

# The Increasing Burden of Heat Related Illness in Texas Prisons

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## Abstract

This paper demonstrates that deaths due to extreme heat exposure is an underreported public health issue in Texas prisons, and should be treated as a public health crisis. The evidence suggests that temperature increase due to climate change in the coming decades will lead to an increase in mortality of up to 116,000 deaths in Texas prisons by the end of the 21st century. To estimate the burden of mortality due to heat, a decade of prisoner death records from the Texas Justice Initiative were analyzed in conjunction with climate data from the National Oceanic and Atmospheric Administration. In this analysis, mortality due to cardiovascular disease is used as a proxy measure to estimate deaths due to heat. Mortality due to cardiovascular disease trends upwards in the analyzed decade: based on this trend and the following analysis, mortality rate due to heat is on track to reach 22.8 deaths per 1000 prisoners in Texas by the end of 2020.

Prisoner health is an emerging topic within public health, and its relationship with climate change is discussed sparingly in the literature. I reported on this gap through the “Union of Concerned Scientists” online publication. My critique of federal prison data collection systems elicited a response from the Bureau of Justice Statistics. They highlighted a lack of resources as a barrier to obtaining the data needed to understand heat related mortality in prisons. My review of prison conditions reveals labor and medical practices which amplify heat susceptibility. These conditions reveal potential improvements the Texas Department of Criminal Justice can make to protect prisoners.

## Background

The current standard of sociomedical research suggests that the physical, social, and medical structure of prisons lead to poor health outcomes more frequently for prisoners compared to the noninstitutionalized.<sup>1</sup> As people in the care of the state, the health outcomes of prisoners are dependent on state and federal policies for medical care, climate control, and programs for mental wellbeing. In Texas, the quality of the state's wardenship of for its 246,000 prisoners is questionable (almost 75% of prisons do not have air conditioning in prisoner housing areas).<sup>2,3</sup> This lack of adequate environmental control was the focus of a US District Court lawsuit in Houston: *Cole v. Collier*.<sup>4</sup> Based on the findings that at least 23 prisoners in Rashoron, Texas had died due to extreme heat exposure, Judge Keith Ellison ordered an injunction in July 2017 mandating Texas prisons install air conditioning for higher risk inmates and develop a plan of action for the predicted increase in heat wave frequency and intensity.<sup>5</sup>

### *Extreme Heat and the Physiological Response*

Due to the global phenomena of climate change, more heat waves of increasing frequency are expected in Texas.<sup>6</sup> The American Climate Prospectus projects that Texas's yearly average temperature will increase by 20% over the next decades, jumping from between 66- and 72- degrees Fahrenheit before 2015 to 84.2 degrees Fahrenheit by 2039, and 90 degrees Fahrenheit by 2099.<sup>6,7</sup>

To deal with this kind of heat, the body relies on the blood vessels to vasodilate, or widen so more blood can flow under the skin and transfer heat to the atmosphere by radiation. We also sweat - the water evaporating off our skin carries heat away from the body. Vasodilation depends on the central nervous system to respond to heat stimuli, and sweat relies on a relatively dry environment . In an environment with more than 60% relative humidity at 86 degrees Fahrenheit, sweat will not evaporate, so the body cannot pass off heat to the atmosphere (see Figure 1 in the Appendix for information on harmful temperature and humidity).<sup>8</sup>

In extreme heat exposure situations, the heart cannot pump blood fast enough to dissipate heat. This cardiac stress causes a buildup of heat in the body. Extreme heat can also dehydrate a person by drawing out too much sweat, depleting the body of water and salt. An extremely dehydrated person will eventually stop sweating to conserve fluids, so dry skin is a crucial sign of overheating.

This high demand on the body's thermoregulation causes four of heat illnesses: syncope, cramps, exhaustion, and stroke (See appendix for a causal pathway diagram in Figure 2).

- Heat syncope is a loss of consciousness resulting from the increased demand on the heart to pump blood to the skin and away from the brain.
- Heat cramps are muscle cramps resulting from dehydration and sodium depletion - this illness is common among outdoor workers like construction

and agricultural workers. This correlation is crucial because, as discussed later, prisoners in Texas often perform agricultural and construction work.

- Heat exhaustion occurs when thermoregulatory systems are fully engaged but the body cannot maintain a normal body temperature. This stress causes the core temperature to increase which results in the experience of dizziness and chills.
- Heat exhaustion can lead to heat stroke, which is potentially fatal. Heat stroke is an elevation of body temperature above 105.5 degrees, accompanied by alteration of mental status, such as inappropriate behavior or impaired judgment, coma, or convulsions. This behavior is due to the brain failing because of the rise in core body temperature. Once the brain fails, the body can no longer thermoregulate so the body's temperature rises even more and causes inflammation, cell death, multiple organ system failure, and death.

### *Tracking Heat Related Illness Mortality*

In his injunction, Judge Ellison describes the social and political context which has allowed extreme heat exposure to continue in the Pack Prison in Rosharon, Texas.

Judge Ellison was “particularly troubled by ... seeming indifference to heat-sensitive inmates... [and] that this indifference has permeated all aspects of... handling extreme heat in the summers, from failing to consider the installation of air conditioning after 23 deaths occurred from heat-related illness, to failing to notify prison officials and inmates when heat advisories have been issued.”<sup>5</sup>

Judge Ellison also drew attention to the summer of 2011, when a record breaking heat wave led to the Pack Prison Unit experiencing temperatures above 100 degrees Fahrenheit for 74 days, leading to 10 reports of death due to heat.<sup>5</sup> As we will come to see in the findings, 2011 is a catalytic point between 2005 and 2015, when a sudden spike in mortality due to heat related illness occurs in multiple Texas prison units.

Incidence of heat-related illness (HRI) correlates with increases in ambient heat, but tracking mortality due to HRI is difficult, especially in prisons since it is not actively screened for or reported. However, a recent occupational health review of heat related illness in construction workers used mortality due to cardiovascular disease (CVD) as a proxy measure for mortality due to HRI.<sup>9</sup> This critical analysis will also use CVD mortality as a proxy for HRI mortality. The Bureau of Justice Statistics is unable to efficiently track HRI mortality due to the number of different presentations and ICD10 codes which can be associated with it. The Bureau launched the Mortality in Correctional Institutions (MCI) program in 2000 to aggregate prisoner mortality causes into a public database; this database was a potential source of HRI mortality information but currently lacks the resolution to make an effective assessment of the burden of HRI mortality in any state. MCI relies on voluntary reports from each state, which come from the state Departments of Corrections individually inputting cause of death from prisoner death certificates. A 2016 technical report out of the Bureau of Justice Statistics noted that relying on multiple departments to report data through this pipeline is to blame for a loss in data resolution - MCI data records on average 1.06 ICD10 codes per prisoner, while locating the same individuals in the National Death Index shows an average of

2.69 ICD10 codes.<sup>10</sup> In other words, the information about how prisoners are dying is not effectively collected into any database, nor are any historic prison death records analyzed for indication of heat related illness mortality.

Using CVD mortality as a proxy measure allows for a rough comparison between Texas prisoners and noninstitutionalized Texans. Between 2008 and 2015, the average mortality due to CVD in Texans was 2.76 deaths per 1000 people.<sup>11</sup> If the prisoner CVD mortality rate is much higher than the noninstitutionalized CVD mortality rate then this paper will have identified a health disparity. In the findings, we see that such a disparity already exists in parts of Texas, and that a similar disparity can be expected in the rest of Texas by 2028.

### *Risk Factors for Heat Susceptibility*

A 2015 report on the challenges of climate change for correctional facilities highlighted four major risk factors in prisoners which make them more susceptible to heat related illnesses: age, physical health, mental health, and drug use.<sup>12</sup> The report notes that the prisoner population is increasingly an older one, with the percent of inmates older than 55 years old having increased by 234% between 1999 and 2013.<sup>13</sup> Old age causes the central nervous system to become less effective in regulating body temperature. Older inmates are more heat-susceptible for this reason, and also because they are more likely to have a chronic physical illness like hypertension or diabetes. The prevalences hypertension and diabetes are about 30% and 10% respectively in the prisoner population.<sup>8</sup> Furthermore, the prison environment has many

social stressors which can cause inmates to “age faster.”<sup>11</sup> This phenomena leads to prisoners having HRI susceptibility comparable to non-institutionalized people 10 years older than them.<sup>1,12</sup>

A high rate of mental illness also puts inmates at higher risk of heat related illness, mainly because of the medications which are prescribed to manage these conditions. About a third of prisoners experience mental illness for which they may be prescribed psychotropic medication.<sup>12</sup> The Marshall Project found that 30,678 Texan inmates were administered such drugs in 2017, putting them at a higher risk of heat-related illness.<sup>13</sup> This point also relates to the last risk factor: drug use.

Anticholinergic medications are regularly prescribed for chronic conditions ranging from allergies to Parkinson’s disease. These drugs interfere with thermoregulation at the nervous system level by dampening the central nervous system response to heat stimuli, thereby suppressing body-cooling reactions like sweat. Diuretics are regularly prescribed as well, and may contribute to prisoner dehydration which is a precursor to heat related illnesses.<sup>12</sup> Finally, high rates of illicit drug usage is a documented problem in prisoners, and this issue also increases the risk of heat related illness.<sup>12</sup> Many common illicit drugs used by prisoners such as alcohol, cocaine and ecstasy interfere with the body’s ability to regulate heat by reducing the body’s ability to sweat and increasing the risk of dehydration.<sup>12,13,14</sup>

### **Specific Aims**



This critical analysis lays out a framework which should be used to mitigate the increasing phenomena of prisoners dying due to extreme heat exposure. Understanding the extent to which heat related illness is underreported in prisons will demonstrate the need for better screening and reporting practices, and also points to the need to form new policy stances in order to put fewer prisoners at risk.

The evidence collected is presented as a causal pathway describing the major factors in heat related illness mortality in prisoners (see Figure 2 in the Appendix for a graphic representation). This causal pathway provides potential intervention points to target to reduce this burden in the coming decades. An effective intervention might address the types of medications dispensed in prison, meaning alternative ways to mitigate high prevalence of chronic illness, mental illness, and substance abuse must be explored. These three issues are complex problems existing in an already complicated environment, so programs should be designed with an understanding of this environment; such an understanding takes into account what programs are offered already and what kind of medical infrastructure is in place.

The following analysis is limited to 4 cities (Galveston, Houston, Huntsville, and Tennessee Colony) containing 14 prison units. The analysis death records from these prisons establishes a crude model by which to estimate how many prisoners are likely to die due to extreme heat exposure in the coming decades. This analysis is specifically concerned with how many deaths can be attributed to a cardiovascular disease - meaning a blood vessel failure or heart failure. The mortality from CVD provides an

estimate for how many prisoners might have died due to an extreme heat exposure. This mortality rate is compared with climate data using a linear regression in order to better understand how the number of prisoners dying from extreme heat increases as temperature increases. The resulting model demonstrates the potential result of not taking immediate action to mitigate the extreme heat exposure of Texas prisoners.

### **Methods**

The literature base was developed using the search terms “prison” + “climate change” + “heat.” Using these terms in Google Scholar and PubMed yielded no relevant public health literature.<sup>15,16</sup> Currently the topic of prisoner health is confined to the legal realm as a topic of interest; most of the compelling evidence for an underreported burden of HRI was found in legal briefs and documented evidence in court cases.<sup>17,18</sup> As a result, I broadened the literature search to any kind of occupational heat exposure in order to find examples of heat exposure frameworks in public health. The expanded search yielded a comprehensive review of heat stress assessment in construction workers which was conceptually useful.<sup>8</sup> However, the majority of occupational heat exposure literature was concerned with outdoor workers, which did not seem generalizable to prisoners, many of whom are exposed to high heat indoors as well as outdoors.

There is no directly relevant public health literature regarding prisoner health. As a result, the only recourse to effectively study this topic was to find a primary data source. The Texas Justice Initiative is a nonprofit organization which collects and

publishes the causes of death for Texas Prisoners online. I downloaded their prisoner mortality records in October 2018 and began to clean and sort these files for mentions of heat related illness.<sup>19</sup>

The initial collection had 8990 records of prisoner deaths from between 2005 and 2018 with a description of the cause of death. In order to keep only complete death records, records from 2016, 2017 and 2018 were excluded. Furthermore, I retained only the records for which mortality cause was categorized as “Natural Illness.” This left 4906 records. In order to focus the search, I excluded female records, records under the age of 18, records where cause of death was unknown or pending autopsy, and records which did not have a city of death listed. Altogether, 2734 records remained for further analysis.

1881 listed causes for the 2734 deaths were sorted into general categories to find how many were deaths caused by cardiovascular diseases. Mortalities were sorted as “blood clot,” “CVD,” “liver failure,” “cancer,” “respiratory failure,” “multi-organ failure,” “seizure,” “stroke,” and “other” (this category included HIV/AIDS, deaths attributed to substance abuse, genetic disorders, and diseases and injuries which could not be otherwise categorized). In order to accomplish this, I relied on the Merck Medical Manual Online to parse out medical terminology.<sup>20</sup> Blood clot was initially a category of interest because of the possibility of a drug interaction, but sufficient data on medication is not available to explore this variable’s significance. Similarly, none of generalized categories had a sufficient number of cases for serious inquiry, except for CVD and cancer. CVD cases were collected into a dataset with only city of death and year of

death retained in the file. I sorted the 1060 prisoners who died of cardiovascular disease to see which cities had the highest incidence of CVD mortality, I retained only the top 4 cities for further analysis, since these were the only cities which had 50 or more CVD deaths between 2005 and 2015: Galveston, Houston, Huntsville, and Tennessee Colony - this left 323 records.

The National Oceanic and Atmospheric Administration's online climate data search tool to download data on for each of the four cities of interest.<sup>7</sup> A variable of interest is cooling degree days (CDD), which refers to a calculation done by fuel economists to estimate how much energy is required to keep buildings under 65-degree Fahrenheit throughout the year. I used this measure in order to estimate heat accumulation within prisons as a proxy measure of the heat exposure of prisoners. Since prisoners spend time in non air-conditioned housing units, along with outdoors for agricultural work or yard time, the number of hotter-than-comfortable days was a reasonable exposure estimate of heat exposure.

CVD mortality rate was estimated by dividing the number of CVD deaths each year by the rated capacity of the prisons in each city of interest, then multiplying by 1000 in order to obtain "deaths per 1000 prisoners." These population ratings were: 365 prisoners in Galveston, 2,153 prisoners in Houston, 13,719 prisoners in Huntsville, and 9,952 prisoners in Tennessee Colony.

In order to contextualize the prison environment beyond this data analysis, a prison conditions were compiled from the Texas Department of Criminal Justice (TDCJ)

website, as well as the news outlets “The Texas Tribune” and “The Marshall Project”.<sup>21,22,23</sup> TDCJ contains a database of prison units in Texas describing the population, medical care capacity, and labor practices of each of the 107 prison units in Texas. Unfortunately, other information which would have been useful such as the home communities and races of the dead prisoners were not readily available in the dataset. These variables and many other confounders could not be fully explored in this first-look analysis but should be considered in future frameworks.

A review of the types of labor in the prison units was used to generate a list of keywords which were explored in conjunction with “heat exposure” and “climate change” using Google Scholar, PubMed, and NCBI. The findings from this literature review in conjunction with testimonials retrieved from the “The Texas Tribune” and “The Marshall Project” helped characterize the Texan prison environment in terms of the routes of extreme heat exposure.

### **Findings**

This critical analysis found that prisoners are dying at a rate which positively correlated with temperature. The implication of this finding is that as temperature increases, so will prisoner mortality. Based on this logic, prisoner deaths in Texas for the rest of the century are estimated to exceed 100,000 deaths.

*Journalism on Extreme Heat Exposure in Prisons*

A survey of testimonials from prisoners, correctional officers, and friends and family of prisoners revealed a number of symptoms associated with heat related illness are commonly experienced. For example, one prisoner revealed both the feeling of heat exhaustion and the attitude of correctional officers:

“Fred Wallace, a 72-year-old plaintiff who is clinically obese and suffers from high blood pressure, said in a statement read by his lawyer that one day he felt he was going to pass out from the heat and asked a guard if he could go to the prison’s barber shop, a cooler area. He was denied permission.

“I felt so sick that I sat down on the floor,” he said in his testimony. “Only when the guard returned 15 minutes later and said, ‘You look like you’re going to die,’ did he allow me to enter the barber shop.”<sup>23</sup>

Individual reports cannot inspire large scale political action, but reporting on the extreme heat exposure in prisons has been an ongoing effort by the Texas Tribune and the Marshall Project for almost a decade now. Efforts by these publications picked after the heat wave of 2011, and in 2017 the seminal Marshall Project article “Cooking Them To Death” was released, detailing the lack of medical care, climate control, and empathy from correctional officers which leads to a high rate of prisoner mortality. These reports formed the basis for criteria used in the following analysis of death records.

### *Analysis of Death Records*

The rate of deaths attributable to cardiovascular disease for prisoners correlate positively with average yearly temperature (see Figure 3 in the appendix for a representation of the data). As visualized in Figure 4, the general trend in CVD mortality is upward between 2005 and 2015: 5.48 deaths per 1000 prisoners in 2005 in Galveston increased to 57.53 deaths per 1000 prisoners in 2015; in Houston the increase was from 1.39 deaths per 1000 to 2.79 per 1000; in Huntsville the increase was from 0.29 deaths per 1000 to 1.6 deaths per 1000; in Tennessee Colony the mortality rate rose from 0.3 deaths per 1000 to 0.7 deaths per 1000 (see Appendix for graphs).

A linear regression of the CVD mortality rate against the cumulative cooling degree rating from the local NOAA showed moderate positive linear correlation, with an R value of 0.53 (see Figure 5 in Appendix for regression graphs and equations). This finding suggests there is a relationship between CVD mortality and the amount of time prisoners are exposed to high levels of heat. However, the low R values is likely due to unaccounted confounders which the available data cannot be used to control for (such as race, city of origin, and pre-existing medical conditions).

Interestingly, an analysis of the rate of cardiovascular disease as a function of days spent in prison showed that most deaths occur on day one of incarceration ( see Figure 6 in appendix for time distribution of deaths). A further analysis of the age distribution of the cardiovascular disease mortalities is presented in Figure 7 and shows that a majority of these cases occurred in prisoners aged between 50-70 year olds (see

appendix for data visualization). The basic explanation for this pattern of older prisoners dying of cardiovascular disease on close to Day 1 in prison would be a lack of acclimatization. As one occupational health study suggests, it takes about 5 days of progressively longer exposures to become acclimatized to a high heat environment.<sup>24</sup> If the mortality is occurring on near day 1, and it is due to heat, then these deaths must be related to prisons which do not have air conditioning in the housing area.

The kind of heat stress which is causing these mortality is “classical heat stress” as opposed to “exertional heat stress.” This differentiation gives a validation to the cause of sorting death records by respiratory failure and blood clots, since classical heat stress causes these symptoms but exertional heat stress does not.<sup>25</sup> Exertional heat stress should not be eliminated as a potential killer however, since it can be associated with renal failure and rhabdomyolysis (deterioration of muscle into the blood) - both of which also were found in the analysis of the death records (see Figure 8 in appendix for broad categories of mortality causes).

Another explanation for the day 1 deaths is more disturbing and requires a birds eye view of all the death records from 2005-2015, not just the ones attributed to natural causes. Figure 9 shows the reasons 1295 prisoners died on their first day in custody between 2005-2015: the almost 650 died from homicide, and almost 250 died from suicide (see Appendix for data visualization). Another 70 were attributed to accidents. There were 80 natural illness deaths, of which 60 could be attributed to cardiovascular disease. As mentioned before, the incompleteness of the available data makes it difficult to discern the underlying causes of this kind of day 1 violence, but this symptom



points to the turbulent social conditions of prisons which are likely to exacerbate not just heat related illness but mental and physical illness of all types.

A more complete model would require a comprehensive dataset with information on medication regimen, work history, and history of chronic illness and mental illness. In the absence of these variables, a great deal of uncertainty will remain in the validity of these results. The use of proxy measures for both the independent and dependent variables of interest is not ideal, but is the only possible utilization of currently available data in order to approach the issue of prisoner heat exposure. Also, the generalization of mortality causes was done by a researcher with no clinical credential. A more comprehensive analysis will require a team with at least one clinician in order to better interpret the contribution of heat to mortality based on information from death certificated.

#### *The Four Cities of Interest*

The four cities of interest contain 14 prison units: 2 medical units in Galveston, 1 medical and 1 correctional unit in Houston, 7 correctional units in Huntsville, and 3 correctional units in Tennessee Colony. Medical units are specifically for ill prisoners, which is likely why Galveston had the most dramatic rise in CVD mortality rate between 2005 and 2015 (2.95 to 30.93 deaths per 1000). The other key factors of interest are the types of labor prisoners perform in these units, the quality of medical care available, and the kind of educational or therapeutic programming provided at the prison unit.

- In Galveston, the units Hospital Galveston and the Young Medical Facility both provide 24/7 medical care, do not have any prisoner labor programs, and offer some basic adult education and community support programs.
- In Houston, the Eastham correctional unit has very limited medical care available and has agricultural and garment jobs which include working with crops, poultry, and cattle. This unit also has substance abuse programming and vocational training available for prisoners. The other unit in Houston is Kegans State Jail which holds parole violators. This unit has no labor programs, has limited medical care capacity, and provides substance abuse and adult education programming.
- The seven units in Huntsville are: Byrd, Ellis, Estelle, Goree, Holliday, Huntsville, and Wynne. These units all have varying degrees of agricultural work for prisoners ranging from horse breeding to crop maintenance and food packaging. Prisoners in Ellis, Huntsville, and Wynne units also can work as bus or automotive mechanics. All seven units have limited medical care capacity beyond basic ambulatory care services, except Byrd which has 24/7 medical care available. Vocational and adult education classes are offered at all seven units, as well as substance abuse programming and some faith based and peer to peer therapy.
- The three units in Tennessee Colony are Beto, where prisoners perform agricultural work and build metal signs, Coffield where prisoners have

similar work opportunities, and Michael where prisoners can work in fields or with animals, or in a mechanic shop. Michael and Beto units have 24/7 medical care, but the Coffield has limited medical care capacity.

These four cities were chosen for analysis because they had a significant enough number of cardiovascular disease deaths for further analysis. As seen in Figure 7, Tennessee Colony has a much higher cancer mortality rate than CVD mortality, and centered around aged 50-60 as well, which is relatively young (see Appendix for data visualization). Further analysis should be done into whether there is relationship between any agricultural exposures and these cancer rates. As previously mentioned, Galveston's prisoner population is entirely prisoners who have been screened to be sick, as it is a medical facility - therefore the exceptional spike in mortality rate (5 deaths per 1000 to 30 per 1000) is due to more hospitalizations (see Figure 10 in Appendix for city specific mortality rates). A spike in CVD mortality rate occurs in 2011 in the other three cities of interest as well, with rates reaching between 1 and 3.5 deaths per 1000 prisoners in 2013 (see Figure 11 in Appendix for city specific mortality rates with different resolution).

#### *Other Mortalities And their Potential Relationship to Heat*

While sorting the causes of death 13 major themes emerged: blood clots, cardiovascular disease, cancer, diabetes, gastrointestinal tortions ie volvulus, infections like pneumonia, internal bleeding ie hemorrhaging, kidney failure, liver failure, multi-organ failure, respiratory failure, stroke, and hyperthermia. The age range of

prisoners affected were very similar, except for seizures, as shown in Figure 12 (see Appendix). All of these mortality causes experienced small increases after the heat wave of 2011, but due to the small number of cases this cannot be visualized effectively. However, these mortality causes have relationships to heat exposure in the literature.

One of the most salient understudied health impact is likely chronic kidney disease (CKD); in fact CKD is a noted heat related illness in occupational health studies surrounding agricultural workers.<sup>28</sup> Trends in prisoner treatment validate this suspicion, since CKD in prisoners is a major burden on the healthcare system. In 2014, the burden of chronic kidney disease (CKD) in prisoners was 1,800 diagnoses, and the incidence has risen since, with 624 more CKD diagnoses in 2013 than in 2011. Two hundred and twenty eight inmates required dialysis in 2014 as a result, accounting for 3% of the Texas prison system's total pharmaceutical budget on treatment for less than 0.1% of its population.<sup>27</sup> CKD is not regularly screened for in prisons, therefore the reported incidence in the prisoner population comes from the most extreme and terminal cases. However, renal failure was a major theme in the 2754 death records analyzed.

The causal framework in the appendix considers this relationship between heat, agricultural work, and chronic kidney disease: agricultural work may be another risk factor for heat related illness (see Figure 2 in Appendix to see how these occupations fit into the causal pathway for heat related illness). A seminal review of the evidence on heat exposure among agricultural workers showed that there 196 deaths from heat

related illness out of 30,000 facilities across the country.<sup>28</sup> This number stands in stark contrast to the 323 CVD deaths parsed out between 2005 and 2015 from 4 Texas cities.

### *Predicting Where CVD Mortality Will Go*

Analyzing CVD mortality trends independent of temperature, only as a function of time, shows that incidence of prisoners dying in manner is set to increase. A temperature-blind prediction is presented in Figure 13, showing that the current rate of CVD mortality in Texas prisoners is about 16.7 deaths per 1000 prisoners per year, and that it will reach 22.8 deaths per 1000 in 2022 (see Appendix for projection graphs). These rates demonstrate that prisoners are clearly suffering in a manner disparate to the noninstitutionalized living in the same cities. The yearly rate of prisoner mortality due to cardiovascular disease is 7 times higher than the non-prisoner mortality rate.

Understanding the results of the findings listed previously, we know that CVD mortality cannot be predicted independent of temperature. The regression model developed in Figure 3 in conjunction with the American Climate Prospectus' prediction that Texas yearly average temperatures 90 degrees Fahrenheit in 2099 can be used to estimate mortality due to heat related illness between 2039 and 2099 (see Appendix for projection graph). Based on Figure 14, this paper predicts of 116,331 prisoner deaths due to heat related illness between 2040 and 2099 if not mitigated immediately (see Appendix for relevant figure).

## **Conclusions**

The public health understanding of climate change's impact on prisoner health is underdeveloped. This critical analysis is the first of its kind to assess the burden of heat related illness on prisoner mortality, and as such it relied on disparate sources of data which introduced many biases. However, there is still an evident relationship within the data, and strong evidence within literature and current legal arguments to conclude that heat related illness is a serious threat to the health of prisoners in Texas. The threat of more frequent and intense heat waves in the coming century means the Texas prison system needs to make changes immediately in order to avoid a rise in prisoner mortality.

### *Study Limitations*

This critical analysis of the state of prisoner health in Texas was severely limited by a lack of directly relevant public health literature. The theoretical background for the analysis is developed from a close reading of occupational health literature studying construction workers and agricultural workers. Prisoners do not share many similarities with these populations beyond the heat exposure, and that too is experienced in a radically different way by prisoners. Furthermore, lack of information regarding communities of origin for these prisoners, and the absence of accurate medical histories and charts limits the scope of a critical analysis relying on death records.

There is a strong possibility of nondifferential exposure and outcome misclassification which would lead to an overestimation of effect. Exposure to heat was abstracted from the average yearly temperature for the entire city and the number of

cooling degree days rated by NOAA - a more accurate exposure assessment would measure temperature directly in the prisons and in the prisoner workspaces. The outcome of heat related death was also abstracted to deaths which could be attributable to cardiovascular disease. A more accurate outcome assessment should be open to all signs of both classical and exertional heat stress, including rhabdomyolysis, blood clots, hyperkalemia, high creatinine in urine, and so on. For this reason, the estimation of 116,000 deaths between 2039 and 2099 should be considered a preliminary finding and should be challenged by other researchers with access to more comprehensive data.

#### *Recommendations for Mitigation of Heat Mortality Crisis*

One proposed intervention to reduce the burden of HRI mortality on prisoners is to grant parole to prisoners over the age of 55 years old and to prisoners diagnosed with chronic illnesses. As legal scholar Jonathan Simon points out, this population of prisoners is essentially a drain on public funding and does not serve any rehabilitative purpose - this population is simply too old and sick to reoffend.<sup>29</sup> For the purposes of the criminal justice system, a prisoner who is old and sick can be functionally considered rehabilitated. By passing legislation to allow prisoners who meet a threshold for old age or incapacitation due to chronic illness, TDCJ can reduce the demand on its medical resources and prevent many deaths due to heat related illness - as shown in Figure 7 most of the heat related deaths occur in prisoners over the age of 55.

Another intervention to address heat susceptibility in prisoners is a review of medication schedules - prisoners on antipsychotics, anticholinergics, and diuretics are

especially heat susceptible, so these prisoners should either be given different medication or monitored carefully to ensure minimal heat exposure. As mentioned previously, there is not sufficient data to assess the actual relationship between certain prescription drugs and heat susceptibility in prisons, nor is there much literature beyond what has already been referenced. For this reason, an effective intervention addressing medication will also need to include a better study of what medications are being given to prisoners and how those prescriptions are related to heat related illness.

Finally, TDCJ can implement a series of administrative controls in line with guidelines established for occupational heat exposure in industries like agriculture and construction. By changing how work shifts are scheduled to decrease work around 2pm, for example, a great deal of heat exposure can be avoided.<sup>25</sup> Agricultural workers reduce their heat exposure by having breaks and indoor work interspersed throughout their work shift.<sup>26</sup> Also, TDCJ should consider restricting certain jobs for prisoners who are not being prescribed diuretics, anticholinergics, or antipsychotics, as well as older prisoner above 55 years of age.

Lastly, TDCJ should implement better climate controls, as order by Judge Keith Ellison, and develop a method to acclimatize prisoners to heat in the meantime to mitigate mortality rates while those systems are being installed. As the occupational study from NIOSH describes, in order to acclimatize to heat a person should start with 2 hours of exposure on day 1 and slowly work up 8 hours of exposure on day 5.<sup>25</sup> To accomplish this in a prison, there would have to be a transitory holding area where new prisoners could spend the remaining 22 hours of the day. However, NIOSH's standard



is for workers who leave the worksite - the heat exposure source - after 8 hours.

Prisoners in Texas may be subjected to extreme heat conditions in their housing area, so acclimatization will not be effective for very long. At most, this protocol will prevent the drastic number of Day 1 Deaths.

### *Implications*

The implications of this critical analysis are that there is looming public health crisis in prisoner health, and that there seems to be nominal political momentum in addressing the risk factors behind it. In practice, the application and refinement of methods developed in this critical analysis can be used to generate a risk rating for each prison in Texas, and eventually the entire country. As reporting systems become more refined and databases become more comprehensive, the basic principles developed in this paper, including the causal pathway in Figure 2, can be validated by controlling for drug interactions, behavioral health factors, and work history (see Appendix for relevant figure).

In order to accomplish a better reporting system, diseases such as Chronic Kidney Disease should be screened for more frequently. Data points to be collected should include ambient temperature and humidity data inside each prison, blood creatinine tests, blood urea nitrogen tests, and fasting blood glucose test to measure blood sugar.<sup>30</sup> In aggregate, this kind of data can assist agencies such as the Bureau of Justice Statistics to understand what prison systems are able to maintain healthier living conditions.

### *The Motivation to Protect Prisoner Health*

Prisoners represent one of the most vulnerable populations in the world. Their condition is exacerbated by the fact that they live in an incredibly stressful environment and are subject to policies established by governments who do not always listen to their needs. In his seminal works, the legal scholar Jonathan Simon discusses the idea of dignity, and how dignity is the state of living in a condition equal to those in the society around you.<sup>29</sup> Simon argues that a just society must ensure that prisoners are able to live a dignified life.<sup>29</sup> In fact, since the ideal goal of the prison system is to rehabilitate prisoners into members of society, it is in the interest of society to ensure prisoners can thrive inside and outside of prison. Prisoners must be afforded dignity, and their health must be protected, in order to maintain a just and decent society.

Simon's scholarship on the American prison system includes critiques of the practices of prison overcrowding and lack of adequate healthcare in American prisons, despite the prison system being one of the largest healthcare providers in the country.<sup>29</sup> These factors are also risk factors in the causal pathway for heat related illness, and infections which were seen in high rates during the analysis. The discovery of more factors to add to the causal pathway reveals how little is truly understood about prisoner health. If the factors which cause poor health outcomes in prisoners are not understood, they cannot be addressed. This knowledge gap is the main motivation for this critical analysis.

### *The Need for More Study*

The other motivation for this line of critical analysis is to draw more researchers to the study of this incoming public health crisis. The current cohort of MPH students has an opportunity to apply new data mining and analysis techniques in order to characterize and address public health issues of all types. The techniques applied in this critical analysis are not particularly novel and could have been performed a decade earlier. That such an analysis had not already taken place indicates that the magnitude of the issue is not understood, or that prisoner health has not adequately been framed as a topic of interest for public health researchers. It is my hope that prisoner health will become a more widely discussed subject in public health.

Future studies on prisoner health should focus not only on heat exposure, but also on factors which affect heat susceptibility, including but not limited to illicit drug use, drug interactions, mental illness/erratic behavior, medical history, community of origin, work history, and other conditions with which prisoners enter incarceration. Furthermore, the effectiveness of prison programs to provide respite from high heat exposure should also be assessed in order to determine what kinds of prison programming should receive more funding. Future research in prisoner health should also assess the efficiency of the physical structures of prisons at releasing heat.

Appendix

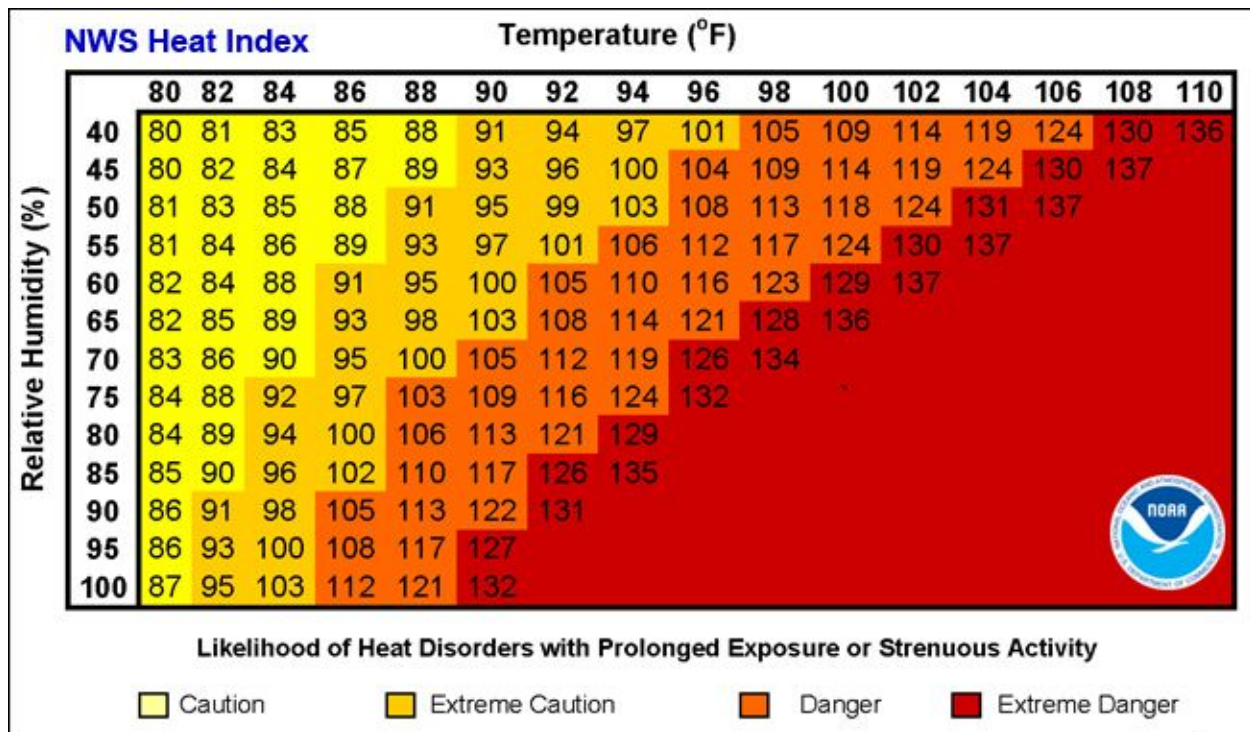


Figure 1. NOAA index for heat stroke risk. The accepted “dangerous” threshold for Texas based on historic summer temperature is 86 degree Fahrenheit at 60% relative humidity.

Image from <US Department of Commerce, NOAA. What is the heat index? National Weather Service. <https://www.weather.gov/ama/heatindex>>.

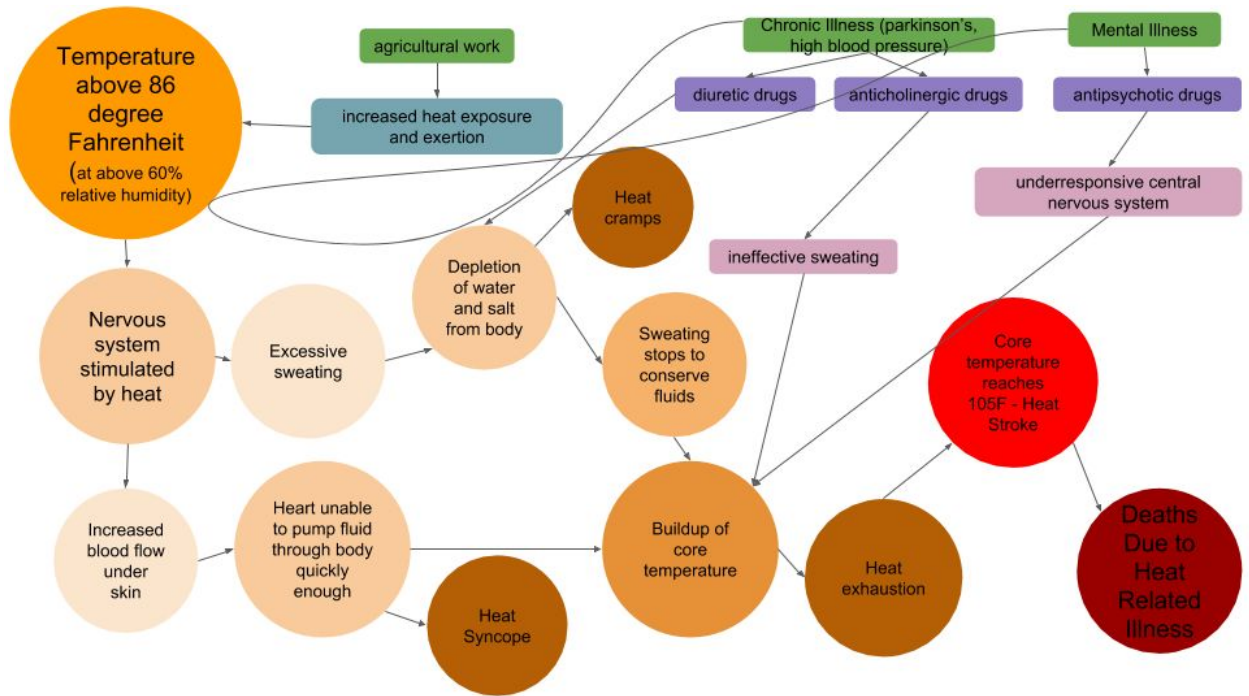


Figure 2. The causal pathway of heat related illness mortality in Texas prisons based on evidence gathered in this critical analysis.

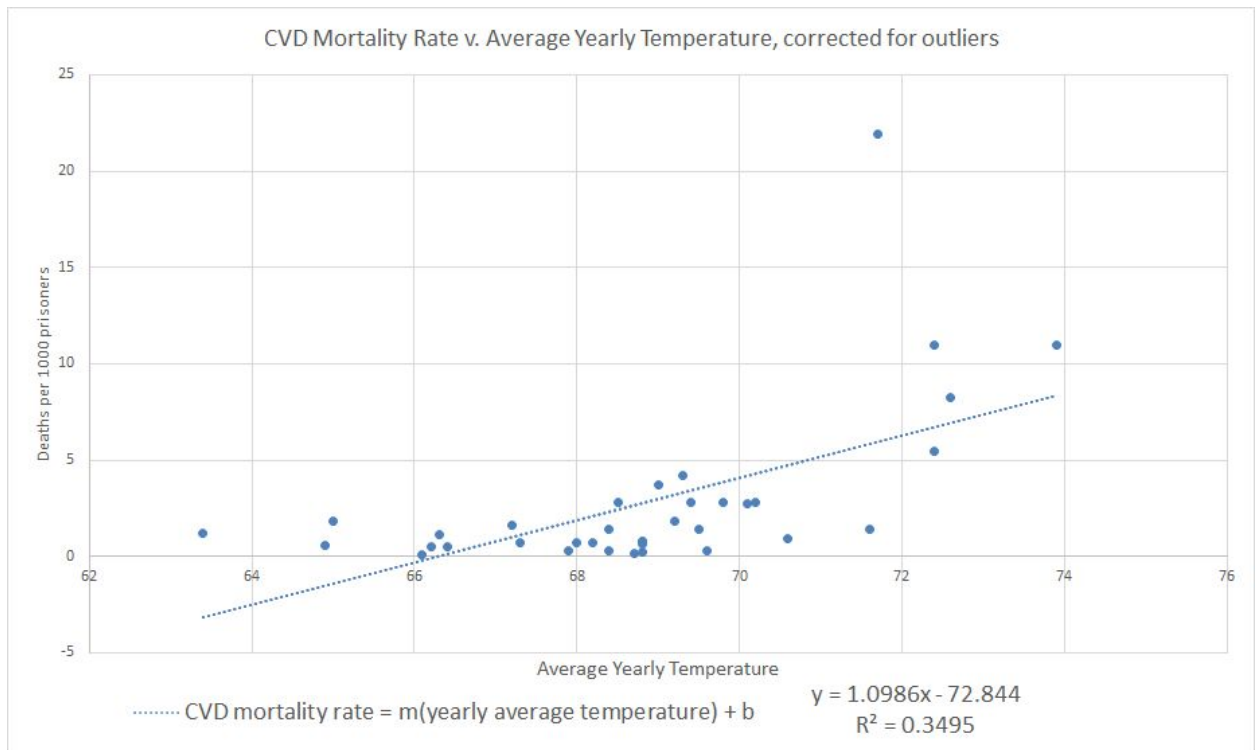


Figure 3. CVD mortality rate is correlated with average yearly temperature. The  $R^2$  value of 0.3495 suggests that 35% of the variance in deaths observed due to cardiovascular disease can be attributable to the rise in average yearly temperature.

Data from <Explore the Data. Texas Justice Initiative.

<http://texasjusticeinitiative.org/data/> and <National Centers for Environmental Information, NCEI. Climate Data Online Search. National Climatic Data Center.

<https://www.ncdc.noaa.gov/cdo-web/search.> >

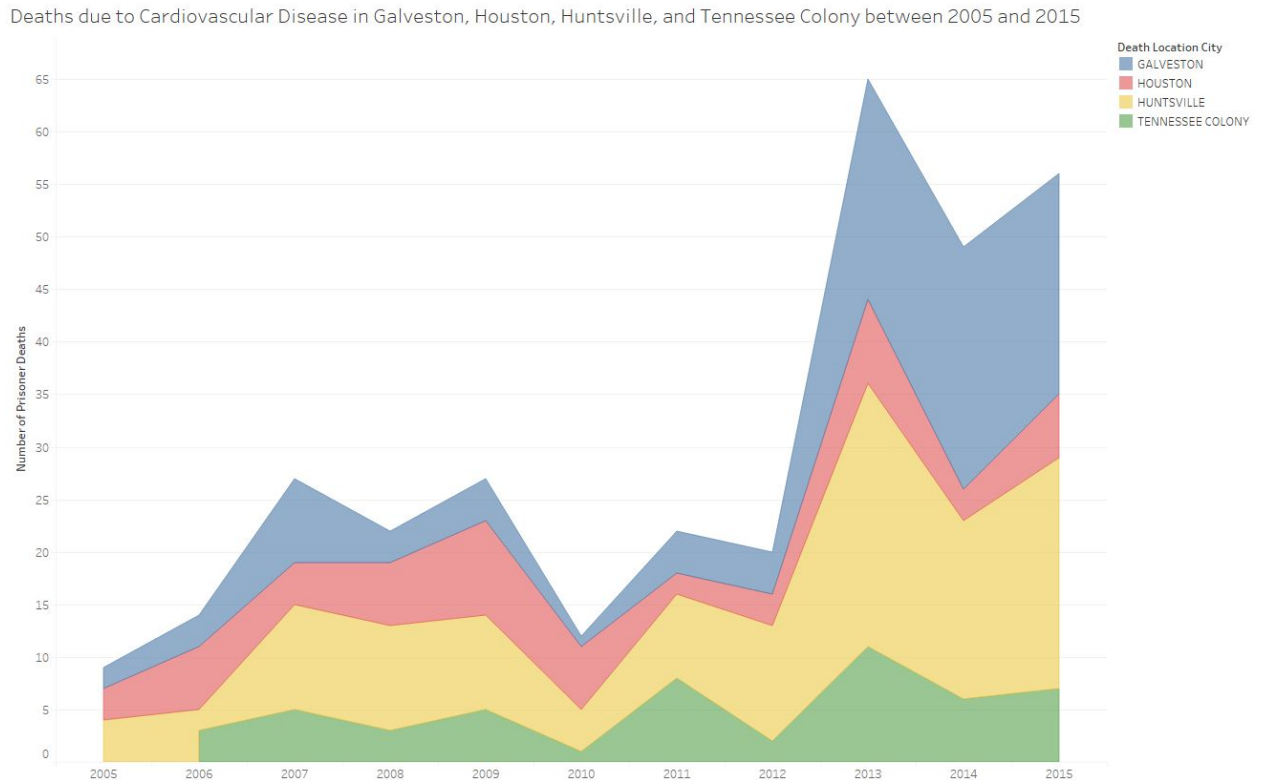


Figure 4. The number of prisoner deaths due to cardiovascular disease in Galveston, Houston, Huntsville, and Te. The spike at 2011 is clearly evident from this visualization, and corresponds to a record breaking heat wave that year. Galveston had an exceptional burden of these cases since both prison units in Galveston are hospital units. Huntsville, on the other hand, is a city with 7 correctional units, the high number of cases in that city is therefore primarily due to the high prisoner population. Yearly average temperature and cumulative cooling degree days are correlated; CCD captures information regarding number of hot days in a year which yearly average temperature does not capture.

Data from <Explore the Data. Texas Justice Initiative.

<http://texasjusticeinitiative.org/data/>>

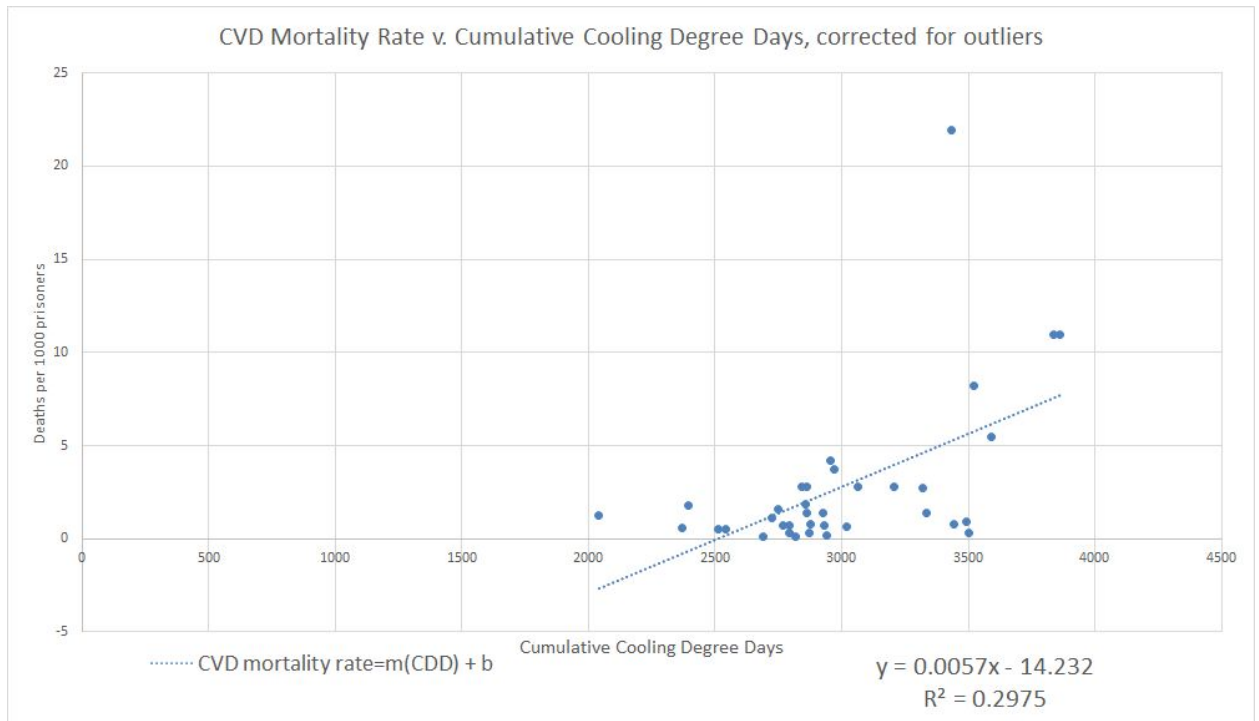


Figure 5. The correlation between mortality due to cardiovascular disease and cumulative cooling degree days. The  $R^2$  value of 0.2975 suggests that 30% of the deaths observed due to cardiovascular disease can be attributable to the variation in cooling degree days. Data from <Explore the Data. Texas Justice Initiative. <http://texasjusticeinitiative.org/data/>> and <National Centers for Environmental Information, NCEI. Climate Data Online Search. National Climatic Data Center. <https://www.ncdc.noaa.gov/cdo-web/search.>>



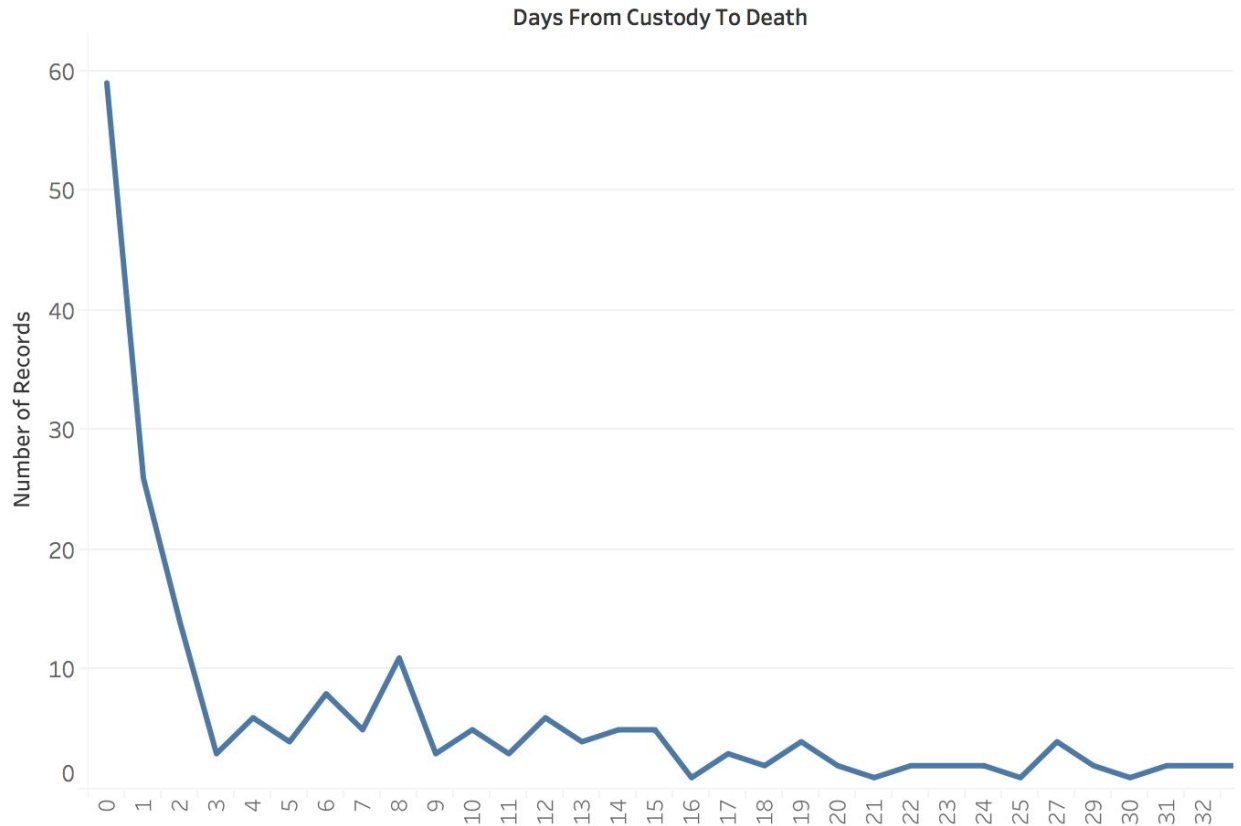


Figure 6. The majority of deaths due to cardiovascular disease occur towards to beginning of a prison sentence, on Day 1 in fact!. This relationship between mortality and “dose” of prison is likely because of an acclimatization effect - that is, people who have spent longer in a high heat exposure environment become better able to thrive in it. Data from <Explore the Data. Texas Justice Initiative.

<http://texasjusticeinitiative.org/data/>>

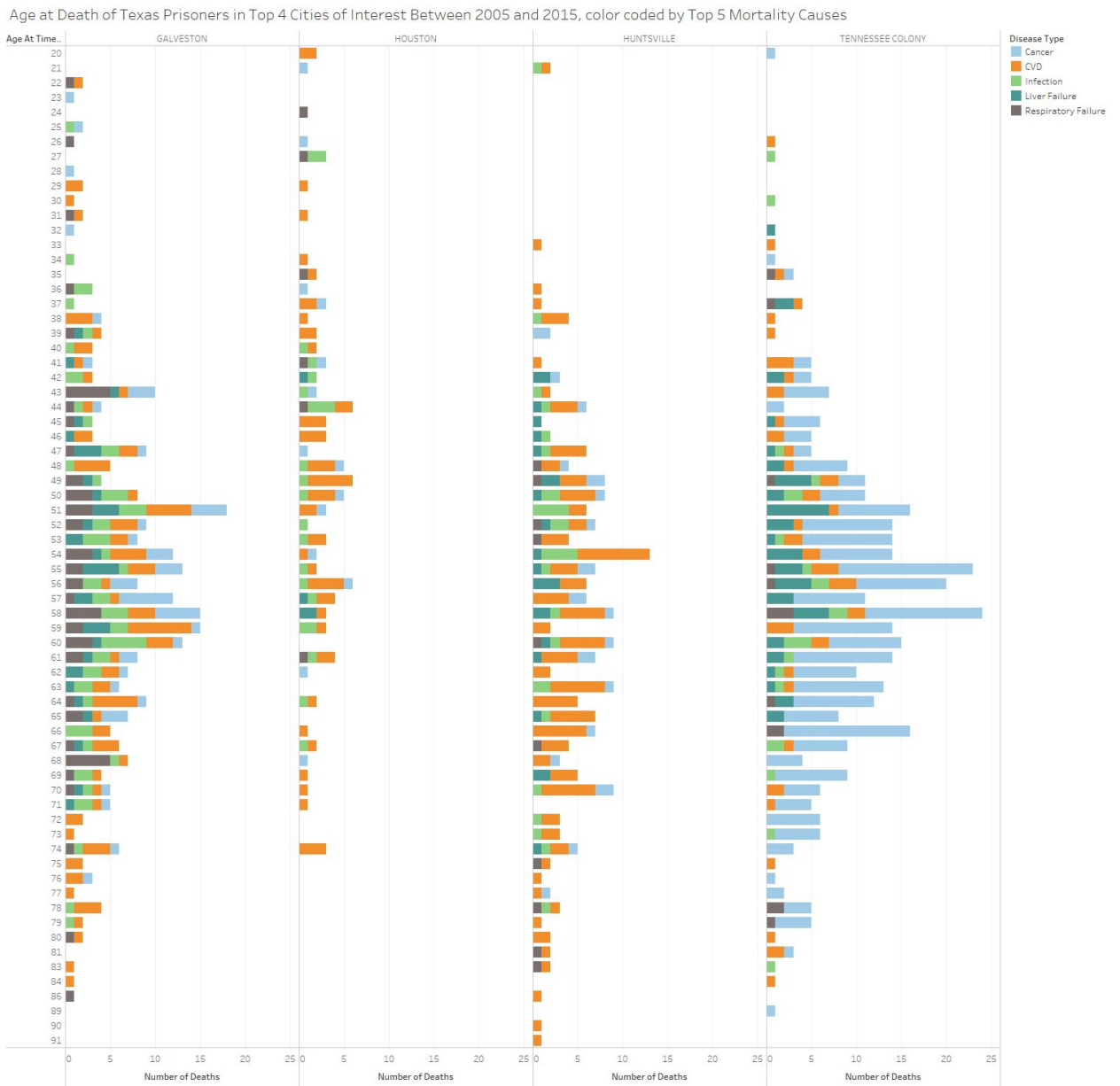


Figure 7. The age and mortality type distribution of dead prisoners in Galveston, Houston, Huntsville, and Tennessee Colony. Notably, cardiovascular disease reflects the highest burden of disease in all cities but Tennessee Colony, which faces an abnormally high rate of deaths due to cancer. This relationship should be studied further in the future.

Data from <Explore the Data. Texas Justice Initiative. <http://texasjusticeinitiative.org/data/>>

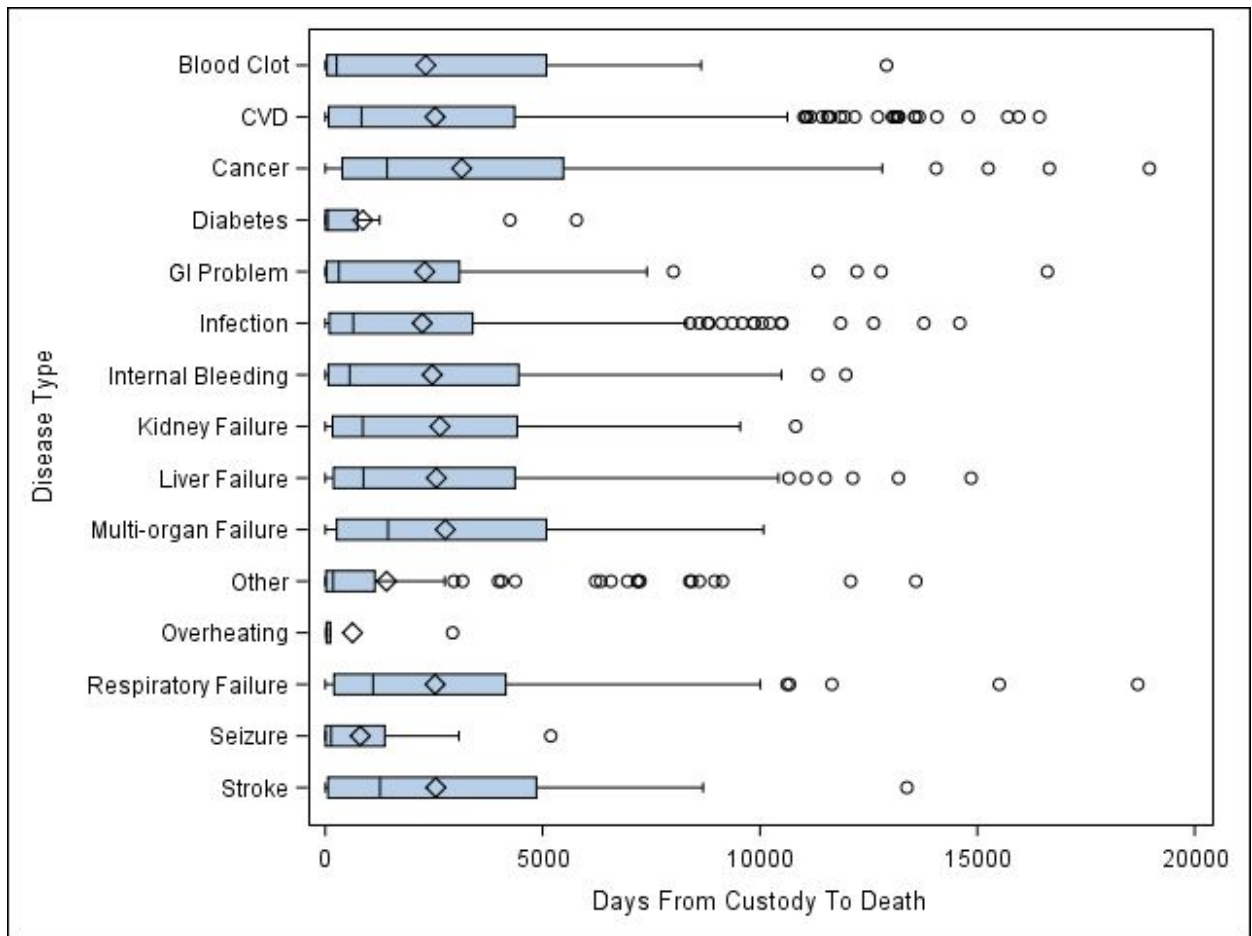


Figure 8. The number of days someone spent in a Texas prison before they died from the general categories of mortality established while sorting the Texas prisoner death records from 2005 to 2015. The most common day to die in prison is on the very first day. There are many social reasons to this as well, but in the context of heat related illness this may be due to a lack of acclimatization to the hot environment.

Data from <Explore the Data. Texas Justice Initiative.

<http://texasjusticeinitiative.org/data/>>

Listed Reasons of Prisoner Death on First Day in Prison, 1295 people between 2005 and 2015

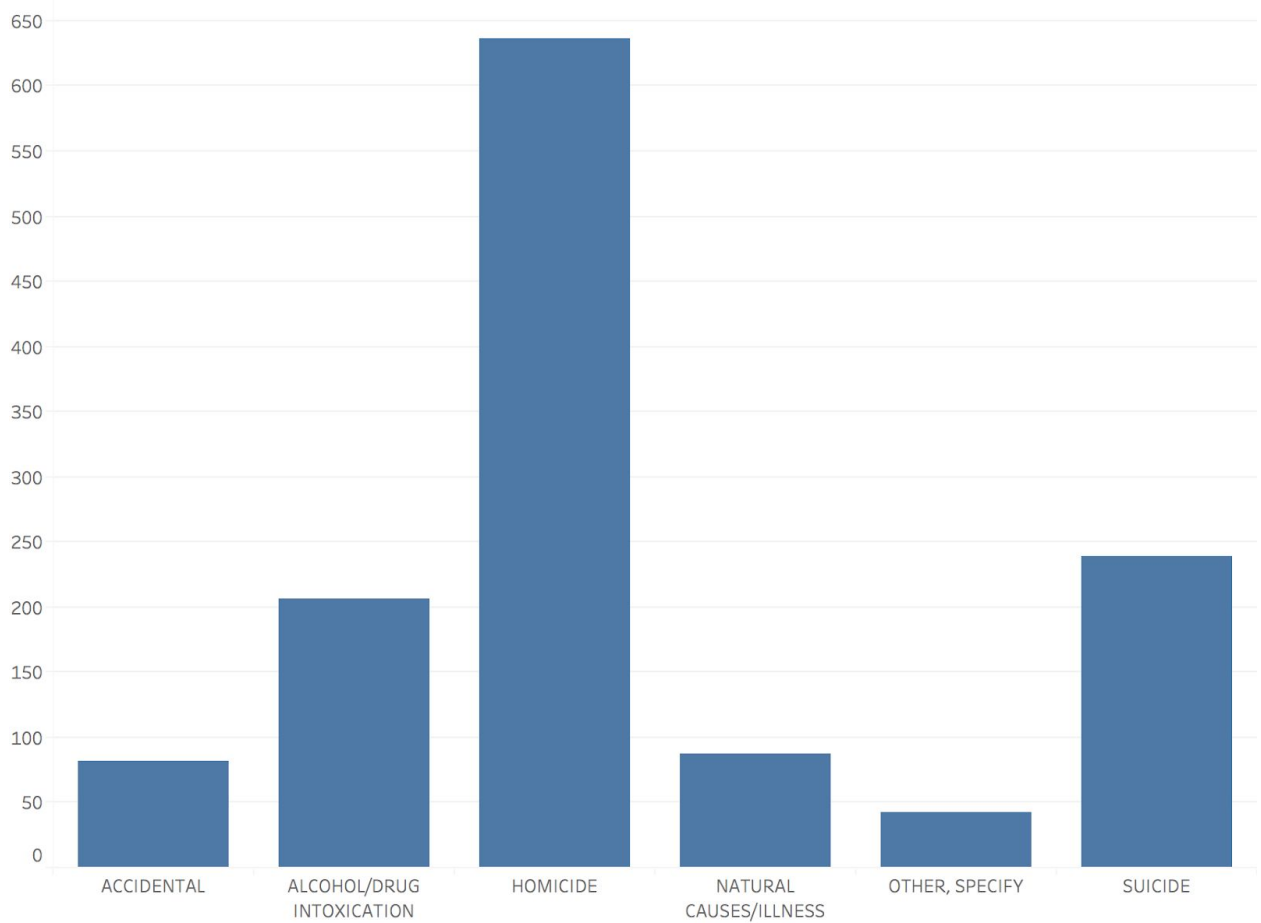


Figure 9. The primary reason prisoners die on their first day of custody is due to homicide. These deaths are primarily due to external social factors which are beyond the scope of the heat related illness analysis.

Data from <Explore the Data. Texas Justice Initiative.

<http://texasjusticeinitiative.org/data/>>

Figure 10. The increase in CVD mortality rate in Galveston outstrip the other three cities of interest drastically, primarily because it is a medical unit. Again, the spike corresponds with the record breaking heat wave of 2011.

Data from <Explore the Data. Texas Justice Initiative.

<http://texasjusticeinitiative.org/data/>>

## Mortality Rates Due to Cardiovascular Disease in Houston, Huntsville and Tennessee Colony between 2005 and 2015

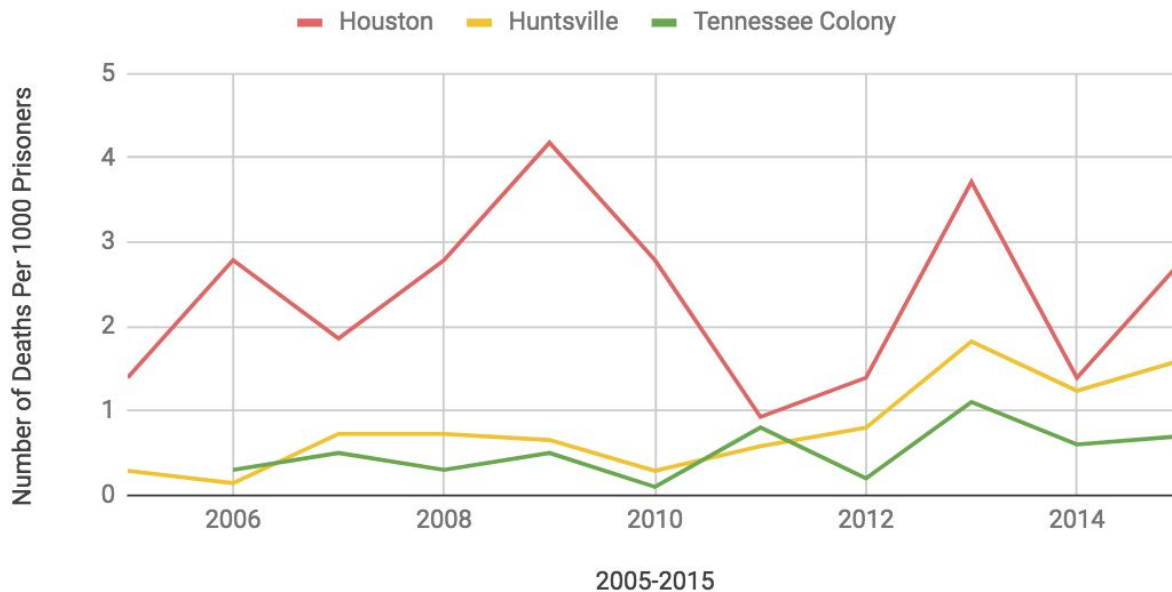


Figure 11. Viewed in the absence of Galveston, the other three cities also show a spike in CVD mortality rate after 2011. Houston's mortality curve is of special interest, as it more closely follows average yearly temperature fluctuations. This may be due to its higher prison population.

Data from <Explore the Data. Texas Justice Initiative.

<http://texasjusticeinitiative.org/data/>>

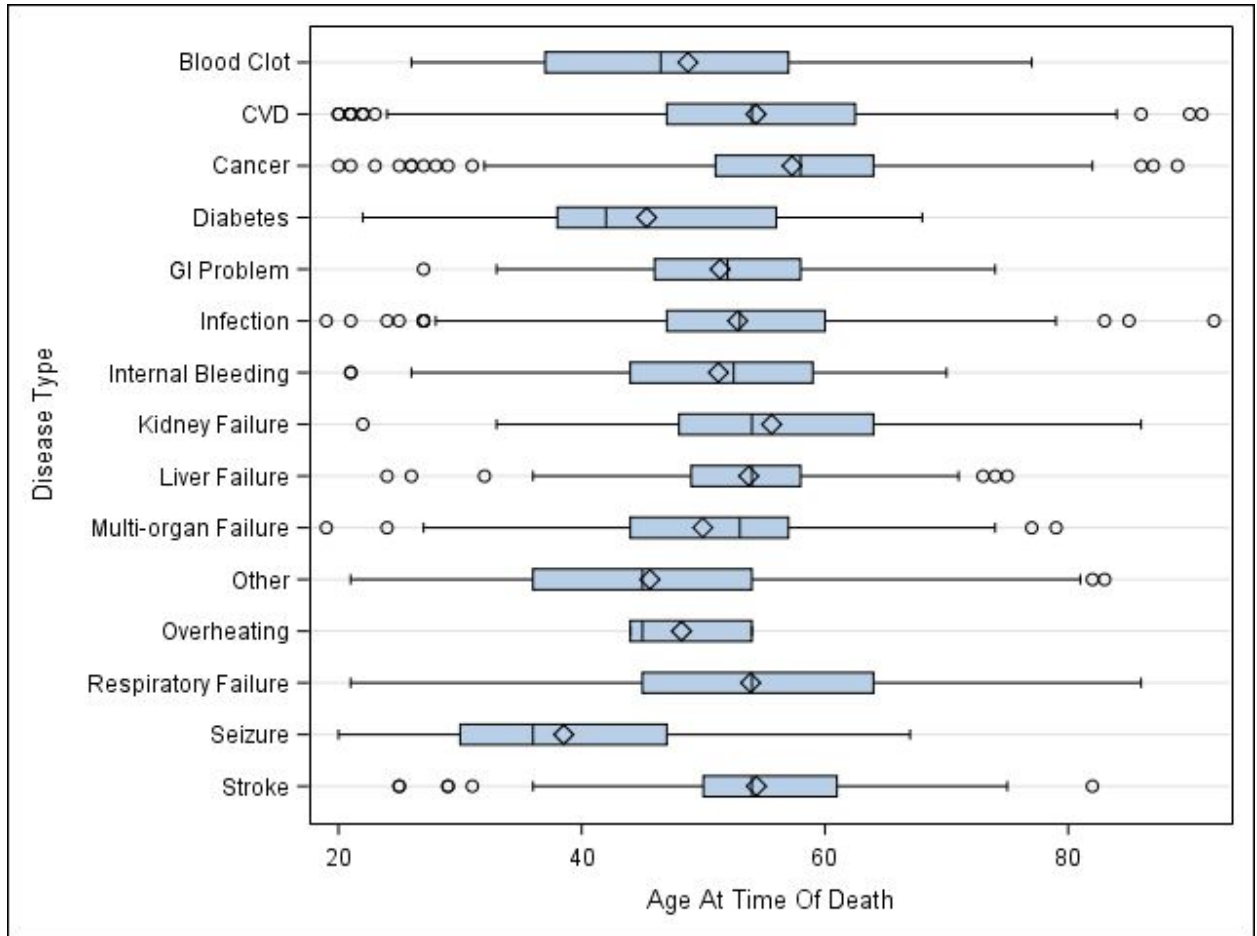


Figure 12. The age range of prisoners as they died from the general categories of mortality established while sorting the Texas prisoner death records from 2005 to 2015.

Data from <Explore the Data. Texas Justice Initiative.

<http://texasjusticeinitiative.org/data/>>

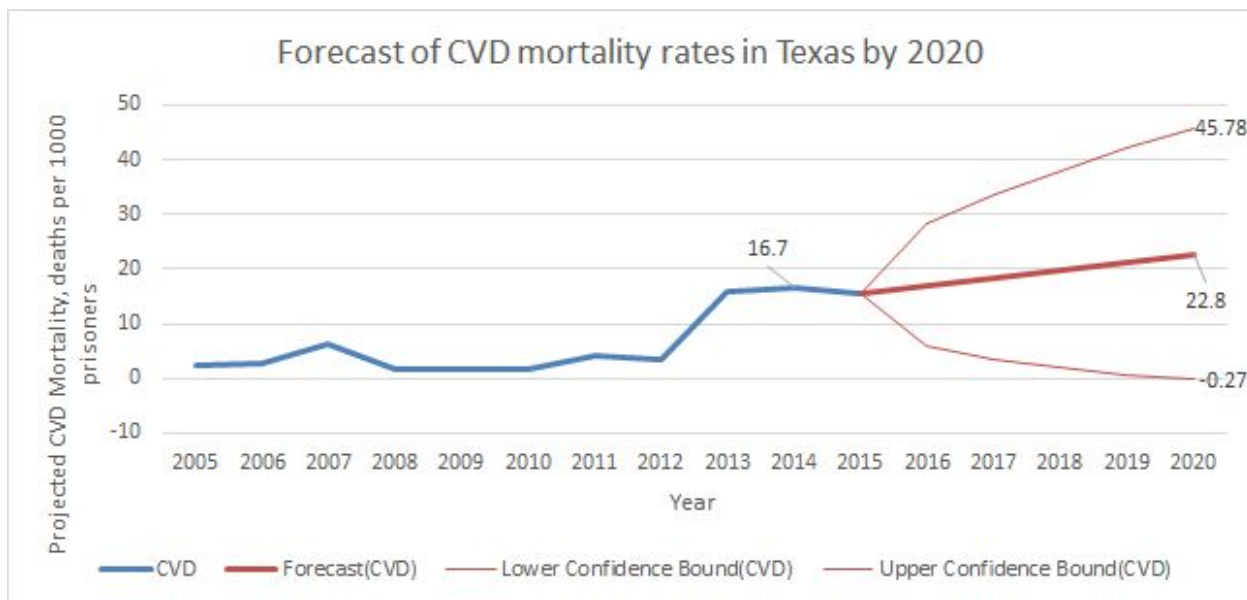


Figure 13. A prediction for CVD mortality rates in the near future based on the collected CVD mortality rates of Galveston, Houston, Huntsville, and Tennessee Colony. Based only on previous trends in CVD mortality, the number of prisoners dying each year from cardiovascular disease is expected to go up, from 16.7 per 1000 prisoners to 22.8 per 1000 prisoners. However, this prediction does not account for to increase in temperature which most climate change models agree is imminent.

Data from <Explore the Data. Texas Justice Initiative.

<http://texasjusticeinitiative.org/data/>>



## Projected Increase in CVD Mortality Based on Projected Increase in Average Yearly Temperature

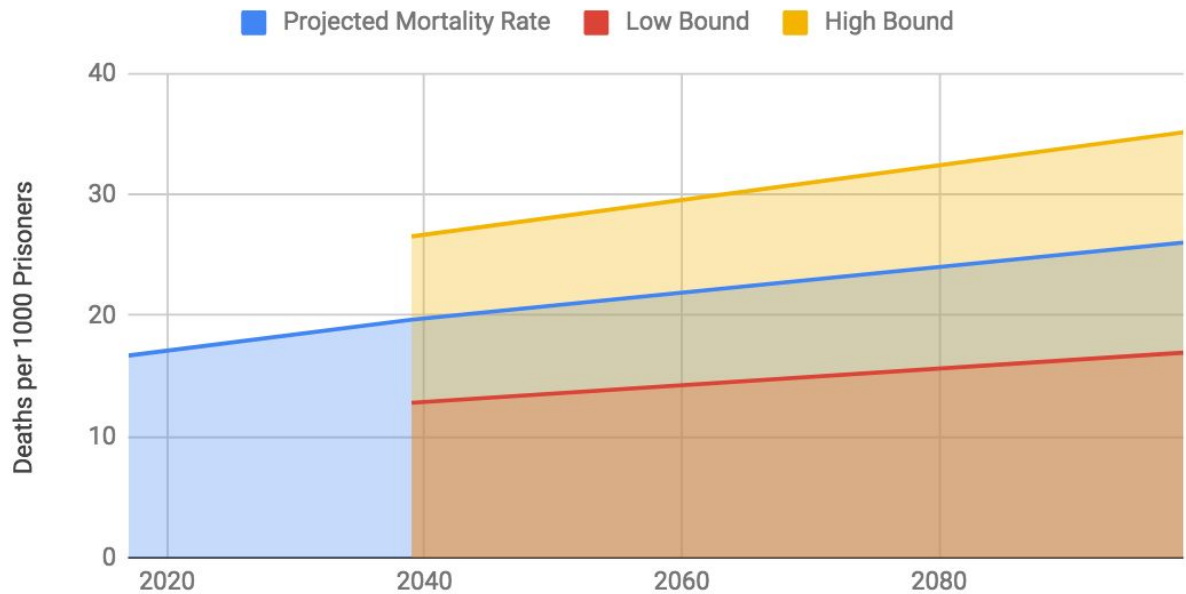


Figure 14. Using American Climate Prospectus' projections for average yearly temperature in Texas, the mortality rate from CVD can be prediction. Taking the area under the curve shows a prediction of 1370.7 prisoner deaths due to CVD between 2040 and 2099. Adjusting for a factor of 246 and a variability prediction factor of 0.345, this paper predicts of 116,331 prisoner deaths due to heat related illness between 2040 and 2099 if not mitigated immediately.

Data from <Explore the Data. Texas Justice Initiative.

<http://texasjusticeinitiative.org/data/> and <National Centers for Environmental Information, NCEI. Climate Data Online Search. National Climatic Data Center. <https://www.ncdc.noaa.gov/cdo-web/search.> >

## References

1. Aging Prisoners Stressing Health Care System. *Jama*. 2004;292(4):423.  
doi:10.1001/jama.292.4.423.
2. McCullough J. After \$7 million legal fight over air conditioning, Texas prison system touts new heat safety policies. The Texas Tribune.  
<https://www.texastribune.org/2018/07/26/texas-prison-heat-air-conditioning-costs/>.  
Published July 26, 2018
3. Initiative PP. Texas profile. Mass Incarceration: The Whole Pie 2016 | Prison Policy Initiative. <https://www.prisonpolicy.org/profiles/TX.html>.
4. *Cole v. Collier*. (United States District Court, S.D. Texas, Houston Division. 2017).
5. Memorandum and Opinion Setting Out Findings of Fact and Conclusions of Law: Injunction in *Cole v. Collier*.  
[https://static.texastribune.org/media/documents/injunction-ruling2017.pdf?\\_ga=2.55598895.561996046.1543426351-676591290.1543426351](https://static.texastribune.org/media/documents/injunction-ruling2017.pdf?_ga=2.55598895.561996046.1543426351-676591290.1543426351). Published July 19, 2017.
6. Hsiang S, Kopp R, Jina A. American Climate Prospectus: Economic Risks in the United States. Climate Impact Lab.  
<http://www.impactlab.org/research/american-climate-prospectus/>. Published October 2014.
7. National Centers for Environmental Information, NCEI. Climate Data Online Search. National Climatic Data Center. <https://www.ncdc.noaa.gov/cdo-web/search>.
8. US Department of Commerce, NOAA. What is the heat index? National Weather Service. <https://www.weather.gov/ama/heatindex>. Published May 29, 2018.

9. Acharya P, Boggess B, Zhang K. Assessing Heat Stress and Health among Construction Workers in a Changing Climate: A Review. *International Journal of Environmental Research and Public Health*. 2018;15(2):247. doi:10.3390/ijerph15020247.
10. Zeng Z, Binswanger I, Blatchford P. Assessing Inmate Cause of Death: Deaths in Custody Reporting Program and National Death Index.  
<https://www.bjs.gov/content/pub/pdf/aicddcrpndi.pdf>. Published April 2016.
11. America's Health Rankings. Cardiovascular Deaths in Texas.  
<https://www.americashealthrankings.org/explore/annual/measure/CVDDeaths/state/TX>.
12. Holt DWE. Heat In US Prisons And Jails: Corrections and the Challenge of Climate Change. Sabin Center for Climate Change Law.  
[https://www.law.columbia.edu/sites/default/files/legacy/files/public\\_affairs/2015/august\\_2015/heat\\_in\\_us\\_prisons\\_and\\_jails\\_aug.\\_2015.pdf](https://www.law.columbia.edu/sites/default/files/legacy/files/public_affairs/2015/august_2015/heat_in_us_prisons_and_jails_aug._2015.pdf). Published August 2015.
13. Schutmaat B. "Cooking Them to Death": The Lethal Toll of Hot Prisons. The Marshall Project.  
<https://www.themarshallproject.org/2017/10/11/cooking-them-to-death-the-lethal-toll-of-hot-prisons>. Published November 21, 2018.
14. Westaway K, Frank O, Husband A, McClure A, Shute R, Edwards S, Curtis J, Rowett D. Medicines can affect thermoregulation and accentuate the risk of dehydration and heat-related illness during hot weather. *Journal of Clinical Pharmacy and Therapeutics*. 2015;40(4):363-367. doi:10.1111/jcpt.12294.
15. Google Scholar. <https://scholar.google.com/>.
16. Home - PubMed - NCBI. Current neurology and neuroscience reports.  
<https://www.ncbi.nlm.nih.gov/pubmed>.

17. Flynn M. As Overheated Prisoners Die, Texas Jailers to Stand Trial Over Sweltering Conditions. Houston Press.  
<https://www.houstonpress.com/news/as-overheated-prisoners-die-texas-jailers-to-stand-trial-over-sweltering-conditions-9202520>. Published September 18, 2017.
18. Hoffberger C. 5th Circuit Affirms Ruling in Texas Prison Overheating Case. Food - The Austin Chronicle.  
<https://www.austinchronicle.com/news/2017-08-25/5th-circuit-affirms-ruling-in-texas-prison-overheating-case/>.
19. Explore the Data. Texas Justice Initiative. <http://texasjusticeinitiative.org/data/>.
20. Merck Manuals Professional Edition. <https://www.merckmanuals.com/professional>.
21. Unit Directory. Texas Department of Criminal Justice.  
[http://tdcj.state.tx.us/unit\\_directory/](http://tdcj.state.tx.us/unit_directory/).
22. Texas Tribune. The Texas Tribune. <https://www.texastribune.org/>.
23. The Marshall Project. The Marshall Project. <https://www.themarshallproject.org/>.
24. Khalaf TM, Ramadan MZ, Al-Ashaikh RA. How many days are required for workers to acclimatize to heat? *Work*. 2017;56(2):285-289. doi:10.3233/wor-162485.
25. Criteria for a recommended standard: occupational exposure to heat and hot environments - revised criteria 2016. January 2016. doi:10.26616/nioshpub2016106.
26. Applebaum, K. M., Graham, J., Gray, G. M., Lapuma, P., McCormick, S. A., Northcross, A., & Perry, M. J. (2016). An Overview of Occupational Risks From Climate Change. *Current Environmental Health Reports*, 3(1), 13-22. doi:10.1007/s40572-016-0081-4
27. Langford T, Chronicle H. With More Inmates on Dialysis, Officials Deal With Rising Costs. The Texas Tribune.

<https://www.texastribune.org/2014/06/02/more-inmates-dialysis-officials-deal-rising-costs>

. Published June 2, 2014.

28. Jackson LL, Rosenberg HR. Preventing Heat-Related Illness Among Agricultural Workers. *Journal of Agromedicine*. 2010;15(3):200-215.

doi:10.1080/1059924x.2010.487021.

29. Simon J. Reversal of Fortune: The Resurgence of Individual Risk Assessment in Criminal Justice. *Annual Review of Law and Social Science*. 2005;1(1):397-421.

doi:10.1146/annurev.lawsocsci.1.041604.120006.

30. Chatterjee A. We Need Better Data about What Is Killing American Prisoners. It's Probably the Heat. Union of Concerned Scientists.

<https://blog.ucsusa.org/science-blogger/we-need-better-data-about-what-is-killing-american-prisoners-its-probably-the-heat>. Published September 6, 2018.