

# streamline

## Exposomic Health

### Overlapping Environmental Factors, Paired with Social Determinants like Diet and Stress, Set Up Agricultural Workers for Poor Respiratory Health – And A Whole Host of Other Health Concerns

By Claire Hutkins Seda, Associate Director of Communications, Migrant Clinicians Network

In California’s San Joaquin Valley, dangers lurk in the air. The valley, the southern half of California’s Central Valley, and an important agricultural region with billions of dollars of annual agricultural output, struggles to meet federal air quality standards, with topography, agriculture, industry, and heat each contributing to the Valley’s poor air quality. During the summers, agricultural workers may toil in the fields or orchards in extreme heat, breathing in very high ozone concentrations, wildfire smoke, dust, and other particulate matter. But San Joaquin Valley is not an anomaly – it is an agricultural harbinger. As climate change, environmental degradation, and industrial agricultural practices continue, the air quality of agricultural basins across the United States may see more extreme heat, coupled with the poor air quality days that San Joaquin already experiences frequently. The health consequences for low-income migrant and immigrant agricultural workers – who experience additional factors that increase the health risks of these exposures – are worse than for the general population. Here, the primary environmental factors that contribute to poor air quality are outlined, followed by two critical health challenges – diet and stress – that agricultural workers typically face, which further impact their respiratory health and ability to recover when exposed to a respiratory stressor like COVID-19.

#### Ozone and Particulate Matter

Ozone is created when ozone precursors like carbon monoxide, methane, and nitrogen oxide are released into the atmosphere by motor vehicles, power plants, and industrial processes. These chemicals react with solar radiation to form ozone. San Joaquin Valley has exceptionally high ozone levels.

“Ozone is one of the primary pollutants in smog in California,” explained John Balmes, MD, a physician member of the California



Photo courtesy of United Farm Workers of America (UFW)

Air Resources Board. Because of its topography, the San Joaquin Valley is particularly susceptible to air pollutants like ozone; pollutants are blown down the Central Valley and get trapped under the San Joaquin’s sunny skies. Climate change is slated to worsen ozone in the region, despite efforts in recent years to reduce it.

“Between cleaning up motor vehicles and [increasing the use of] renewable energy, there are fewer precursors for ozone,” noted Dr. Balmes. “But it’s still a problem. There’s a direct relationship between how hot it is, and how much ozone there is.” As the San Joaquin Valley gets hotter, ozone’s threat on agricultural work increases.

“It’s pretty toxic to the airways,” Dr. Balmes explained. “It chemically burns the lungs, and that can cause even healthy people to have some respiratory symptoms, especially if they’re exercising – breathing through their mouth, breathing harder, and more per minute. Construction and farm workers have the highest exposure. Even if they’re healthy, with no health conditions, they can get symptoms.” Short-term exposure to ozone can reduce lung function and

cause an inflammatory response in the airway.<sup>1</sup> Patients may experience reduction in forced expiratory volume, shortness of breath, throat irritation, coughing or wheezing, or pain, tightness, and/or burning in the chest. Reaction to exposure varies greatly; one patient may experience no symptoms or lung function changes, while another person exposed to ozone in the same concentration and time duration will experience a 50% decrement in forced expiratory volume in one second (FEV1) and significant and disruptive symptoms.<sup>2</sup>

Chronic exposure to ozone results in impaired development of lung function in children. “We worry that kids that grow up in polluted areas and have lower lung function in early adulthood are at greater risk for respiratory problems later in life,” Dr. Balmes explained. Chronic exposure to ozone, regardless of age, is linked with asthma. Those already diagnosed with asthma or other pulmonary disorders like bronchitis or emphysema are more likely to experience health effects from pollution exposure.

Air pollution in the San Joaquin Valley is not limited to ozone, however. Fine particulate matter (PM2.5), airborne particles that are 2.5 micrometers or smaller, is released into the San Joaquin air from sources like agricultural equipment, residential wood burning, and commercial charbroiling.<sup>3</sup> The Fresno region – the Valley’s largest city — is ranked as having the worst PM2.5 rates among metropolitan areas in the country.<sup>4</sup> The impact of PM2.5 exposure is similar to that of ozone, and the two have often been studied simultaneously. In 1992, the Children’s Health Study from the University

of Southern California began to track the respiratory health of children from fourth to twelfth grade, charting their health against the ozone, nitrogen dioxide, and PM2.5 levels in their neighborhood. By age 18, those children growing up in more polluted areas had underdeveloped lungs.<sup>5</sup>

Since then, the study, along with many others, has connected air pollution exposure to health consequences beyond the lungs. Contaminants, researchers found, enter the circulatory system from the lungs and have effects on the heart, brain, and metabolic system.<sup>6</sup> For example, when air quality is

poor, cardiovascular events increase, and adults are more at risk of type 1 diabetes.<sup>7</sup> Air pollution impairs white blood cells in the lungs, which reduces the body’s ability to mount an effective immune response or induces a shift in white blood cell immune responses toward allergy.<sup>8,9</sup>

**Pollution in the Age of Climate Change**

These significant health risks from PM2.5 and ozone are now being accompanied by new factors: wildfire smoke and excessive

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## Heat-Related Illness and Agricultural Workers

These excerpts are from the Heat-Related Illness Clinician’s Guide, developed jointly by Migrant Clinicians Network and Farmworker Justice. The Guide is available for download, in English and Spanish, on our website: <https://www.migrantclinician.org/resource/heat-related-illness-clinicians-guide-june-2021.html>

Agricultural workers are at significant risk for heat stress. Heat stress results when the body cannot get rid of excess heat and its core temperature rises. Heat stress may lead to more severe heat illness including heat exhaustion, heat cramps, heat stroke, and even death if left untreated. Agricultural work, which requires performing physically demanding work for long hours in hot and sometimes humid weather, places workers at high risk.

High environmental temperatures, humidity, low- or no-wind conditions, sun exposure, dehydration, and physical exertion are all risk factors for heat illness. Consuming alcohol or drinks high in caffeine – such as energy drinks – may increase the risk even further. Personal factors such as age, weight, pregnancy, physical condition, and use of certain medications may also put workers at greater risk... Serious heat illness is also more common among workers who are not accustomed to working in the heat. Approximately 50-70% of deaths attributed to outdoor heat exposure happen within the first few days of working in a warm or hot environment, due to lack of acclimatization.

Risk factors such as past episodes of heat illness and medical conditions or medications that affect the body’s heat-regulation mechanism can make workers more susceptible to the effects of heat. Therefore, ascertaining a patient’s clinical history is a key step toward identifying those at higher risk... Physiological and pharmacological risk factors [additionally are] associated with a greater risk of heat illness.

The following three tables (Tables 1-3) are taken from the Clinician’s Guide. The Guide includes additional sections on: chronic kidney disease of nontraditional origin; prevention, treatment, medical attention, and post-treatment follow-up; messaging and resources; social determinants of health; and heat-related illness and the law.

**Table 1. Types of heat illness and their symptoms**

Heat stress	Heat exhaustion	Heat cramps	Heat stroke
<ul style="list-style-type: none"> <li>• Feeling of discomfort</li> <li>• Physiologic strain (indicated by increases in core temperature and heart rate in response to heat strain)</li> </ul>	<ul style="list-style-type: none"> <li>• Rapid heartbeat</li> <li>• Heavy sweating</li> <li>• Extreme weakness or fatigue</li> <li>• Dizziness</li> <li>• Nausea, vomiting</li> <li>• Irritability</li> <li>• Fast, shallow breathing</li> <li>• Slightly elevated body temperature</li> </ul>	<ul style="list-style-type: none"> <li>• Muscle cramps, pain, or spasms in the abdomen, arms or legs</li> </ul>	<ul style="list-style-type: none"> <li>• High body temperature</li> <li>• Confusion</li> <li>• Loss of coordination (ataxia)</li> <li>• Hot, dry skin or profuse sweating</li> <li>• Throbbing headache</li> <li>• Seizures, coma</li> </ul>

Sources: Jardine DS. Heat illness and heat stroke. *Pediatr Rev.* 2007 Jul;28(7):249-58. doi: 10.1542/pir.28-7-249. Erratum in: *Pediatr Rev.* 2007 Dec;28(12):469 and National Institute for Occupational Safety and Health. (2010). NIOSH Fast Facts: Protecting Yourself from Heat Stress. (DHHS (NIOSH) Publication No. 2010-114). <https://www.cdc.gov/niosh/docs/2010-114/pdfs/2010-114.pdf>.

**Table 2. Health conditions and individual factors that may increase workers’ risk of heat-related illness**

- Advanced age
- Altered cytokine production
- Cardiovascular disease
- Diabetes
- Hypohidrosis
- Kidney disease
- Low physical fitness
- Lung disease
- Malignant hyperthermia
- Overweight/obesity
- Pregnancy
- Previous episodes of heat illness
- Recent fever, diarrhea, cold
- Sickle cell trait
- Small body size
- Sunburn
- Sympathectomy
- Type II fiber predominance

Sources: Westwood CS, Fallowfield JL, Delves SK, Nunns M, Ogden HB, Layden JD. Individual risk factors associated with exertional heat illness: A systematic review. *Exp Physiol.* 2021 Jan;106(1):191-199. doi: 10.1113/EP088458. Epub 2020 May 8. Lundgren K, Kuklane K, Gao C, Holmér I. Effects of heat stress on working populations when facing climate change. *Ind Health.* 2013;51(1):3-15. doi: 10.2486/indhealth.2012-0089.

**Table 3. Medications/drugs that may increase workers’ risk of heat-related illness**

- Alcohol
- Alpha-adrenergic agonists
- Amphetamines
- Anticholinergics
- Antihistamines
- Benzodiazepines
- Vasoconstrictors including migraine and allergy medications
- Antipsychotic Drugs (ACDs)
- Beta blockers
- Calcium channel blockers
- Cocaine
- Diuretics
- Ephedra-containing supplements
- Laxatives
- Selective Serotonin Reuptake Inhibitors (SSRIs)
- Neuroleptics
- Phenothiazines
- Stimulants
- Thyroid receptor agonists
- Tricyclic antidepressants
- Serotonin Norepinephrine Reuptake Inhibitors (SNRIs)

This list of medications is not exhaustive. Certain medications in combination may also increase risk. See Resources for more information. Source: Becker JA, Stewart LK. Heat-related illness. *Am Fam Physician.* 2011 Jun 1;83(11):1325-30. Serani D. Heat intolerance and psychiatric medications. *Psychology Today.* 27 July 2021.

heat. California is rapidly changing, as climate change drives drier conditions, prolonged droughts, and unprecedented heat, with both higher temperatures and longer duration of heat waves.

The pollutants in wildfire smoke are dangerous, but the specific long-term consequences of repeated exposure that agricultural worker families are now experiencing every year in San Joaquin Valley have yet to be quantified. “Young children who experience, every year, a fire season – there’s a concern, but no evidence at this point, that they are at greater risk for respiratory problems later. We just don’t know yet, for wildfire smoke,” Dr. Balmes said. But the data are accumulating. A 2021 study determined that wildfire smoke increased the risk of preterm birth in California.<sup>10</sup> Other studies point to increased risk of respiratory, mental, and perinatal health concerns, and possible cardiovascular consequences as well.<sup>11-14</sup> Premature mortality resulting from wildfires is only expected to grow as the climate crisis progresses.<sup>15</sup> The climate crisis is expected to increase the number of wildfire-related smoke days in the US, particularly in the West and Great Plains.<sup>16</sup> When a new respiratory disease arrived – COVID-19 – those exposed to wildfire smoke were predisposed to poorer outcomes. A 2021 study found that there were an estimated 20,000 additional COVID-19 infections and 750 COVID-19 deaths associated with exposure to wildfire smoke in the West in 2020.<sup>17</sup>

Heat is also on the rise due to the climate crisis, which in turn exacerbates the pollution crisis. Extreme heat days are associated with high ozone. Ozone production accelerates at high temperatures, and in the Valley, extreme temperature days are frequently associated with high air pressure and no wind, which prevents air pollution from being swept out of the Valley. Already, the San Joaquin Valley experiences more heat than in the past. In 2021, Fresno experienced 69 summer days above 100 degrees – a stark difference than the average of 10.3 days above 100 for the Valley, between 1961 and 1990.<sup>18,19</sup> And its heat is projected to significantly worsen. Its four to five average extreme-heat days – those over 104 degrees – will increase to 18 to 28 days by mid-century.<sup>20</sup> (See sidebar on heat-related illness.)

### **Agricultural Workers Struggle to Avoid Exposure**

The impact of pollution and heat combined

are not evenly felt across the San Joaquin Valley. Agricultural workers are particularly at risk for adverse effects of these exposures due to their workplace and lifestyle. Most farmworkers in San Joaquin Valley are routinely exposed to ozone, extreme heat, and PM2.5 while working outdoors, often completing high-exertion tasks while growing, harvesting, and packing fruits, vegetables, and nuts, which increases their susceptibility to the adverse effects of heat, ozone, and PM2.5 exposure.

Regulations to limit these exposures in California have had mixed results. California law requires employers to provide water, rest, and shade for agricultural workers in high-heat environments, but workers who are paid piece rate may find these breaks hard to take as they result in lost income (although, in California, mandated rest breaks must be compensated<sup>21</sup>). Some have complained that water and shade are provided too far from the area in which they are working to be effective. Additionally, agricultural workers often come to work already dehydrated, compounding the stress on their bodies.<sup>22</sup> (See sidebar on an analysis of California’s heat regulation.) California’s 2019 emergency regulation to protect agricultural workers from wildfire smoke requires employers to provide N95 masks on poor air quality days. This regulation may be at odds with the realities of farm work; many agricultural workers may decide to forgo respiratory protection even in heavy smoke. Many workers find high-exertion work difficult while wearing a fitted respirator properly for hours at a time.<sup>23</sup> Under the regulation, outdoor work must be suspended entirely when air quality dips into “hazardous” conditions, in which PM2.5 registers between 301 and 500 parts per million, but such a loss of income, even for one day, may cause severe financial strain. Agricultural workers often struggle to afford basic needs like housing and food, as most live in poverty and from paycheck to paycheck. What’s more, agricultural workers, due to poverty, immigration status, and language differences, may not want to voice concern over hazardous conditions that are regulated in California. Others wish to continue working, despite the health risks.

Exposures to heat and pollution do not end when workers leave the fields. Agricultural workers frequently live in sub-standard, poorly insulated housing without air conditioning or air filtration. This results

in ongoing exposure to heat and pollution, even when sleeping at night. Ozone levels drop and wildfire smoke plumes sometimes shift when the sun sets, but pollution often continues at unhealthy levels at night, and temperatures in the San Joaquin Valley remain elevated even at night.

These social determinants place agricultural workers in positions that result in the inability to avoid exposure. Consequently, an agricultural worker’s body is constantly under stress from these physical exposures to PM2.5, ozone, wildfire smoke, and heat.

### **Exposomic Health: Taking All Exposures, Including Social Determinants of Diet and Stress, Together**

The body’s stress from these external factors is enhanced by yet more damaging exposures including psychosocial stress, says Dr. Balmes. For example, experiencing racism raises baseline stress levels, which reduces the body’s ability to ward off the health consequences of physical stress-inducing exposures. “You can measure biomarkers of stress in people who experience racial discrimination, and you can see how air pollution affects those who experience it, versus those who don’t. Psychosocial and physical exposures – they’re synergistic,” Dr. Balmes noted. Baseline stress is also elevated by continuous concerns over finances. Consequently, low-income people of color like most agricultural workers have increased susceptibility to respiratory distress because of the body’s persistent state of stress.<sup>24</sup>

Poor nutrition among agricultural workers further reduces the body’s ability to repair itself in the face of air pollutants. Agricultural workers suffer more than the general population from diet-related chronic health outcomes like obesity and elevated cholesterol. These health incidences point to diets low in antioxidant-rich fruits and vegetables. In addition to fending off these chronic health conditions, fruits and vegetables improve respiratory health. “Antioxidants actually protect the airways from being burned” by ozone and other pollutants, explained Dr. Balmes. Air pollution like ozone contains oxidants that create free radicals that injure respiratory tract cells, causing burns and inflammation. Inflamed and damaged lungs, in turn, are more susceptible to infection. “Antioxidants do exactly as they sound –

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they act against the oxidants.”

Scientists are just beginning to uncover the linkages between exposures and mechanisms like diet and stress that, over the course of a lifetime, lead to poor respiratory health. An “exposomic” approach takes into account all of these environmental, physical, social, nutritional, and psychosocial aspects of an agricultural worker’s life. As expected, it’s complicated. “Multiple pathways with complex interdependencies must be considered when examining the integrative influence of social, chemical, and physical environmental factors on respiratory disease,” notes a February 2023 journal article on advancing exposomic research in respiratory disease.<sup>25</sup> Yet, these overlapping factors help clinicians tease out how agricultural workers are predisposed to poor health and premature death.

### Solutions At Hand

Clinicians, including community health workers and outreach workers, have a significant role in pursuing and promoting solutions to the exposures that affect agricultural workers’ respiratory health.

Within the community, clinicians can design culturally contextual education to help agricultural worker communities understand the risks they take at work and the rights they have to protect their health. Training on practical approaches, from respirator wearing, to nutrition, to home ventilation, is key to

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### Practical Considerations on Agricultural Worker Exposure to Respiratory Risks

N95 respirators during smoky days are difficult to tolerate when exerting one’s self. Encourage agricultural workers to use N95 respirators with an external valve, which may make heavy breathing more comfortable. The external valves are inappropriate for a clinical setting, or anywhere where COVID-19 spread is a concern, but work well in an outdoor setting when the goal is to reduce exposure to air pollution.

Air purifiers are expensive. Some air quality districts, including in San Joaquin Valley, offer programs to provide free or reduced cost air purifiers. Another option, says Dr. Balmes, is to secure a MERV-13 air filter over a box filter – likely less effective than an air purifier, but an inexpensive and effective alternative. One design, the Corsi-Rosenthal Box, utilizes 4 filters.<sup>27,28</sup>



Photo courtesy of United Farm Workers of America (UFW)

## California’s Heat Standard as a Model for the Nation

Only five states have regulations to protect workers from heat stress: California, Washington, Colorado, Minnesota, and Oregon. Additionally, heat stress regulations are being considered in Arizona, New York, Maine, and Maryland. Simultaneously, the movement for a national heat standard has gained momentum. In August 2022, the Natural Resources Defense Council released a report analyzing California employer adherence and the overall effectiveness of the rule, which in turn can inform the development and enforcement of a national regulation. Their key findings:

- Workers in agriculture are affected by heat-related illness and injury more than workers in any other industry. However, heat affects workers across multiple occupations in outdoor settings and indoor environments without adequate cooling, such as construction, outdoor maintenance (e.g., landscaping), indoor maintenance (e.g., pest control), security and parking services, warehouses, and bus and delivery services.
- Many heat penalties imposed on employers by California’s Division of Occupational Safety and Health (known as Cal/OSHA) stem from complaint-initiated inspections rather than routine inspections.
- Businesses that violate California’s heat illness prevention standard commonly do so more than once.
- Cal/OSHA routinely reduces penalties imposed on employers for violating the heat standard.
- Employers provide inadequate worker training on how to avoid heat-related injuries and illnesses.
- Worker experiences with the California heat standard greatly differ, with vulnerable worker populations such as day laborers and car wash workers bearing the brunt of employer inaction.<sup>29</sup>

Their key recommendations include:

- Increase funding and recruitment so Cal/OSHA can hire more staff and bilingual inspectors.
- Include more detail in the standard about how employers should provide potentially life-saving elements such as water, rest, shade, and training.
- Better protect workers who report unsafe conditions from retaliation by employers.
- Revise Cal/OSHA’s current citation-reduction policies.<sup>30</sup>

The report summary concludes, “Overall, the California standard is a good model for OSHA and other states to look to when developing their own heat standard but there is still much room for improvement in how the standard is written and enforced.”

Read the complete report, entitled “Feeling the Heat: How California’s Workplace Heat Standards Can Inform Stronger Protections Nationwide,” at the NRDC website: <https://www.nrdc.org/resources/feeling-heat-how-californias-workplace-heat-standards-can-inform-stronger-protections>

helping agricultural workers reduce their pre-existing health risks before the next climate-induced heat wave, wildfire, and/or air pollution event. (See sidebar on Practical Considerations for some ideas.) As climate change progresses, ongoing relationships with agricultural worker communities are essential to ensure that trust and communication are high between the clinic and the agricultural worker community to build community mobilization and inclusion before a climate-fueled disaster strikes.<sup>26</sup>

At the clinic, a greater focus on reducing health disparities and addressing the social

determinants of health may mean more emphasis on warm hand-offs to social workers, nutritionists, educators, and others who focus on reducing disparities.

At the state and federal level, clinicians can loudly voice the need for strong protections from heat and air pollutants, the need for improved management of forests to reduce the likelihood of megafires, and for bold and urgent action to reduce greenhouse gases. Migrant Clinicians Network regularly participates in these advocacy efforts and invites clinicians to join. Clinicians, as trusted members of the local

medical community, can assist by providing context and understanding of the significant and worsening local health consequences of this global phenomenon. ■

**Resources:**

Ventilation as an Essential Control Strategy to Avoid Contagion, by Migrant Clinicians Network with support from National Resource Center for Refugees, Immigrants, and Migrants (NRC-RIM): <https://www.migrantclinician.org/resource/ventilation-essential-control-strategy-avoid-contagion.html>

The Western States Pediatric Environmental Health Specialty Unit (PEHSU) has a website with resources for clinicians: <https://wspehsu.ucsf.edu>

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# The Implications of Slow Disaster Recovery on the Mental Health of Children of Agricultural Workers and the Surrounding Community

By Marysel Pagán Santana, DrPH, MS

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**P**ublic health emergencies and natural disasters cause significant disruptions to our daily lives and quality of life. Compound emergencies — experiencing more than one emergency at a time — or consecutive ones can cause significant alterations of our environments, routines, and lifestyles, from which one cannot easily recover. Although these environmental stressors impact everyone in a community after a disaster, the impact is not of equal magnitude for everyone. Among the populations that exhibit the most vulnerability to disasters are children and low-income individuals.

In rural Puerto Rico, these vulnerability factors converge among the children of low-income agricultural workers. This territory of the United States has been impacted by intense and catastrophic natural disasters in recent years, including Hurricane Maria (2017), the Southwest earthquakes (2019), and Hurricane Fiona (2022). The recovery and response phases of these events also coincided with the emergence of the COVID-19 pandemic in 2020. The burdens that these stressors have on the community may be exacerbated by the absence of protective factors such as a healthy school envi-

ronment, particularly for children in rural farming communities whose families experienced lost income and additional exposures due to the nature of their work.

Migrant Clinicians Network carried out a research project to explore the impact that these disasters have had on the health of children of agricultural workers in Castañer, a small town in Puerto Rico. This isolated mountainous farming community is located in the west-central region of Puerto Rico between the municipalities of Yauco, Lares,

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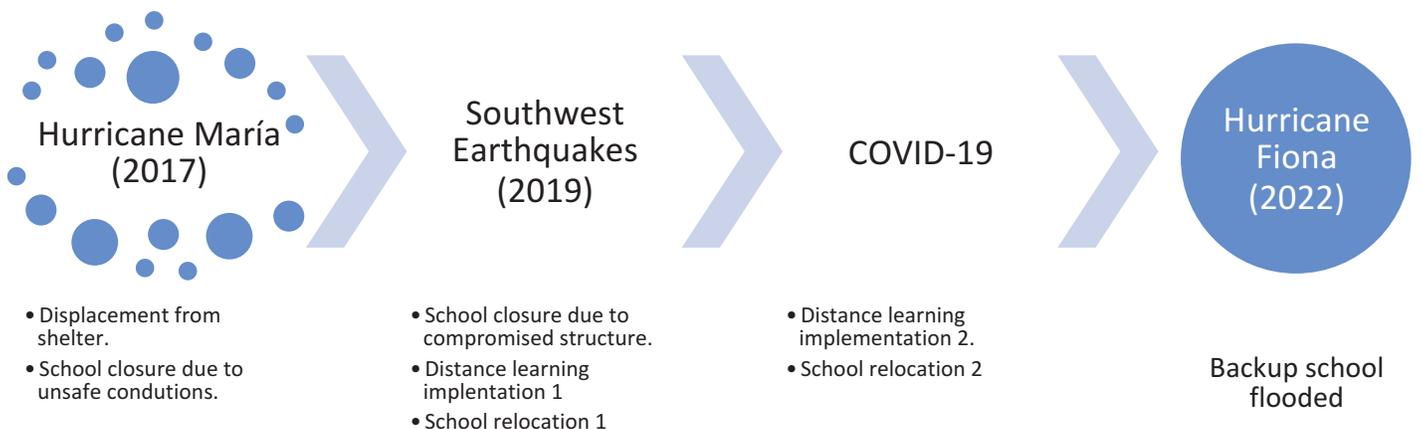
Adjuntas, and Maricao. The region is a key agricultural area due to a large amount of arable land and crops of different products including oranges, coffee, bananas, plantains, and various root vegetables. In this region there are many small family farms or “fincas” and often the whole family, including the children, participates in some way in their productivity.<sup>1</sup> Castañer, Puerto Rico, is part of an agricultural region that has been greatly impacted by natural and public health disasters. The region, with more than half of the population below the federal poverty level, is one of the poorest areas in Puerto Rico.<sup>1</sup> During and after these events, these farming families have been affected due to substantial crop loss, destroyed or damaged homes, lack of resources, food insecurity, and interrupted education.

This region has faced the closure or relocation of schools, which reduces immediate access to education and other associated services such as meals.<sup>1</sup> The remaining schools have suffered direct or indirect impacts from all these emergencies. Among the results obtained in the processes of focus groups and interviews, what was experienced by a particular community and its educational infrastructure, in this case, an elementary school, stood out. Physical damage to the campus dates to 2017, when flooding due to the copious rains from Hurricane Maria destroyed its security fence (Figure 1). Some of the students themselves were refugees at the time the school flooded, having to be rescued from what was once considered their safe haven. The damage caused the return of students to the classroom to be delayed until a preventive fence was placed to provide some type of security. Then in 2019, the school’s infrastructure was compromised by the earthquakes in the south, being temporarily closed. The school was relocated to another

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Figure 1. Timeline of events and related impacts





# Emerging Concerns About Pesticides and Agricultural Worker Health

By Claire Hutkins Seda, Associate Director of Communications, Migrant Clinicians Network

Numerous classes of pesticides have been found to have significant acute and chronic consequences for the agricultural workers and their families who are exposed to them. Exposure comes in many forms: pesticide applicators may be exposed when mixing or applying pesticides; agricultural workers are exposed to residues of the chemicals when growing or harvesting; family members may be exposed from workers' clothing or shoes; anyone in rural communities may be exposed to pesticide drift. Clinicians serving those at highest risk for exposure may find the following updates helpful.

## Link Between Non-Hodgkin Lymphoma and Exposure to Glyphosate

Glyphosate, the active ingredient in the Monsanto-owned herbicide RoundUp™, is widely used in gardens and fields across the United States. While the Environmental Protection Agency as recently as 2020, determined that glyphosate poses no risk of concern to human health when used in accordance with labels, the World Health Organization has determined otherwise, listing glyphosate as "probably carcinogenic," since 2015.<sup>1,2</sup> Specifically, the WHO highlighted a positive association between glyphosate exposure and non-Hodgkin lymphoma.

A January 2023, study published in the Journal of the National Cancer Institute may provide some insight to the link. The study measured glyphosate levels in the urine of farmers and others at elevated risk of exposure and found that higher concentrations of

the pesticide in urine were associated with higher biomarkers of oxidative stress, a key characteristic of carcinogens.<sup>3</sup>

Worker advocates from the Legal Aid Justice Center, The Lawyers Committee for Civil Rights Under Law, and Public Citizen are informing agricultural workers, landscapers, and gardeners who have been exposed to RoundUp™ and developed non-Hodgkin lymphoma about their right to join a lawsuit to help them recoup medical costs. The coalition of advocates is currently suing Bayer, which acquired Monsanto in 2018, for excluding a non-United States citizen agricultural worker from its settlement program due to her citizenship status.<sup>4</sup> Kathryn Youker, with the Lawyers' Committee for Civil Rights, encourages clinicians to support patients with non-Hodgkin lymphoma by connecting them to legal resources.

"Farmworkers, landscapers, and gardeners are at high risk of exposure to this herbicide and often face myriad barriers to medical treatment and access to justice," said Youker. "We hope that allies in the medical community will help patients overcome some of these barriers by discussing the possible link between NHL and environmental exposure in exam rooms and during community outreach and referring them to our non-profit coalition to learn about their rights."

Access flyers in English and Spanish: <https://link.edgepilot.com/s/8f6955b7/MPkRxn4zBUWANjjoBApApQ?u=https://bit.ly/3XnHN09>

Learn more: <https://www.lawyerscommittee.org/lawyers-committee-files->

[lawsuit-against-bayer-monsanto-for-violating-civil-rights-statute/](#)

## New Report Shows Pesticide Health Concerns Amplified Due to Climate Change

In January, the Pesticide Action Network of North America (PANNA) published, "Pesticides and Climate Change: A Vicious Cycle." The report outlines the two-way relationship between pesticides and climate change.

"Climate change impacts us all," noted Margaret Reeves, PhD, Senior Scientist of Environmental Health and Workers' Rights at PANNA. "It affects us in many ways, including exacerbating the impacts of pesticides on workers. This report explains why we expect even worse health outcomes as climate change progresses."

Pesticides contribute to climate change throughout their lifecycles. The report discusses the climate impacts at each step, through pesticide manufacturing, packaging, transportation, application, degradation after application, and disposal. Further, climate change is predicted to increase the use of pesticides, as the impacts of unpredictable weather, including increased pest and weed pressure, will likely lead to a heavier reliance on chemical agents to maintain crop production under the industrial model. For example, climate change is expected to increase soil temperatures, which precipitates faster degradation of herbicides, which may lead to an increased use of herbicides for weed control. This, in turn, raises the risk of exposure for the agricultural workers in those fields. Thus, the report displays an

industrial agricultural system stuck in a “vicious cycle of ecosystem destruction.”

While the report focuses on the environmental impacts of pesticide use in a changing climate, several key predicted outcomes have significant impact on agricultural worker health. Agricultural workers and rural communities will face greater exposure to pesticides while also contending with longer and hotter heat waves, wildfire smoke, and other climate-related weather extremes and exposures. As climate change progresses and pesticide use increases, clinicians need to be aware of the compounding health impacts from these exposures. Indeed, agricultural pesticides are an air pollutant on their own; fumigant pesticides, and some non-fumigant pesticides, volatilize into gases that react with nitrogen oxides and UV rays to produce ozone, which can increase agricultural worker exposure to ozone, which presents a significant risk to agricultural worker health. (See “Exposomic Health,” in this issue, for more on the link between ozone and agricultural worker health.)

The report emphasizes the importance of the widespread implementation of agroecological farming methods that reduce or eliminate synthetic pesticide use while also leading to more climate-resilient soils and crops. Such adaptations, Reeves says, can benefit agricultural worker health in multiple ways. Many agricultural workers' families, for example, are unable to provide healthy meals for their families, despite their work in producing and harvesting the ingredients for healthy meals, like fruits and vegetables. Clinicians, she says, can promote healthy growing practices to reduce exposure to pesticides while increasing access to nutritious foods. “You see examples of farmworker communities [implementing] sustainable organic agroecology projects in their home gardens. They can produce their own food and do so without pesticides – and there are many health benefits,” she noted. Reeves pointed to the community gardens in the Farmworker Association of Florida’s Agroecology program as a model. “Farmworkers have the solutions, and they’re creating [them] in their own communities,” Reeves said.

Read the entire PANNA report: <https://www.panna.org/resources/pesticides-and-climate-change-vicious-cycle-report>

Learn about Farmworker Association of Florida’s Agroecology program, which focuses on some of the solutions that the report outlines: <https://floridafarmworkers.org/our-impact/agroecology/>

### Updated Cholinesterase Testing Protocols

Pesticide handlers have increased risk of exposure during mixing and application.



Cholinesterase is a protein within the nervous system. Organophosphate and carbamate pesticides inhibit cholinesterase levels. To determine the level of exposure, cholinesterase monitoring is advised; indeed, it is required in several states. Because cholinesterase levels are highly individual, baseline readings are needed before exposure. Clinicians must also follow protocol on post-exposure testing, medical removal from handling, and return to handling. To guide clinicians through this process, Migrant Clinicians Network, National Farm Medicine Center, and AgriSafe Network have updated and re-released their Cholinesterase Testing Protocols for Healthcare Providers and Cholinesterase Testing Protocol Algorithm.

Access the updated cholinesterase testing protocol and algorithm in English and Spanish: <https://www.migrantclinician.org/resource/cholinesterase-che-testing-protocols-and-algorithm-healthcare-providers.html>

Consult the Pesticide Exposure Reporting and Workers’ Compensation Map, MCN’s popular pesticide comic books in Spanish, and additional pesticide clinical tools and resources on MCN’s Pesticide page: <https://www.migrantclinician.org/explore-environmental-justice-and-worker-health/pesticides.html>

Find MCN’s Pesticide Exposure Clinical Guidelines and Assessment Form, in English and Spanish: <https://www.migrantclinician.org/resource/mcn-pesticide-exposure-clinical-guidelines-and-assessment-form.html>

Access MCN’s Environmental/Occupational Health Screening Questions, in English

and Spanish, and available in EHR format: <https://www.migrantclinician.org/toolsource/resource/eoh-screening-questions-primary-care.html>

MCN recommends EPA’s comprehensive manual for health care providers on toxicology, diagnosis, and pesticide treatment, Recognition and Management of Pesticide Poisonings Manual: 6th Edition: <https://www.epa.gov/pesticide-worker-safety/recognition-and-management-pesticide-poisonings>

Learn more about recognition and treatment of pesticide exposure on MCN’s archived webinar, “Pesticide Poisonings: Are You Prepared?”: <https://www.migrantclinician.org/webinar/pesticide-poisonings-are-you-prepared-2017-04-20.html>

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## A Health Network Case Study



*One type of fixator on a tibia fracture.*

# Fractured Tibia, Fractured Care

By Robert Kinnaird, Communications Project Coordinator, Migrant Clinicians Network

**A** compression break on a tibia can be a painful experience from which it is difficult to heal. Such a severe injury can cause extreme pain for a significant period of time, and patients often need consistent care – care which is near impossible to find while migrating. Ramona\*, a woman in her early 30s from Central America, was enrolled in Health Network by a shelter on the US-Mexico border for a painful tibia fracture, which she sustained while crossing the US-Mexico border in search of asylum. At the time of enrollment, Ramona had already sought care at the border. Her initial treatment was provided by a team of orthopedic surgeons in Texas, who fitted her with an external fixator. The fixator is a brace that is applied externally to keep the fractured bone stabilized and in alignment. She was on her way to family in the mid-Atlantic region, so her clinician enrolled her in Health Network, Migrant Clinicians Network's virtual case management program, to connect her with care on the East Coast.

Nestor Reyes, Health Network Associate, was assigned her case. Reyes began by working to find her a primary care provider, after which he would find her the specialty care she needed for her tibia. This would entail numerous calls to community health centers near her new home, trying to find a center that would accept her despite her low income and immigration status, and gathering and transferring medical records from the border. Ramona's care had several complicating factors. Such fractures are difficult to heal and take significant time, and

patients often need to take medication like anti-coagulants or antibiotics to prevent pin-point infections. Consistent care is important with cases like Ramona's. However, complications around transfer of care and records created an especially challenging situation for Ramona, including struggles to get her past medical records in order to forward them, and related challenges for Ramona's clinicians to pick up her care where her previous clinicians left off.

She was seen at a hospital near her family, complaining of pain from her external fixator. At this point, Ramona's fixator had been in place for four months. This is typically on the lower end of what an orthopedic specialist may consider enough time with a fixator before the device can be removed and the healing can be completed with a standard cast. Because of this, there was some question of whether it should be removed yet, or if there was anything that could be done to reduce the pain from the contraption. It would not be unusual for a doctor to decide that the fixator needed to remain for another four months, but usually patients work with the same team or trusted colleagues from the time the fixator is applied to when it is removed. Ramona's interrupted care because of migration is far from common.

Ramona's clinicians on the East Coast felt unprepared to remove her external fixator, and the team of physicians that handled her initial case had to meet to discuss the possibility of removing it and the time frame in which that needed to occur. The case was not just frustrating for Ramona, but for Reyes and

the doctors as well. After a lengthy period of debate and communication between her, Reyes, and the various doctors she had seen, she decided on her own to return to Texas to have the original team remove the fixator.

For her, this meant a harrowing journey of well over 20 hours on the road, all while dealing with the severe pain she initially complained to her mid-Atlantic medical team about. She was finally able to have the fixator removed in the border state where she entered the US, so she could continue her healing in a more traditional cast.

After Ramona returned to the East Coast with the fixator removed, Reyes stepped in once more to assist her in scheduling follow-up appointments and connecting Ramona to needed physical therapy. With no income and little support, Ramona continues to struggle to get to her follow-up appointments. Reyes has contacted many health centers and clinics to find assistance, but transportation is still a primary issue. As with many Health Network patients, overlapping barriers to care result in many hours of work for Health Network Associates, and, sometimes, the support they need is unavailable locally. Reyes will continue to support Ramona as best as he can until she completes treatment for her tibia break, or until Ramona confirms she no longer needs assistance. ■

*Learn more about Health Network and how to enroll migrant patients:*  
<https://www.migrantclinician.org/our-work/health-network.html>

\* Name and geographic details are changed or anonymized for the protection of the patient's identity.

school with which it shares facilities. This requires students to travel twice as far to get to their schools and doubles the overall hours the student spends in school-related activities, leaving almost no time for extracurricular or recreational activities. When looking at the impact of these events, it is important to see beyond the damaged infrastructure. Although this may be the obvious result of an emergency, the social and emotional health implications that these events and decisions had on the children of this community, most of whom are children of farmers, are substantial.

Our research included focus groups with parents and teachers in the community and interviews with school administrators. We also interviewed personnel from Hospital General Castañer, a community health center that provides outreach and education to their community. The results of these interactions were not encouraging, since we observed a community emotionally and physically affected by a lack of resources and quick response to facilitate the return to what represents more than an educational center. The role of a school in such rural, isolated, and low-income communities goes beyond providing education in math or history. These schools are the central piece of community engagement. During an emergency, they often serve as shelters, and school personnel facilitate emergency response and recovery.

The effect of flooding on students' emotional health is still being observed by teachers, who report having to intervene to calm students at times when it starts to rain during the school day. All participants expressed a sense of loss and community disconnection after the school relocation. The faculty and students were located, and continue to be located, in a community that is not their own, and the school to which they have been relocated has its own post-disaster health concerns including mold and poor ventilation. One of the difficulties that arose most often within the community was the need for more resources to attend to emotional and behavioral health. After a disaster, communities often rely on these resources to provide outlets of emotion and community strengthening activities. The school's gym and theater were both damaged by flooding; no new outlets were developed. Under the current conditions, the school lacks any resources to attend to the emotional and behavioral health concerns that they observe. In the case of the regions of Puerto Rico where farm families are located, not addressing these issues can deepen the social and economic immobility of this population. Similarly, as a social determinant of health, an unhealthy school environment



*It is important that as programs get developed to attend to the health of children after disasters, the key elements for healthy school environments are present, including immediate school recovery, as schools are the center of community resilience.*

will also deepen the health inequities we see today. However, the community has engaged in some protective activities after their disasters. Participating in cleanup and providing opportunities for students to catch up through dedicated class time are two ways the community has shown their sense of ownership to the land and their commitment to the students, both of which can build resilience and connection.

It is important that as programs get developed to attend to the health of children after disasters, the key elements for healthy school environments are present, including immediate school recovery, as schools are

the center of community resilience. MCN will continue to work with the schools to connect them with our partners and resources to support them in improving the health and safety of their current school environment and advocating for their return to their community school once it is safe.

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## calendar

**31st Annual Midwest Stream Forum for Agricultural Worker Health**

April 24 - 26, 2023

Austin, TX

<http://www.ncfh.org/midwest-stream-forum.html>

**Atendiendo la violencia de género en espacios de atención a la salud: Experiencia de personas migrantes en Puerto Rico**

Begins April 12, 2023

MCN Four-Part Virtual Webinar Series

<https://www.migrantclinician.org/webinars/upcoming>

**2023 Conference for Agricultural Worker Health**

May 2 - 4, 2023

Seattle, WA

<https://www.nachc.org/conferences/agricultural-worker-health/>

**Health Network: A Care Coordination Program for Mobile Patients**

MCN Virtual Webinar

May 4, 2023

<https://www.migrantclinician.org/webinars/upcoming>

**2023 National School-Based Health Care Conference**

June 26 - 28, 2023

Washington, DC

<https://www.sbh4all.org/2023-national-conference-registration/>

**2023 Pre-Health Dreamers' Annual Conference**

July 13, 2023

Los Angeles, CA

<https://www.phdreamers.org/conference-info>

**2023 North American Refugee Health Conference**

July 21 - 23, 2023

Calgary, AB, Canada

<https://refugeesociety.org/narhc-conference/>