. THE NEED FOR A FEDERAL HEAT STANDARD

For at least 50 years, farmworker advocates, unions, researchers, civic groups, and organizations like NIOSH have consistently pushed to develop a federal occupational heat standard.[112,113] Under the Biden Administration, OSHA has recently begun developing this standard, which has the potential to be a transformative change that could significantly improve the lives of all outdoor workers, *especially* farmworkers, in America.[74]

A federal heat standard is no panacea. Even where current state-level standards exist, there remain significant issues with employer compliance, under-resourced enforcement departments, and inadequate employee training on their heat-related occupational rights.[73,114,115] Furthermore, studies have shown the continued presence of heat-related illness among farmworkers in these areas even where protocols are being strictly followed, indicating that existing protocols require further strengthening and refinement.[116] Any protocol, new or otherwise, will also need to be monitored and evaluated to adapt to shifting conditions due to climate change, as well as to new knowledge from the scientific community.

Nonetheless, a federal heat standard would set an enforceable benchmark to protect farmworker health and clarify employers' responsibilities nationwide. OSHA's development of this standard is a considerable step towards ameliorating a long history of farmworkers' exclusion from occupational policymaking and the invisibilities of the occupational safety and health crisis farmworkers have shouldered as temperatures rise.

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