

UNWORKABLE

*Dangerous Heat Puts
Florida Workers at Risk*



PUBLICCITIZEN

Acknowledgments

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About Public Citizen

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About the Farmworker Association of Florida

The Farmworker Association of Florida is a 35-year old, statewide, non-profit, grassroots farmworker membership organization with five offices in Central and South Florida and a membership of over 10,000 Haitian, Hispanic and African American families and includes farmworkers who work in the vegetable, citrus, mushroom, tropical fruit, fern and foliage industries in the state. The mission of the organization is to build power among farmworker and rural, low-income communities to respond to and gain control over the social, political, economic, workplace, health and environmental justice issue that impact their lives. The organization's guiding vision is a social environment where farmworkers' contribution, dignity, and worth are acknowledged, appreciated, and respected through economic, social, and environmental justice. This vision includes farmworkers being treated as equals, and not exploited and discriminated against based on race, ethnicity, immigrant status, gender, or socioeconomic status.



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Introduction

Due to greenhouse gas pollution, temperatures have been rising rapidly in recent decades. One important and often overlooked effect of rising global temperatures is that heat-related injuries and illnesses are increasing as well. Under the administration of President Donald Trump, the U.S. government has been working aggressively to intensify rather than mitigate the problem of heat stress by accelerating the burning of fossil fuels. It is therefore critical that other jurisdictions both work to mitigate climate change and begin protecting the populations that are most vulnerable to its harms. This report discusses the problem of heat stress generally, then focuses on Florida outdoor workers, showing that they work in dangerous heat conditions a high proportion of the time and their health is suffering as a result.

Heat Is a Major and Growing Public Health Problem in Florida.

Heat was the leading weather-related killer in the U.S. over the past 30 years,¹ and the problem is growing worse due to climate change. The human body must stay within a narrow temperature range to remain healthy. The body's temperature can be raised by heat in the environment or heat that the body generates internally, especially with physical activity. When the body cannot disperse heat quickly enough, it can progress toward serious injury or death. Heat exhaustion results from prolonged heat exposure and loss of fluids and salt, usually from sweating. Symptoms include headache, nausea, dizziness, weakness, irritability, thirst, heavy sweating, elevated body temperature, or decreased urination. If heat exhaustion goes untreated, it can progress to heat stroke, a life-threatening condition in which the body rapidly loses the ability to control its temperature. Symptoms include confusion, slurred speech, hot and dry skin or profuse sweating, seizures, and loss of consciousness (coma).²

Excessive heat stress can harm anyone, but some populations are at greater risk.

All people are at risk of heat illness, which can occur in temperatures as mild as the 70s (Fahrenheit).³ But some populations are more vulnerable than others.

Children. Physiological differences in infants and children, particularly those under age 4, impair their ability to manage heat.⁴ Compared to adults, children have a greater ratio of surface area to body mass, which means environmental heat affects them more strongly. Moreover, children do not sweat as easily as adults, which impairs their ability to cool down. And children will not feel thirsty until they have lost two percent of their body weight as sweat, at which point they are already dehydrated.⁵ One particular caution is that children should not be left in parked vehicles, in which temperatures can rise faster than a child's ability to regulate his or her internal temperature. According to the National Weather Service, dozens of children left in parked vehicles die from hyperthermia each year.⁶ The majority of these deaths occur in children age three and younger.⁷ Likewise, children and parents should exercise additional caution when children are playing sports or otherwise exerting themselves in the heat.

Seniors. Older adults are also at significant increased risk of heat illness. According to the National Institute of Aging, most heat-related deaths occur in people over 50 years old.⁸ Several factors

increase their vulnerability. Older adults are more likely to have chronic medical conditions like heart, lung, or kidney disease that impair the body's normal responses to heat. They also may have poorer blood circulation or less efficient sweat glands, and are more likely to be taking medications that can impair the body's ability to regulate or respond to heat.⁹ For the same reasons, individuals with chronic medical conditions can be especially vulnerable to excessive heat.

Older adults who lack air conditioning or fans are at increased risk of overheating, as the nation witnessed from the tragic deaths at a Florida nursing home in the aftermath of Hurricane Irma. The Rehabilitation Center at Hollywood Hills lost power during the storm and waited until the following day to request emergency medical services. Eight people between the ages of 70 and 99 died, and initial reports indicated that excessive heat was a significant factor in the loss of life.¹⁰ That incident was not the facility's first encounter with electricity problems. In 2016 the Florida Agency for Healthcare Administration, the agency tasked with regulating the state's nursing homes, found that the nursing home "failed to maintain the emergency generator."¹¹

Low-income individuals also are more likely to be exposed to heat and can be more vulnerable to heat stress due to lack of access to air conditioning or fans, poorer quality of dwellings, lack of access to public services, and more.¹² In addition, pregnant women are more vulnerable because they are more prone to dehydration and their bodies must work harder to keep cool.¹³

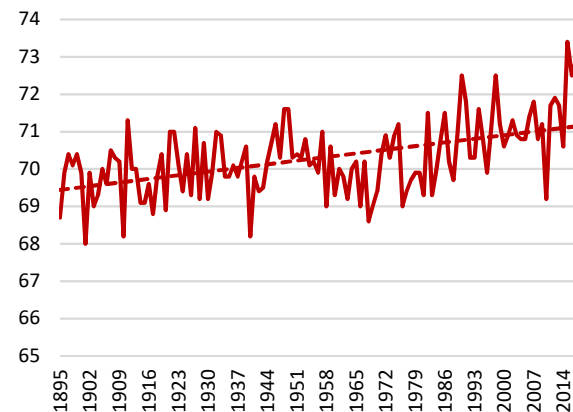
Workers. As this report discusses in greater depth below, occupation is a major risk factor for heat illness. Many indoor and outdoor workers are exposed to dangerously high temperatures in the course of their job. Because they are working, workers typically have less ability to engage in natural responses to dehydration and heat, such as drinking water, resting, and moving to a shadier or cooler space. Farm workers and construction workers are the highest risk populations. This is due in part to greater heat exposure. But workers in these sectors often are especially vulnerable for other reasons. Many attempt to work through discomfort or illness without complaint because they cannot afford to lose work time or fear losing their jobs. They may speak little or no English, may not know their rights, or may lack proper work permits and fear deportation if they raise health concerns that could be perceived as complaints.

Climate change is exacerbating heat stress, and the Trump administration is exacerbating climate change.

The threat of heat illness is rising due to global warming. Seventeen of the 18 hottest years on record have occurred since 2001.¹⁴ According to the Fourth U.S. National Climate Assessment, average annual temperatures in the contiguous U.S. have already risen by 1.2°F (0.7°C) for the period 1986–2016 relative to 1901–1960 and by 1.8°F (1.0°C) for the period 1895–2016.¹⁵ As shown in Figure 1, Florida temperatures are on a similar trajectory. This warming trend is projected to continue and accelerate. When average temperatures rise, the number and intensity of extremely hot days rises more rapidly.¹⁶

Florida already has one of the highest rates of heat-related hospitalizations in the nation, even when the data are adjusted for age.¹⁷ In 2016, the most recent year for which data are available, Florida had 1,112 hospitalizations.¹⁸ These figures are almost certainly undercounts, as many of the illnesses that can result from heat stress, such as stroke or heart attack, often are not recognized or documented as having anything to do with heat.

Figure 1: Florida Average Annual Temperature 1895–2017 (°F)



Source: National Oceanic and Atmospheric Association

At present, there is no sign that rising heat will stop. The Trump administration has been working aggressively for policies that accelerate greenhouse gas pollution and invite more, and more rapid, global warming. The administration's most significant actions include:

- Announcing a U.S. withdrawal from the Paris Climate Accord and attempts to undermine that agreement rhetorically.
- Repeal of the Clean Power Plan, the nation's first-ever limits on carbon pollution from power plants.¹⁹
- Rolling back fuel economy standards.²⁰
- Repealing two regulations that would have limited methane leaking, venting and flaring on federal and tribal lands.²¹

Together, these actions are a major step backward on climate change at a time when the need for progress is more urgent than ever.

Florida Workers Routinely Labor in Dangerous Heat and Suffer Predictable Harm to Their Health.

Florida's outdoor laborers routinely work in dangerous heat conditions.

A comparison of recent temperature records with safety recommendations from the National Institute of Occupational Safety and Health (NIOSH), part of the U.S. Centers for Disease Control and Prevention, indicates that Florida's outdoor workers routinely labor in dangerous conditions.

In 2016, NIOSH updated its recommendation — originally issued in 1972 and updated in 1986 — for temperature limits over which workers should be protected from heat. Currently, U.S. workers are not protected by any federal rule on heat stress. A group of more than 130 organizations, including Public Citizen and the Farmworker Association of Florida, petitioned the U.S. Occupational Safety and Health Administration (OSHA) in July 2018, urging the agency to enact a rule that largely follows NIOSH's recommendations.²² The safety limits that NIOSH recommends are similar to those issued by the American Conference of Governmental Industrial Hygienists, the American Industrial Hygiene Association, and the International Organization for Standardization,²³ as well as those used by the U.S. military and some other nations.²⁴

Safety thresholds for heat stress are based on a combination of two sources of heat: environmental and metabolic (body-generated). Workers engaged in heavier labor produce more metabolic heat and therefore need protection at lower environmental temperatures. For this reason, the limits for safe temperature vary by workload. In addition, when assessing environmental heat, it is important to account for factors other than air temperature that influence the body's experience of heat and its ability to cool itself, such as humidity, wind, and direct sunlight. Like most heat stress exposure limits, NIOSH's recommended limits are given in "wet bulb globe temperature" (WBGT), a measure that accounts for air temperature, humidity, wind, and radiant energy such as direct sunlight.²⁵

Employers can use a number of interventions to protect workers from heat that rises above safe levels.²⁶ For outdoor laborers, the simplest and most common interventions recommended by NIOSH are to provide rest breaks and shade (or air conditioning if possible). Workers also should be given adequate potable water to drink when working in heat: one cup of water every 15–20 minutes, plus replacement of electrolytes during periods of prolonged sweating.²⁷ Researchers and community organizations, collaborating with large agricultural employers, have implemented effective interventions for heat stress and dehydration that actually improved worker productivity in Central America.²⁸ There is a paucity of similar endeavors in the U.S.

Most agricultural and construction workers perform at least "moderate" work, the equivalent of normal walking and moderate lifting. It is likely that many if not most frequently perform some "heavy" (heavy material handling, walking at a fast pace) and "very heavy" (pick and shovel work) work as well. For moderate work, NIOSH recommends a WBGT limit of 82.4°F. For heavy and very heavy work, it recommends limits of 78.8°F and 77°F, respectively.²⁹ At those WBGTs, workers are at heightened risk of illness and should be protected from the heat in some manner, such as by providing shade, rest breaks, or both.

Table 1. Metabolic work rates

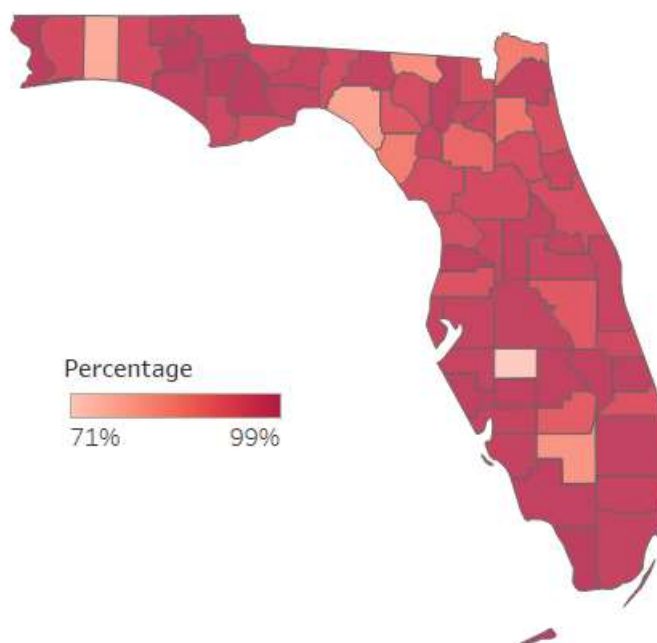
Work Category	Metabolic Rate (Watts)	Examples
Rest	115	Sitting
Light	180	Sitting, standing, light arm/hand work and occasional walking
Moderate	300	Normal walking, moderate lifting
Heavy	415	Heavy material handling, walking at a fast pace
Very Heavy	520	Pick and shovel work

Adapted from: ACGIH "2017 TLVs and BEIs" Table 3 and presented here as shown in OSHA, TECHNICAL MANUAL: HEAT STRESS, <https://pubc.it/2Jhx84W> (viewed on Oct. 25, 2018).

A review of hourly average WBGT records for the period May 1 to September 30, 2018, reveals that outdoor workers in every Florida county were exposed to heat above these thresholds — meaning dangerous levels of heat — an extraordinary proportion of the time.

In every Florida county, there was at least one hour when the average WBGT exceeded NIOSH's recommended limit for workers engaged in very heavy labor (77°F) on 71 percent of days or more (108 of 153 days).³⁰ In fact, temperatures reached that level on 90 percent of days or more in at least 59 of 67 counties, and possibly in all counties.³¹ At least fifteen counties exceeded it on 99 percent of days. See Figure 2 and see Table 6 in the Appendix.

Figure 2: Percentage of days from May 1 to Sept. 30 in each Florida county during which the average WBGT exceeded NIOSH's safe limit for very heavy labor (77°F) for at least one hour



Source: WeatherSTEM

“I worked for more than 15 years (in a nursery) and we women were exposed a lot on the job, because we had to complete our production quotas daily, and to fulfill our production, we waited to drink water so that we didn’t have to go to the bathroom so often.”

—*Maria Piñeda*

Regarding the safe threshold for heavy labor (78.8°F), every county exceeded that limit for at least one hour on at least 66 percent of days (101 days out of 153). Fifty-nine counties exceeded it on 85 percent of days or more, and 51 did so on at least 90 percent of days.

For moderate labor, the WBGT limit is 82.4°F. Every county exceeded that limit for at least one hour on 56 percent of days. Fifty-eight

counties exceeded it on at least 75 percent of days. For full data on all counties for moderate, heavy, and very heavy labor, see Table 6 in the Appendix. For data on light work, see Table 8 in the Appendix.

Of particular significance are counties with large numbers of outdoor workers. According to the U.S. Census Bureau, the top 10 counties by number of agricultural and construction workers are home to 422,000, or about 61 percent of employees in those sectors across the state. (The Census Bureau vastly undercounts the number of agricultural and construction workers,³² but its numbers may fairly represent the relative distribution of these populations among Florida counties.)

Table 2: Percentage of days from May 1 to Sept. 30 during which the WBGT exceeded NIOSH’s safe threshold for at least one hour, for three levels of exertion, in the top 10 Florida counties by population of agricultural and construction workers

County	Rank	Number of workers	Very Heavy (77°F)	Heavy (78.8°F)	Moderate (82.4°F)
Miami-Dade	1	98,203	98%	94%	84%
Broward	2	59,533	98%	95%	81%
Palm Beach	3	52,541	99%	96%	88%
Hillsborough	4	50,405	97%	95%	87%
Orange	5	38,702	97%	92%	85%
Lee	6	29,197	98%	93%	85%
Pinellas	7	24,810	97%	95%	82%
Duval	8	24,724	98%	96%	90%
Polk	9	23,371	98%	94%	83%
Collier	10	20,471	99%	97%	89%

Sources: U.S. Census Bureau (number of workers), WeatherSTEM (hourly average WBGT)

All of the Florida counties with a high population of outdoor workers experienced an extraordinarily high proportion of days on which the WBGT exceeded safe thresholds for at least one hour. All exceeded the safe threshold for very heavy labor (77°F) on at least 97 percent of days, for heavy labor (78.8°F) on 92 percent of days, and for moderate labor (82.4°F) on 81 percent of days. See Table 2.

Also noteworthy are counties in which outdoor workers make up a large proportion of the employed workforce, irrespective of their absolute numbers. For example, Hendry County has roughly 5,000 agricultural or construction workers. This is a far cry from Miami-Dade County’s 98,000, but workers

in these two sectors make up more than 34 percent of Hendry’s workforce, compared to 8 percent of Miami-Dade’s. In counties with a high percentage of outdoor workers, medical providers and policymakers should be particularly aware of and responsive to occupational heat risks.

“[W]hen someone is feeling bad, you need to sit for 5, 10 minutes to refresh yourself and that is so that you don’t get dizzy from the heat, but, we don’t because people have fear of retaliation from the bosses, then that would be good (to know your rights.)”

–H0204

Like the counties with high absolute numbers of agricultural and construction workers, those with a large percentage of the workforce in these sectors also experienced a high number of days on which the heat exceeded NIOSH’s safe thresholds for at least one hour, as shown in Table 3. Every county exceeded the threshold for very heavy labor on at least 71 percent of days, for heavy labor on at least 66 percent of days, and for moderate labor on at least 56 percent of days.

Moreover, these numbers are likely understated. Counties with the lowest percentages of days when WBGTs exceeded safe thresholds are the same counties with large gaps in the data. Hamilton, Hardee, and Hendry counties are missing 16, 39, and 23 percent of data entries, respectively.³³ These gaps likely explain some of the days on which WBGTs appear not to have exceeded safe thresholds.

Table 3: Percentage of days from May 1 to Sept. 30 during which the WBGT exceeded NIOSH’s safe threshold for a least one hour, for three levels of exertion, in the top 10 Florida counties by percentage of workforce employed in agriculture or construction.

County	Rank	Number of workers	Percentage of workforce	Very Heavy (77°F)	Heavy (78.8°F)	Moderate (82.4°F)
Hendry*	1	5,260	34.4%	81%	77%	69%
DeSoto	2	4,132	33.0%	99%	97%	86%
Hardee*	3	2,834	29.9%	71%	66%	56%
Glades	4	817	22.5%	92%	87%	76%
Okeechobee	5	2,768	20.5%	99%	95%	87%
Calhoun	6	877	19.0%	99%	95%	82%
Lafayette	7	429	16.8%	92%	88%	78%
Liberty	8	463	16.8%	99%	92%	84%
Levy	9	2,306	16.1%	95%	93%	82%
Hamilton*	10	596	15.3%	82%	78%	69%

Sources: U.S. Census Bureau (number of workers), WeatherSTEM (hourly average WBGT)

* Hendry, Hardee, and Hamilton counties are missing 23, 39, and 16 percent data entries, respectively.

Another useful metric is the percentage of daytime hours during which the WBGT exceeded safe thresholds. In each of the top 10 Florida counties by population of agricultural and construction

workers, temperatures exceeded NIOSH's safe limit for moderate labor at least 45 percent of the time between the hours of 7 a.m. and 7 p.m. The highest proportion was 56 percent of the time in Collier, Duval, and Palm Beach counties. For heavy labor, the WBGT exceeded the safety threshold at least 66 percent of the time in every county, with the highest figure being 79 percent in Palm Beach County. It exceeded the limit for very heavy labor at least 75 percent of the time in all counties, with the highest being Broward and Palm Beach counties, at 87 percent, with Miami-Dade and Pinellas close behind at 86 and 85 percent, respectively. See Table 4.

"[To protect yourself from the heat, you need to] drink liquids, lots of liquids, to try to protect myself from the sun with clothing I wear a long-sleeve shirt, cover my head, and, if possible, avoid direct sunlight. That is what is important, but at times, you are not able to do it. That's the way the work is and the bosses at times do not care about your well-being. They only care about themselves. That is the problem."

—Ho309

Table 4: Percentage of hours between 7 a.m. and 7 p.m. during which the average temperature exceeded NIOSH's safe thresholds for three levels of exertion in the top 10 counties by population of agricultural and construction workers.

County	Rank	Number of workers	Very Heavy (77°F)	Heavy (78.8°F)	Moderate (82.4°F)
Miami-Dade	1	98,203	86%	75%	47%
Broward	2	59,533	87%	77%	48%
Palm Beach	3	52,541	87%	79%	56%
Hillsborough	4	50,405	75%	68%	50%
Orange	5	38,702	79%	68%	47%
Lee	6	29,197	79%	69%	50%
Pinellas	7	24,810	85%	76%	52%
Duval	8	24,724	81%	73%	56%
Polk	9	23,371	76%	66%	45%
Collier	10	20,471	83%	76%	56%

Sources: U.S. Census Bureau (number of workers), WeatherSTEM (hourly average WBGT)

The top 10 counties by proportion of the employed workforce in agriculture or construction also had many hours between 7 a.m. and 7 p.m. when the WBGT exceeded NIOSH's recommended limits. For moderate work, the WBGT exceeded the threshold at least 32 percent of the time in every county, and at least 40 percent of the time in most of the counties, with a high of 53 percent in DeSoto and Okeechobee counties. For heavy labor, the figures are at least 50 percent of the time in each county, and more than 60 percent in most, with a high of 72 percent in Okeechobee County. For very heavy labor, the temperature exceeded the safe limit at least 56 percent of the time in every county, and more than 70 percent of the time in most counties, with a high of 82 percent in Okeechobee County. See Table 5.

As with the percentage of days during which the WBGT exceeded safe limits for at least one hour, these figures are likely underestimates for certain counties due to gaps in the data. Among the few counties that are missing a relatively large number of data points for hourly average WBGT, the missing data are concentrated during the warmer months.³⁴

Table 5: Percentage of hours between 7 a.m. and 7 p.m. during which the average temperature exceeded NIOSH’s safe thresholds for three levels of exertion, in the top 10 counties by percentage of workforce employed in agriculture or construction.

County	Rank	Number of workers	Percentage of workforce	Very Heavy (77°F)	Heavy (78.8°F)	Moderate (82.4°F)
Hendry	1	5,260	34.4%	72%	62%	42%
DeSoto	2	4,132	33.0%	78%	70%	53%
Hardee	3	2,834	29.9%	65%	57%	37%
Glades	4	817	22.5%	70%	59%	32%
Okeechobee	5	2,768	20.5%	82%	72%	53%
Calhoun	6	877	19.0%	72%	62%	43%
Lafayette	7	429	16.8%	56%	50%	35%
Liberty	8	463	16.8%	72%	62%	44%
Levy	9	2,306	16.1%	72%	62%	41%
Hamilton	10	596	15.3%	70%	61%	40%

Sources: U.S. Census Bureau (number of workers), WeatherSTEM (hourly average WBGT)

For data on WBGTs between the hours of 7 a.m. and 7 p.m. for moderate, heavy, and very heavy labor in all counties, see Table 7 in the Appendix. For data on light labor during those hours, see Table 8 in the Appendix.

The health of Florida workers is suffering from working in excessive heat.

Given the prevalence of dangerous heat levels, it is no surprise that individual workers report heat illness symptoms and show indications of heat stress in startlingly high numbers. Researchers at Emory University and the Farmworker Association of Florida recently studied farmworkers in multiple Florida locations and found multiple indicators of health harms related to heat stress.

In the Girasoles (Sunflower) Study, funded by NIOSH, researchers looked comprehensively into the heat hazards experienced by agricultural workers in Florida over three workdays. The study, led by Linda McCauley, PhD, RN, had three main components: (1) survey data about work practices, demographic information, behaviors around heat, and barriers to heat-illness prevention at the worksite, as well as self-reported heat-related illness symptoms; (2) biological data to measure dehydration and examine blood chemistry results; and (3) physiologic biomonitoring. Study locations were in Central and South Florida and included the towns of Pierson, Apopka, Fellsmere, Immokalee, and Homestead.

Researchers examined worksite and regional temperatures, as well as information about the kind of work tasks performed and the duration of the workday. Participants also reported the types of beverages they drank during hot weather and barriers to heat illness prevention at the worksite,

including insufficient hydration breaks. The Girasoles team used physiologic biomonitoring to gather information about participants' levels of exertion and data that described their physiologic responses to the heat. After ingesting a temperature pill, participants wore sensors to monitor their core body temperature, heart rate, activity, and energy expenditure.

During the study, the average heat index experienced by the workers was 91.4°F (33°C). Heat index is an environmental heat stress measure calculated from air temperature and humidity combined. Employers may be able to access it more easily than WBGT and can use it as a substitute.³⁵

Study results showed that over four in five workers had core temperatures that exceeded 38°C (100.4°F) on at least one of the study days.³⁶ This temperature is the recommended physiologic limit for core temperature, at which the risk of serious heat injury rises steeply for many individuals.³⁷

Beyond body core temperature that exceeded recommended limits, multiple participants were found to meet criteria for acute kidney injury on at least one of the three study days. Over one in three workers experienced acute kidney injury stage 1 or higher on at least one study day according to the change in their blood creatinine levels from before the workday to after. Approximately half of the workers were dehydrated prior to going to work, and that proportion increased to over three-fourths after the workday. The likelihood of a worker developing acute kidney injury during a workday increased by nearly 50 percent for each 5-degree F increase in heat index.³⁸

Workers also frequently reported heat-related illness symptoms. Most common were heavy sweating, headache, dizziness, and muscle cramps, with female participants having three times the odds of experiencing three or more symptoms compared to male participants.³⁹

I have been working for two years in different jobs including construction, picking tomatoes, in roofing, in plant nurseries, etcetera. Around a year ago, when I was working on a very hot day, my nose began to bleed. They gave me permission to go buy medicine, which I paid for and then went home, around 4 in the afternoon. Where I work now, in a plant nursery, they give us drinking water and let us take a five-minute break in the shade every four hours. I have never received any training on the job about how to protect myself from the sun.

—Enrique, 18 years old

I have been working in agriculture for 16 years. Once in 2003 when I was picking tomatoes in a place called Quincy [Florida], it was very hot. I just couldn't take it anymore and I fainted. There was no one working around me and no one noticed. I came to sometime later, and didn't receive any assistance. Where I work now [in a plant nursery], they give us drinking water, but don't let us rest in the shade. My employer says only if we feel bad can we rest a little in the shade. I haven't received any training to protect myself from the sun. I would like it if we received more protection, but the supervisors demand more production from us to look good with their superiors.

—Elena, 30 years old

“In the mornings, we would start work in the fields where it is very hot, because in the mornings, you don’t feel it so much, right? But between noon and 2pm in the afternoon, there is a very intense heat. What they should do in the afternoons is move us to an area where there is a little bit of a breeze or air circulation or a little bit of shade during the time when it is hottest. And, they should give us water or ice. This is what we would like, what the employers ought to give us, that they give us a little bit of consideration on this.”

—*Ho302*¹

is Culturally Appropriate (PISCA) project led by Dr. Joseph G. Grzywacz and Dr. Antonio Tovar. This training also includes information on how to use a smart phone app developed by OSHA and NIOSH that calculates local heat index, the current heat risk level, and provides heat illness prevention recommendations.⁴⁰

In addition to providing heat illness prevention trainings like the PISCA project’s, it is of paramount importance for community groups, researchers, and health care providers to work directly with employers to implement NIOSH- and OSHA-recommended water, rest, and shade protections at the workplace. Additional next steps include piloting the implementation of heat-adaptive interventions in Florida agricultural workplaces. The collaborative implementation of heat illness prevention actions and interventions can provide physiologic documentation to identify the most effective approaches for implementing the recommended interventions and allow for the evaluation of associated productivity and health status improvements.

Conclusion

It is no surprise that Florida is hot. But less recognized is that the heat is harming Floridians — and it is rapidly growing worse. Outdoor workers are one of the most vulnerable populations. They routinely work in dangerous heat, and their health suffers severely as a result. At a time when federal policy aims to accelerate rather than mitigate global warming, Florida workers need protection from heat more than ever.

The Girasoles Study sets the foundation for future heat stress adaptation and heat illness prevention efforts by documenting that agricultural workers in Florida are at risk for heat illness and other heat-related health impacts. Next steps for this project include the translation of research findings into trainings and pilot-testing heat adaptive interventions for Florida agricultural workers.

To engage with agricultural workers and employers about heat illness prevention, data from the Girasoles Study was used to develop heat illness prevention trainings by a team of researchers through the Pesticide & Heat Stress Education for Latino Farmworkers that

Appendix

Table 6: Percentage of days between May 1 and Sept. 30 in each Florida county in which the WBGT exceeded NIOSH's safe thresholds for three levels of exertion for at least one hour

County	Very heavy labor (77°F)	Heavy labor (78.8°F)	Moderate labor (82.4°F)
Alachua	90%	86%	65%
Baker	94%	88%	82%
Bay	98%	95%	84%
Bradford	96%	93%	84%
Brevard	97%	95%	88%
Broward	98%	95%	81%
Calhoun	99%	95%	82%
Charlotte	97%	93%	81%
Citrus	95%	89%	69%
Clay	87%	81%	72%
Collier	99%	97%	89%
Columbia	99%	95%	85%
DeSoto	99%	97%	86%
Dixie	86%	82%	73%
Duval	98%	96%	90%
Escambia	99%	99%	86%
Flagler	97%	91%	84%
Franklin	95%	90%	77%
Gadsden	96%	93%	84%
Gilchrist	97%	91%	82%
Glades	92%	87%	76%
Gulf	96%	90%	77%
Hamilton	82%	78%	69%
Hardee	71%	66%	56%
Hendry	81%	77%	69%
Hernando	99%	93%	84%
Highlands	99%	94%	85%
Hillsborough	97%	95%	87%
Holmes	99%	95%	85%
Indian River	96%	93%	84%
Jackson	98%	93%	83%
Jefferson	95%	92%	84%
Lafayette	92%	88%	78%
Lake	98%	95%	88%

County	Very heavy labor (77°F)	Heavy labor (78.8°F)	Moderate labor (82.4°F)
Lee	98%	93%	85%
Leon	97%	93%	83%
Levy	95%	93%	82%
Liberty	99%	92%	84%
Madison	98%	97%	90%
Manatee	97%	92%	80%
Marion	95%	91%	78%
Martin	93%	90%	84%
Miami-Dade	98%	94%	84%
Monroe	99%	95%	84%
Nassau	86%	83%	77%
Okaloosa	77%	75%	65%
Okeechobee	99%	95%	87%
Orange	97%	92%	85%
Osceola	92%	88%	80%
Palm Beach	99%	96%	88%
Pasco	93%	89%	81%
Pinellas	97%	95%	82%
Polk	98%	94%	83%
Putnam	95%	91%	84%
Santa Rosa	95%	92%	76%
Sarasota	99%	95%	85%
Seminole	97%	92%	84%
St. Johns	94%	90%	82%
St. Lucie	99%	96%	88%
Sumter	97%	93%	83%
Suwannee	95%	89%	78%
Taylor	78%	77%	67%
Union	97%	92%	86%
Volusia	95%	91%	86%
Wakulla	97%	93%	79%
Walton	95%	90%	78%
Washington	99%	95%	85%

Source: WeatherSTEM

Table 7: Percentage of hours between 7 a.m. and 7 p.m. from May 1 to Sept. 30, when the average WBGT exceeded NIOSH's safe thresholds for three levels of exertion in each Florida county

County	Very Heavy (77°F)	Heavy (78.8°F)	Moderate (82.4°F)
Alachua	66%	54%	24%
Baker	71%	63%	42%
Bay	73%	66%	46%
Bradford	71%	64%	45%
Brevard	78%	71%	52%
Broward	87%	77%	48%
Calhoun	72%	62%	43%
Charlotte	74%	66%	47%
Citrus	76%	65%	36%
Clay	73%	63%	41%
Collier	83%	76%	56%
Columbia	77%	68%	49%
DeSoto	78%	70%	53%
Dixie	76%	67%	47%
Duval	81%	73%	56%
Escambia	78%	69%	48%
Flagler	77%	68%	48%
Franklin	76%	64%	38%
Gadsden	73%	65%	47%
Gilchrist	76%	67%	46%
Glades	70%	59%	32%
Gulf	76%	67%	43%
Hamilton	70%	61%	40%
Hardee	65%	57%	37%
Hendry	72%	62%	42%
Hernando	76%	67%	48%
Highlands	78%	68%	50%
Hillsborough	75%	68%	50%
Holmes	73%	65%	46%
Indian River	74%	69%	52%
Jackson	71%	62%	44%
Jefferson	76%	69%	52%
Lafayette	56%	50%	35%
Lake	79%	69%	51%
Lee	79%	69%	50%
Leon	79%	70%	49%
Levy	72%	62%	41%
Liberty	72%	62%	44%
Madison	76%	69%	53%
Manatee	74%	65%	46%
Marion	74%	64%	39%

County	Very Heavy (77°F)	Heavy (78.8°F)	Moderate (82.4°F)
Martin	77%	67%	45%
Miami-Dade	86%	75%	47%
Monroe	97%	90%	80%
Nassau	78%	70%	50%
Okaloosa	77%	67%	45%
Okeechobee	82%	72%	53%
Orange	79%	68%	47%
Osceola	79%	69%	49%
Palm Beach	87%	79%	56%
Pasco	74%	66%	46%
Pinellas	85%	76%	52%
Polk	76%	66%	45%
Putnam	75%	66%	45%
Santa Rosa	81%	69%	44%
Sarasota	83%	73%	54%
Seminole	77%	67%	47%
St. Johns	79%	69%	43%
St. Lucie	84%	75%	56%
Sumter	75%	66%	44%
Suwannee	59%	52%	34%
Taylor	70%	62%	46%
Union	77%	67%	50%
Volusia	81%	72%	50%
Wakulla	60%	55%	38%
Walton	70%	61%	40%
Washington	74%	65%	48%

Source: WeatherSTEM

Table 8: Percentage of days and daytime hours from May 1 to Sept. 30, when the average WBGT exceeded NIOSH's safe threshold for light work in each Florida county

County	Light (86°F)	Light (86°F)
Alachua	4%	0%
Baker	46%	13%
Bay	61%	23%
Bradford	56%	19%
Brevard	65%	23%
Broward	47%	12%
Calhoun	60%	18%
Charlotte	58%	18%
Citrus	15%	2%
Clay	38%	10%
Collier	77%	29%
Columbia	70%	25%
DeSoto	71%	24%
Dixie	52%	21%
Duval	80%	35%
Escambia	62%	23%
Flagler	58%	17%
Franklin	39%	11%
Gadsden	62%	22%
Gilchrist	57%	17%
Glades	20%	3%
Gulf	39%	10%
Hamilton	31%	9%
Hardee	21%	6%
Hendry	47%	14%
Hernando	52%	16%
Highlands	65%	21%
Hillsborough	69%	22%
Holmes	63%	24%
Indian River	71%	27%
Jackson	55%	18%
Jefferson	68%	28%
Lafayette	41%	10%
Lake	71%	26%
Lee	67%	21%
Leon	63%	23%
Levy	46%	10%
Liberty	52%	17%
Madison	76%	32%
Manatee	50%	13%
Marion	24%	6%
Martin	43%	13%

County	Light (86°F)	Light (86°F)
Miami-Dade	39%	9%
Monroe	65%	27%
Nassau	59%	25%
Okaloosa	35%	15%
Okeechobee	69%	27%
Orange	50%	14%
Osceola	66%	25%
Palm Beach	67%	26%
Pasco	43%	12%
Pinellas	59%	20%
Polk	48%	12%
Putnam	56%	17%
Santa Rosa	39%	13%
Sarasota	59%	22%
Seminole	57%	14%
St. Johns	44%	9%
St. Lucie	76%	31%
Sumter	58%	18%
Suwannee	41%	10%
Taylor	48%	20%
Union	65%	25%
Volusia	53%	14%
Wakulla	58%	17%
Walton	44%	14%
Washington	64%	25%

Source: WeatherSTEM

Table 9: WeatherSTEM stations used for this analysis, by Florida county

County	Station
Alachua	University of Florida
Baker	Baker County High School
Bay	Deane Bozeman School
Bradford	Lawtey Elementary School
Brevard	PAC Academy
Broward	HT Birch State Park
Calhoun	Blountstown Middle School
Charlotte	Port Charlotte Middle School
Citrus	Marine Science Station
Clay	Lake Asbury Junior High
Collier	Naples Botanical Garden
Columbia	Melrose Park Elementary School
DeSoto	West Elementary School
Dixie	Dixie County High School
Duval	Jacksonville Country Day School
Escambia	West Florida High School
Flagler	Buddy Taylor Middle School
Franklin	Franklin County School
Gadsden	West Gadsden Middle School
Gilchrist	GCEM Trenton High School
Glades	Moore Haven Middle-High School
Gulf	Gulf County Emergency Operations Center
Hamilton	Hamilton County High School
Hardee	Wauchula Elementary School
Hendry	Upthegrove Elementary School
Hernando	Challenger K8 School of Science and Math
Highlands	Eagle Ranch Orange Groves
Hillsborough	Florida Learning Garden
Holmes	Holmes County High School
Indian River	Oslo Middle School
Jackson	Cottondale High School
Jefferson	Jefferson County Middle/High School
Lafayette	Lafayette High School
Lake	Mount Dora Middle School
Lee	Estero Fire Rescue
Leon	Tallahassee Community College
Levy	LCEM Williston Middle High School
Liberty	W.R. Tolar K-8 School
Madison	Agner Farm
Manatee	Manatee Technical College
Marion	Dr. N H Jones Elementary School
Martin	South Fork High School

County	Station
Miami-Dade	University of Miami
Monroe	Marathon High School
Nassau	Yulee Middle School and High School
Okaloosa	Choctawhatchee High School
Okeechobee	Central Elementary School
Orange	Rosen Centre
Osceola	Poinciana High School
Palm Beach	Addison Mizner Elementary School
Pasco	Pine View Middle School
Pinellas	Bay Point Middle School
Polk	Winston Academy of Engineering
Putnam	Putnam County Emergency Services
Santa Rosa	Woodlawn Beach Middle School
Sarasota	Ringling Museum of Art
Seminole	Heathrow Elementary School
St. Johns	Aerospace Academy at St. Augustine High School
St. Lucie	Southport Middle School
Sumter	South Sumter High School
Suwannee	Branford High School
Taylor	Big Bend Technical College
Union	Lake Butler Middle School
Volusia	Embry Riddle Aeronautical University
Wakulla	Wakulla High School
Walton	Walton County Emergency Management
Washington	Florida Panhandle Technical College

Table 10: Percentage of 3,672 data points missing, by Florida county

County	Percentage
Alachua	0%
Baker	1%
Bay	0%
Bradford	1%
Brevard	0%
Broward	0%
Calhoun	1%
Charlotte	1%
Citrus	0%
Clay	13%
Collier	0%
Columbia	0%
DeSoto	0%
Dixie	15%
Duval	0%
Escambia	0%
Flagler	0%
Franklin	0%
Gadsden	2%
Gilchrist	2%
Glades	0%
Gulf	0%
Hamilton	16%
Hardee	39%
Hendry	23%
Hernando	0%
Highlands	0%
Hillsborough	0%
Holmes	1%
Indian River	3%
Jackson	0%
Jefferson	7%
Lafayette	0%
Lake	0%
Lee	0%
Leon	1%
Levy	0%
Liberty	1%
Madison	1%
Manatee	2%
Marion	0%
Martin	0%

County	Percentage
Miami-Dade	0%
Monroe	4%
Nassau	13%
Okaloosa	30%
Okeechobee	0%
Orange	0%
Osceola	8%
Palm Beach	0%
Pasco	3%
Pinellas	0%
Polk	0%
Putnam	0%
Santa Rosa	2%
Sarasota	0%
Seminole	0%
St. Johns	0%
St. Lucie	0%
Sumter	4%
Suwannee	1%
Taylor	24%
Union	1%
Volusia	0%
Wakulla	1%
Walton	3%
Washington	0%

ENDNOTES

- ¹ National Weather Service, *Weather Fatalities*, (viewed on Oct. 17, 2018) <https://pubc.it/2z0StlD>.
- ² Centers for Disease Control and Prevention, *Heat Stress – Heat-related Illness*, (viewed on Oct. 17, 2018) <https://pubc.it/2z1MAuO>.
- ³ National Weather Service, *Children, Pets and Vehicles*, (viewed on Oct. 8, 2018), <https://bit.ly/2Mbyobw>.
- ⁴ Mayo Clinic, *Heat Exhaustion*, (viewed on Oct. 17, 2018), <https://mayocl.in/2t2xfaj>.
- ⁵ *Id.*
- ⁶ *Id.*; NoHeatStroke.org, *Heatstroke Deaths of Children in Vehicles* (viewed on Oct. 8, 2018), <https://bit.ly/2yqmlbU>.
- ⁷ American Academy of Pediatrics, *Heat Stress Tips for Young Children*, (viewed on Oct. 8, 2018), <https://bit.ly/2GifRTI>.
- ⁸ National Institute on Aging, *Hot Weather Safety for Older Adults*, (viewed on Oct. 8, 2018), <https://bit.ly/2wdPuKM>.
- ⁹ National Institutes of Health, Press Release, *Heat-Related Health Dangers for Older Adults Soar During the Summer* (Jun. 27, 2018), <https://bit.ly/2N4Gwbk>; *Heat Exhaustion*, MAYO CLINIC (viewed on Oct. 8, 2018), <https://mayocl.in/2t2xfaj>; Centers for Disease Control and Prevention, *Heat and Older Adults*, (viewed on Oct. 8, 2018), <https://bit.ly/2r8qz8e>.
- ¹⁰ Jamie Wells, *Why Florida Nursing Home Death Counts Were So High after Hurricane Irma*, AMERICAN COUNCIL ON SCIENCE AND HEALTH (Sept. 15, 2017), <https://bit.ly/2IKOCnM>.
- ¹¹ Travis Fedschun, *Florida Nursing Home Where 8 Died After Hurricane Irma Previously Cited for Generator Issues*, FOX NEWS (Sept. 18, 2017), <https://fxn.ws/2C7uwCZ>.
- ¹² *Populations of Concern*, GLOBALCHANGE.GOV (viewed on Oct. 8, 2018), <https://bit.ly/2OMkXjq>.
- ¹³ *Reproductive Health and the Workplace*, CENTERS FOR DISEASE CONTROL AND PREVENTION (viewed on Oct. 17, 2018), <https://pubc.it/2EERnbZ>.
- ¹⁴ Henry Fountain et al., *2017 Was One of the Hottest Years on Record. And That Was Without El Niño*, N.Y. TIMES, <http://pubc.it/2Bd5Pki>.
- ¹⁵ FOURTH NATIONAL CLIMATE ASSESSMENT (NCA4), VOLUME I, CLIMATE SCIENCE SPECIAL REPORT, <https://pubc.it/2yVDvE3>.
- ¹⁶ *Id.*
- ¹⁷ See Ekta Choudhary & Ambarish Vaidyanathan, *Heat Stress Illness Hospitalizations—Environmental Public Health Tracking Program*, 20 States, 2001–2010, 63 SURVEILLANCE SUMMARIES 1 (2014) <https://pubc.it/2z0552M>.
- ¹⁸ The Centers for Disease Control and Prevention, National Environmental Public Health Tracking Network, <https://ephtracking.cdc.gov/DataExplorer/#/>.
- ¹⁹ Lisa Friedman, *Trump’s Plan for Coal Emissions: Let Coal States Regulate Them*, N.Y. TIMES, Aug. 17, 2018, <https://pubc.it/2yYDLSh>.
- ²⁰ Coral Davenport, *E.P.A. Takes a Major Step to Roll Back Clean Car Rules*, N.Y. TIMES, May 31, 2018, <https://pubc.it/2yWvP4h>.
- ²¹ Lisa Friedman, *Trump Administration Formally Rolls Back Rule Aimed at Limiting Methane Pollution*, N.Y. TIMES, Sept. 18, 2018, <https://pubc.it/2yYAlldd>; Marianne Lavelle, *Trump Targets Obama’s Methane Rules in Latest Climate Policy Rollbacks*, INSIDE CLIMATE NEWS, Sept. 18, 2018, <https://pubc.it/2yVoEtb>.
- ²² See Public Citizen, *Petition to OSHA for a Heat Standard*, <https://pubc.it/2yVwumB>.
- ²³ See, e.g., NIOSH, CRITERIA FOR A RECOMMENDED STANDARD: OCCUPATIONAL EXPOSURE TO HEAT AND HOT ENVIRONMENTS 70, 104 (2016) (hereinafter NIOSH 2016 RECOMMENDATIONS).
- ²⁴ *Id.* 107.
- ²⁵ *Id.* 113.
- ²⁶ *Id.* 8–10.
- ²⁷ *Id.* viii.
- ²⁸ T. Bodin et al., *Intervention to Reduce Heat Stress and Improve Efficiency Among Sugarcane Workers in El Salvador: Phase 1*, 73 OCCUP. ENVIRON. MED. 409 (2016).
- ²⁹ NIOSH 2016 RECOMMENDATIONS 70.

³⁰ The analysis in this report uses hourly average WBGTs from WeatherSTEM, <https://pubc.it/2Sm7i1h>. In many Florida counties, WeatherSTEM has multiple stations. Where there was a choice between stations, an attempt was made to use the station that had the most complete data and was most centrally located. For a list of the stations used, see Table 9 in the Appendix.

³¹ The remaining eight counties are missing enough data points for hourly average WBGT that the absence of data, rather than low temperatures, may be the reason why they did not hit this mark. The amount of data missing for these counties ranges from 13 percent (Nassau County) to 39 percent (Hardee County). Note that detailed WBGT data of the type used in this analysis are rare. As a whole, the value of the data set easily exceeds the drawbacks of missing some entries. For the percentage of data points missing for each county, see Table 10 in the Appendix.

³² See, e.g., U.S. GOVERNMENT ACCOUNTABILITY OFFICE, REPORT TO THE RANKING MINORITY MEMBER, COMMITTEE ON GOVERNMENT REFORM, HOUSE OF REPRESENTATIVES, DECENNIAL CENSUS, LESSONS LEARNED FOR LOCATING AND COUNTING MIGRANT AND SEASONAL FARM WORKERS 4 (July 2003), <https://pubc.it/2SaSItM>. The analysis in this report uses the Census Bureau's data only to identify particular counties that may merit closer scrutiny based on the composition of their workforce. The data are likely to be adequate for that purpose so long as the undercounting of particular populations occurs roughly equally in all counties.

³³ WeatherSTEM CEO and Founder Edward Mansouri explained by email to Public Citizen that the missing data entries likely stem from a lack of maintenance at some sites. WeatherSTEM does not have the resources to maintain all of the stations itself, and some hosts are more attentive than others to ensuring that their WeatherSTEM unit has unbroken power supply and network access. For the number of entries missing for each county, see Table 10 in the Appendix.

³⁴ For example, Hendry County is missing data for 684 hours (23 percent of the total possible), and the missing entries are split almost evenly between July and for September. None are in May, the coolest month. The missing entries for Hamilton and Hardee counties also are skewed toward the warmer months, though not as dramatically.

³⁵ AW Tustin et al., *Evaluation of Occupational Exposure Limits for Heat Stress in Outdoor Workers—United States, 2011–2016*, 67 MORBIDITY & MORTALITY WEEKLY REPORT 733(2018).

³⁶ Vicki Hertzberg et al., *Novel Analytic Methods Needed or Real-Time Continuous Core Body Temperature Data*, 39 WESTERN J. NURSING RESEARCH 95 (2017).

³⁷ See, e.g., NIOSH 2016 RECOMMENDATIONS 97–98.

³⁸ J. Mix et al., *Hydration Status, Kidney Function, and Kidney Injury in Florida Agricultural Workers*, 60 J. OCCUP. & ENV. MED., e253 (2018).

³⁹ *Id.*; A.D. Mutic et al., *Classification of Heat-Related Illness Symptoms Among Florida Farmworkers*, 50 J. NURSING SCHOLARSHIP 74 (2018).

⁴⁰ The app can be accessed at <https://itunes.apple.com/us/app/osha-niosh-heat-safety-tool/id1239425102?mt=8>.