Health Collaborative
Bexar County's Community Health Leadership

The City of San Antonio in 2036: The Impacts of Climate Change on Public Health

A Special Report by the
Bexar County Community Health Collaboartive

Prepared for
The City of San Antonio Office of Sustainability

JANUARY 2022

Overview

The following pages detail findings from a thorough scientific inquiry into the potential and anticipated public health consequences of climate change in the city of San Antonio by 2036. The year 2036 was chosen as a benchmark to align with the Texas 2036 project and the corresponding report from the Office of the State Climatologist at Texas A & M University that predicts catastrophic consequences state-wide if swift action is not taken to arrest climate change. This report represents a joint effort between by the city of San Antonio's Office of Sustainability and the Bexar County Community Health Collaborative (also known as The Health Collaborative), a non-profit organization founded in 1997 to conduct critical research on community health needs that is known for its annual Community Health Assessment (CHA), a comprehensive data collection and analysis effort to discern public health threats in Bexar County and coordinate city and county-wide efforts to address these systemic issues and in turn, promote a healthier community. In Fall 2021, the city Office of Sustainability commissioned the Health Collaborative (THC) to conduct a thorough assessment of the ways in which the changing climate is likely to exacerbate (and perhaps even cause) illnesses, injuries and even deaths through extreme weather events and an increased frequency and severity of diseases exacerbated by the climate crisis as a planning guidance document and vital supplemental companion to the city's Climate Ready Action Plan. THC was tasked with determining what threats pollution-induced environmental changes pose to the city of San Antonio and to quantify the excess morbidity and mortality that can be attributed to the climate crisis. This serves the greater purpose of crafting evidence-based strategies on how to mitigate these losses that conclude this report. In sum, this report offers insight into the public health and safety toll climate change can affect by the year 2036 if actions such as those suggested are not promptly undertaken.

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Introduction

Climate change remains an ever-present concern for residents in all instances and policymakers, San Antonio being no exception. However, the direct and indirect impacts are more complex and widespread than once thought. Studies now affirm the direct correlation between climate change and public health (Crimmins, 2016). Experts indicate that harm to citizens attributed to climate change cannot be mitigated by public health and healthcare sectors alone; that building stronger and healthier communities requires cross-sector alignment and support (Landers et al., 2020). This must begin with a thorough examination of literature and local data that shows distinctly what the most exigent concerns are in San Antonio in order to know where to focus these efforts.

Moreover, the third question that requires an answer is not a "what" or a "where," but "who": who in San Antonio is most at risk for health problems connected to climate change? Scientific literature also stresses that the harm from environmental factors takes a greater toll on the most vulnerable citizens, those who already suffer from less access to the most basic human needs such as safe housing, nutritious food, and healthcare. The National Institute of Environmental Health Sciences' report Environmental Health Disparities and Environmental Justice (2018) aptly sums it up this way, "a combination of poor environmental quality and social inequities have more sickness and disease than wealthier, less polluted communities."

Unsurprisingly, it is often the most marginalized who in turn, suffer a disproportionate share of climate event impacts because of greater exposures, increased physical sensitivities, or less capacity to take protective actions (Ebi & Hess, 2020). The Alamo City is home to a disproportionate population of citizens at disproportionate risk of harm from climate change, groups we call "frontline communities" who are most vulnerable to the negative health impacts of environmental factors. Decreasing the harm to frontline communities is critical in limiting the health harms affected by climate change as a whole. Developing an equity-focused, cross-sector, city-wide climate action plan can guide San Antonio in a strategic direction that may reduce resident vulnerability to climate events and thereby transform the community into one of wellness and resiliency (Yuen, 2017). Fortunately, the City already has

such a plan – one it began developing in 2017 and was formally adopted by the San Antonio City Council in 2019. It is known as the SA Climate Ready: Climate Action and Adaption Plan (Climate Action & Adaptation, 2019). The data presented here is designed to inform decisions regarding plan implementation and offer evidence-based guidance on what strategies to employ in order to achieve plan goals. In particular, this report aims to provide analyses on marginalized and at-risk populations, to further the Alamo City's commitment to promoting equity across its initiatives and programs.

ECONOMICALLY DISADVANTAGED PEOPLE, THOSE WHO LABOR OUTDOORS, PERSONS WITH DISABILITIES, THE ELDERLY, CHILDREN 5-YEARS-OLD AND YOUNGER, PEOPLE OF COLOR (POC); THESE ARE EXAMPLES OF GROUPS WHO SUFFER SUBSTANTIALLY MORE FROM ENVIRONMENTAL HAZARDS DUE TO CLIMATE CHANGE.

Assessing Risk-Level by Demographic Group

The following sections demonstrate the leading climate stressors impacting the health of San Antonians, especially frontline communities like people of color, low-income individuals, the elderly, young children (particularly those under 5-years-old), and persons with disabilities. The relationship between climate change and health is summarized and contrasted with city-wide demographics and health data to identify San Antonio's greatest vulnerabilities.

These are specific areas where climate change can hurt citizens the most unless efforts are undertaken. These are organized into three leading areas: heat stress, flooding, food security, and diabetes, and followed by other health areas of interest that are sensitive to climate change like asthma, allergies, respiratory ailments like COVID-19, and finally, mental health and suicide rates. Recommendations for policies and protective measures for the citizens of San Antonio are included at the conclusion of this report.

Climate Change Impacts on Public Health

Climate change impacts health primarily in that it threatens the basic environmental needs that humans require to live: clean air, safe water to drink, enough nutritious food, and even shelter (WHO, 2021). Disasters created or exacerbated by climate change impede these basic necessities and reduce the health and wellness of communities. For example, wildfires pollute the air, destroy homes and create barriers to accessing clean food and water. Floods sweep away houses and hospitals, contaminate drinking water and provide breeding grounds for disease-spreading mosquitoes. Increased emissions also degrade the nutritional quality of food as well as cause droughts that jeopardize agriculture altogether.

The World Health Organization (WHO) estimates a quarter of a million more people will die between 2030 and 2050 from malnutrition, malaria, diarrhea, and heat exposure if measures are not taken to curb climate change (2021). In its first report in seven years, the Intergovernmental Panel on Climate Change (IPCC) just reported that the rate of damage is much more rapid and severe than once thought. The degree of temperature rise and the speed appear to have been greatly underestimated (2021).

While this is a global crisis, the degree and types of harm from the effects of climate change vary by geographic factors and demographic ones as well. Aspects of a city's landscape can preclude, mitigate or exacerbate the damage of rising temperatures and extreme weather events. For example, proximity to the coastline increases the threat of hurricanes and rising sea levels while distance inland conversely decreases damage from those particular risks, although Hurricane Harvey was a lesson in how widespread flooding can be. Likewise, the severity of harm a city can anticipate corresponds to the vulnerability of its populations, referred to as risks to "frontline communities." Economically disadvantaged people, those who labor outdoors, persons with disabilities, the elderly or the very young, people of color (POC); these are examples of groups who suffer substantially more from environmental hazards due to climate change.

The Aim of This Report

This report aims to identify what populations are most at risk for various health harms attributed to climate change. We accomplish this by first, identifying the harms to which we are most susceptible as a city because of our demographic and geographic characteristics. Then, we look for pre-existing areas of weakness for these threats. We look for injuries, illnesses that are already disproportionately large in our area relative to comparable urban areas and are most likely to increase from climate change. Finally, we attempt to project the excess degree of morbidity and mortality we can anticipate if existing data permits. If sufficient data is lacking, we calculate disparities to determine what populations are expected to suffer the largest burden if swift and bold steps are not taken to curb climate change.

SINCE FRONTLINE COMMUNITIES COMPRISE THE MAJORITY OF THIS CITY, DECREASING THE HARM TO THESE POPULTIONS IS CRITICAL IN LIMITING THE DAMAGE THAT SAN ANTONIO AS A WHOLE MAY FACE DUE TO CLIMATE CHANGE

Methodology

The scientific community is still determining ways to isolate and estimate excess morbidity and mortality because of the sheer number of variables at play. It is difficult to isolate the proportion of harm attributed exclusively to climate change when climate change increases the likelihood of one outcome, which leads to another, that finally results in sickness or death. For example, climate change poses inherent threats due to unsafe ozone levels and poor air quality and has been correlated to increased diagnoses of asthma, chronic obstructive pulmonary disorder (COPD), and lung cancer.

Researchers even say that air pollution rivals smoking as the leading risk factor for these conditions. (Arbex et al., 2012). Calculating the excess morbidity and mortality from air pollution is possible by comparing outcomes in polluted vs. unpolluted areas, but suppose a person with a compromised respiratory system due to air pollution ultimately succumbs to a secondary condition like COVID-19. Those with pre-existing conditions like those caused or exacerbated by poor air quality are far more likely to die from COVID-19 than those without a compromised respiratory system. That person may have never contracted the disease or may have beaten the disease altogether if emissions were reduced before causing or exacerbating this pre-existing condition. Therefore, the question is whether or not this is an excess death from climate change and how it would be possible to make that distinction given that respiratory diseases can have other causes and antagonists. Isolating how many cases or fatalities are due directly to climate change is limited by limitations in data and the complexity of the issue itself.

THERE IS VIRTUALLY NO AREA OF HUMAN LIFE UNTOUCHED BY CLIMATE CHANGE, SO ISOLATING WHAT NEGATIVE HEALTH OUTCOMES TO ATTRIBUTE TO ENVIRONMENTAL FACTORS IS A MAJOR UNDERTAKING AS WELL AS A SIGNIFICANT SCIENTIFIC CHALLENGE.

Furthermore, we can calculate the number of heat-related illnesses and deaths from the increase in the temperature and/or frequency of dangerously hot days, but what if a construction worker does not become ill or suffer heatstroke because they chose to stay home and suffer the lost wages? And suppose those who cannot safely endure the heat are outright fired by their employer. Unemployment often means losing health coverage, which leads to missing preventative care and delaying or foregoing medical treatment. The loss of income can also cause food insecurity that leads to Type 2 diabetes. Diabetics are at a significantly higher risk of complications and death during extreme temperatures. It is arguable that these consequences would be excess casualties from climate change, but never counted as such.

Limitations

Projecting excess morbidity and mortality often involves going down a proverbial rabbit hole like this. There is virtually no area of human life untouched by climate change, so isolating what negative health outcomes are due primarily to environmental factors is a major undertaking as well as a significant scientific challenge. Scholarly research provided ways to measure the increased health risk from climate change, suggesting correlation coefficients or relative risk values that would have provided a way to measure the degree of frequency or severity of health outcomes increased by climate change. For health conditions featured in the research, the calculating figures varied, and not all health conditions were addressed. Some compound morbidity and mortality rates are based on the length of heat waves, which is dubious to replicate. Other studies sampled a population so large and diverse that it was not possible to scale downward for use at the local, county, or even state level.

Measures to Promote Data Integrity and Validity

Whenever possible, actual frequencies of health indicators in San Antonio are employed to provide the projected number and percentage of excess morbidity and mortality. Data from Bexar County was used as a proxy when city data was not available, even data from the State of Texas if more micro-level data was unavailable. Despite scouring these resources, sometimes the data needed to quantify the effect of climate change was absent or limited to numbers too small or too large that scaling to a meaningful level was not possible. Likewise, some data was reported as actual temperature and others as heat index, taking humidity into account and not just surface temperature. Units of analysis also did not match between those data and local data. Studies that calculate excess diagnoses of a disease could not validly predict excess mortality, and local data often lacked equivalent data where those studies could be used to calculate a valid comparison. In all, these incongruences made it hard to accurately project excess morbidity and mortality rates for the City of San Antonio.

For the sake of this report, illnesses and diseases that science shows we can expect to see more of due to climate change (but lacked data on exactly how much more) are reported by disparity. THC has opted to highlight areas of vulnerability and calculate the degree of burden certain groups would face. This calculation was used in identifying the front line communities, groups, or areas most likely to be hit the hardest.

Populations Most at Risk: Defining Frontline Communities

The CDC Climate and Health Program's Regional Report identifies several concerns specific to the Southern Great Plains: Texas, Oklahoma, and Kansas. Identified environmental risks included air quality and extreme weather (in particular, heat emergencies and flash flooding), water-related illnesses (often caused by flooding), vector-borne diseases, and finally food safety, nutrition, and distribution (CDC Climate and Health Program, 2020). While San Antonio is not immune from any of those concerns, some are more alarming than others because of the differences in population makeup between the Alamo City and other proximate cities in Texas.

When a city has a pre-existing disparity with regards to certain negative health outcomes (especially among specific groups), it stands to reason that climate change could easily increase the number of cases to an unmanageable level that is too great for San Antonio to accommodate. This is key because the city population of San Antonio is increasing. The 2020 census shows that Texas grew 15.9%. This is already twice the rate of the U.S. (7.4%) and yet, Bexar County grew at an even faster rate: 17.2%. Certain groups have historically endured hardships, driving down their adaptive capacity to endure climate change. These groups include the very young

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(children under five), those retirement age and older (65+), people in poverty, people of color, persons without health insurance and persons with disabilities.

The U.S. Census Bureau sets parameters in these categories, such as defining poverty according to income and family size relative to consumer costs in each area and limiting the definition of disabled to those under 65 with specific limitations with sight, hearing, cognition and ambulation that impede performing daily life functions. Likewise, only those under 65 are counted among persons without health insurance due to automatic coverage at retirement age in the federal Medicare program.

San Antonio's Frontline Community Concentrations Compared to Other Urban Areas in Texas

These most recent figures from the 2020 U.S. Census allow us to compare local demographic composition to other Texas cities, in order to get an overview of the city's populations that could be disparately impacted by climate change differently or more acutely than other urban areas in the state. The health impacts of climate change can vary in severity based on a person's capacity to respond to these challenges. Those with health insurance have an advantage over those who do not have access to care. Likewise, those families that are economically disadvantaged are the least capable of obtaining the resources to protect themselves from environmental threats or recover from the consequences of climate change. Many groups face a combination of impediments to their health: economic, physical and social. Table 1 offers some of those groups and compares the share of the population in San Antonio with five other Texas urban centers.

Table 1: Demographics of the City of San Antonio vs. Comparable Major Texas Cities (U.S. Census Bureau, 2020)

	TEXAS URBAN DEMOGRAPHICS	San Antonio	Austin	Houston	El Paso	Dallas	Fort Worth	Median	Margin+	Rank++
FRONTLINE COMMUNITIES	Total population size	*1,434,625*	961,855	2,304,580	649,121	1,304,379	741,206	1,133,117	301,508	2
	Person's Under 5 years	*6.90%*	6.40%	7.60%	8.00%	7.50%	7.40%	7.45%	-0.55%	5
	Person's 65 years and over*	*12.00%*	8.90%	10.50%	9.70%	10.30%	12.70%	11.25%	0.75%	2
	People of color*	*75.30%*	51.70%	75.60%	87.20%	71.00%	60.80%	73.15%	2.15%	3
	Persons with disabilities (under 65)*	*11.10%*	6.20%	6.40%	9.30%	6.70%	7.40%	8.35%	2.75%	1
	Persons without health insurance (under 65)	*18.70%*	14.70%	25.40%	21.50%	26.00%	20.00%	20.75%	-2.05%	5
	Persons in poverty	*17.80*	13.20%	20.10%	19.10%	18.90%	14.50%	18.35%	-0.55%	4

*Significant, Ranking 1st or 2nd
+ Degree San Antonio Population is Above /Below the Median
++ How San Antonio Ranks Among the Cities Listed, From 1-6

As Table 1 demonstrates, San Antonio has slightly fewer children under 5 than the expected percentage for Texas cities. Also encouraging is that San Antonio is in the bottom half of cities when it comes to the percentage of citizens in poverty and is second only to Austin in the number of citizens who have health insurance. Access to medical care afforded by insurance coverage puts people in a better position to overcome illnesses and injuries caused by extreme weather and pollution.

Economically-disadvantaged Citizens of San Antonio are Fewer than in Other Cities, Yet Still Comprise Nearly 1/5 of San Antonio's Population

Poverty impacts virtually all aspects of life, from safe housing with adequate climate control to the ability to access and afford nutritious food, and also, obtaining regular preventative healthcare as well as acute care services. 2020 Census data reveals that an estimated 17.8% of San Antonians live in poverty. This exceeds the state percentage by 4.2 points, yet is slightly below the median for rural areas. Nonetheless, 17.8% is over a quarter of a million citizens in San Antonio (255,363) who are under-resourced and particularly susceptible to public health threats caused by climate change.

Poverty impacts virtually all aspects of life, from safe housing with adequate climate control to the ability to access and afford nutritious food, and also, obtaining regular preventative healthcare as well as acute care services. 2020 Census data reveals that an estimated 17.8% of San Antonians live in poverty. This exceeds the state percentage by 4.2 points, yet is slightly below the median of 18.35% for urban areas. Although it may be encouraging that San Antonio have fewer citizens in dire economic distress, it is vital to remember that 17.8% is over a quarter of a million citizens in San Antonio (255,363) who are under-resourced and particularly susceptible to public health threats caused by climate change.

San Antonio Ranks First in the Percentage of Citizens with Disabilities

Persons with disabilities (whether physical or intellectual) can face additional obstacles that inhibit their health. Like those living in food deserts (places that lack markets with fresh produce within walking distance), persons with disabilities can have an even more difficult experience with traveling to supermarkets- and also to doctors and pharmacies. Over 11% of San Antonians have a disability, contrasted with the 7.9%

state-wide. Only San Antonio and El Paso exceed this state average, but San Antonio exceeds the median for urban areas by 2.75%. This is notable because the American Community Survey employed by the Census Bureau has a very narrow scope for qualifying someone as having a disability.

Those with intellectual or mental afflictions like developmental delays or autism may register as disabled if certain activities of daily living are impaired, but those with cognitive disorders that manifest only in certain circumstances may not, since these challenges might not occur daily. However, many of these limitations are recognized as disabilities under federal law and could inhibit a person seeking safety from climate-related health threats like natural disasters. An agoraphobic person fearful of crowds may be unwilling to take refuge in crowded shelter like a claustrophobic person may be unable to shelter in small, enclosed spaces. San Antonio already exceeds the number of persons with disabilities to accommodate even with narrow scope, yet easily may have more vulnerable citizens to consider when planning for environmental crises.

Post-Traumatic Stress Disorder (PTSD) disproportionately impacts veterans and the Alamo City is home to 2.39-fold more veterans than other Texas Cities. This equals potentially 0.78%-2.48% more persons with disabilities to accommodate than the U.S. Census Data shows.

Many Disabled Veterans Likely Uncounted in Current Statistics

One example would be those battling post-traumatic stress disorder (PTSD), an affliction that can impact anyone who suffered a trauma but is most commonly associated with military veterans. Around 6-7% of the general population experience PTSD at some point in their lives, but

this number is 11% to 35% of veterans (U.S Department of Veterans Affairs, 2021). While PTSD manifests differently from case to case, natural disasters caused by climate change could easily be a trigger for many that impairs their ability to seek safety for themselves and those who may depend on them. San Antonio has 101,723 veterans as of 2019, while the median for Texas cities is 42,474 making the Alamo City home to 2.39-fold more veterans. Houston has only 69,335 in spite of boasting nearly one million more people; yet when controlling for population size, San Antonio's population is 7.09% veteran, whereas Houston is only 3.01%. Overall, San Antonio has over 50% more veterans per capita than other Texas cities. If the Veteran's Affairs data is valid, this means 11,189 to 35,603 San Antonians who may be impeded by PTSD. The equals .78% - 2.48% more citizens to count when considering what preparations are needed to protect persons with disabilities from the dangers of climate change.

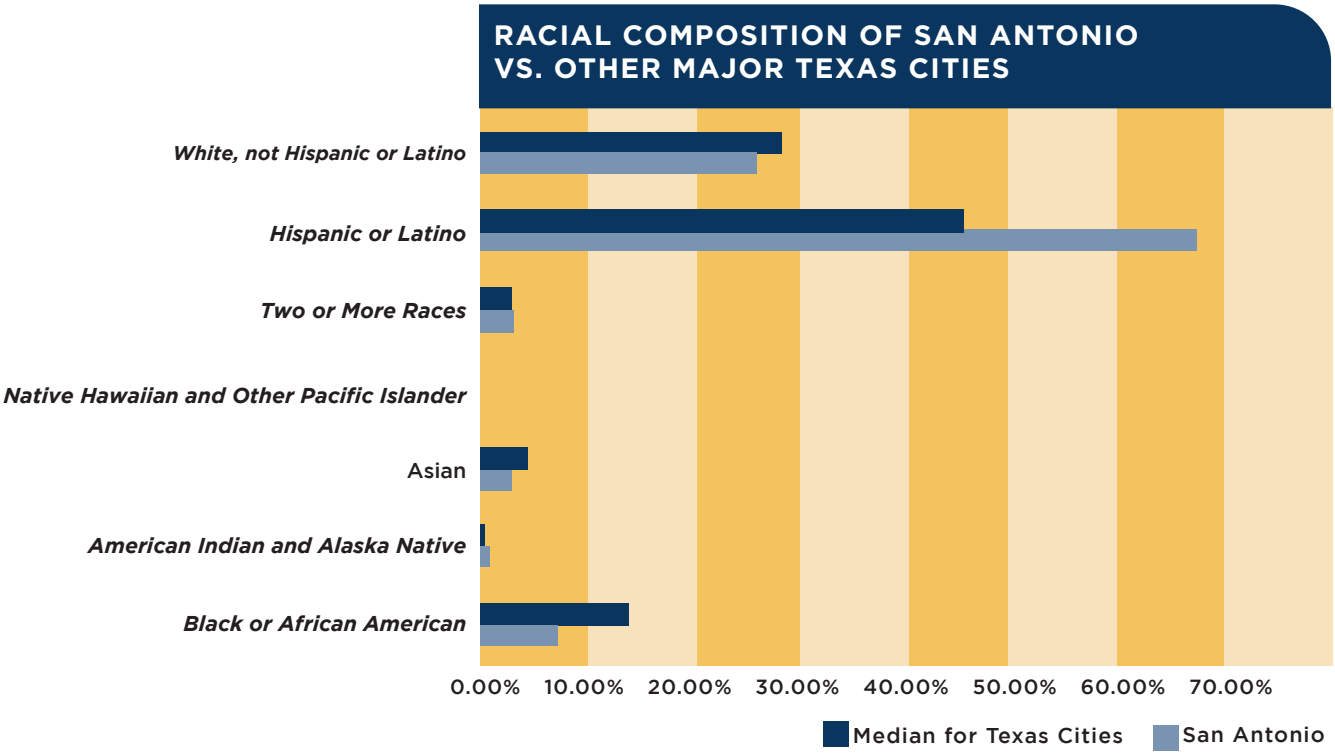
San Antonio Ranks Second in the Percentage of Citizens Over 65

At 12%, San Antonio is second only to Fort Worth as having the highest percentage of citizens that are retirement age. This 12% figure is only marginally above the median for Texas cities (11.25%), but still adds up to 172,155 people who may require special protections and assistance. With age comes additional challenges for many who face ambulatory, auditory and visual limitations that were not present in their younger years. Associated age-related health risks can put senior citizens in greater danger as well, especially the greater sensitivity to extreme heat caused by climate change. Likewise, fixed incomes can inhibit older people's access to both the basics of life as well as their abilities to recover from natural disasters.

People of Color in San Antonio

The second most striking disparity between San Antonio and other Texas cities comes to racial composition. Figure 1 examines this more closely.

Figure 1: Racial Breakdown of San Antonio vs. Other Comparable Cities Statewide (U.S. Census Bureau, 2020)



It is not remarkable that people of color outnumber white citizens in San Antonio. This is typical in urban areas. What is atypical when San Antonio is compared to the median percentage of citizens by race in other cities; it differs from the norm in that it is home to 20.80% more Hispanic citizens than other cities and nearly half the percentage for Black or African American citizens. San Antonio is like other cities in that nearly three-quarters of the population of San Antonio are people of color, but unlike other Texas cities, three out of five such people are Hispanic.

People of Color and Health Outcomes

In Texas, the Hispanic population has grown 1.7% since 2010 and the white population has dropped 5.6%. San Antonio is comparable in that the white population decreased by 3.2% while the Hispanic population increased by 0.7%. That increase is not significant until

you stop to remember that Hispanics compromise nearly 65% of San Antonio's total population as is, and yet this number is likely to grow. That is why targeted concern must be paid to how this group specifically is impacted by climate change and make recommendations that also benefit other communities of color as well.

Understanding the racial composition of the City is critical because racial minorities as a whole are frontline communities, People of color face disproportionate hardships economically and socially as is, and are therefore more vulnerable to the negative health effects of climate change.

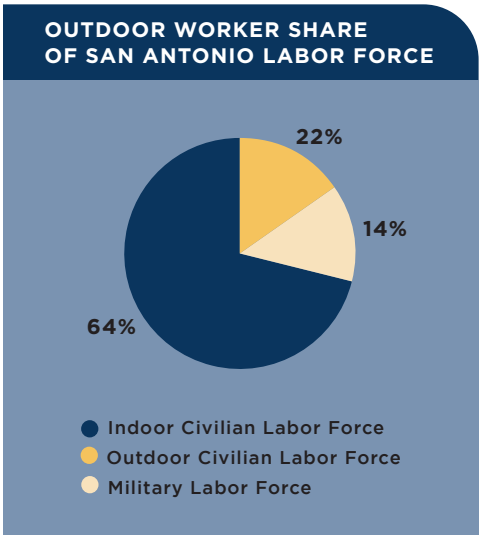
The 7% of Black San Antonians face many of the same risks from climate change as the 64% of Hispanics in our City (and as research shows, likely bear a greater burden on many health issues), so it stands to reason that any efforts to mitigate climate change harm by looking primarily at the toll on Hispanics would also benefit the others of color in our city, not just the 3/5ths who are Hispanic.

Additional Communities of Concern: Outdoor Workers

This report pays particular attention to another group of people: outdoor workers. These laborers are exposed to changing environmental hazards from ground-level ozone, smoke from wildfires and mostly, oppressive heat (Centers for Disease Control, 2021). In Bexar County, these workers include 8,357 in protective service occupations; 35,359 groundskeepers and building maintenance technicians; 1,243 farmers; fishermen/women or in forestry occupations; 54,068 construction workers or natural resource extractors; 28,484 workers in various technical roles like installation, maintenance, and repair of outdoor equipment; 31,844 in transportation;

and 19,354 who work as material movers. In total, this means that around 188,709 people in Bexar County labor in jobs that are primarily outdoors: This is 22% of the entire workforce on the frontlines of the changing climate as Figure 2 demonstrates.

Figure 2: Outdoor Workers as Share of the San Antonio Labor Force (U.S. Bureau of Labor Statistics,)



Greater Exposure, Greater Risk

Over 1/5th of the workforce exposed to the elements is a considerable number as well as an arguably significant part of our economy that need protection. These people face greater exposure to hazardous conditions. The Union of Concerned Scientists emphasizes the importance of the heat index metric rather than just temperature alone, noting how the temperature can be lower, but relative humidity can make it feel far hotter (2019).

The authors explain that outdoor workers may feel forced by the economic need to work in dire conditions when the heat index is at unsafe levels, else they suffer from lost wages (which impacts health in other ways). This group is in a particularly disadvantaged state- a lose-lose situation, unless policy changes are made to curb rising temperatures and to protect them physically and economically from working in unsafe conditions (Too Hot to Work, 2020).

Military Personnel Working in the Elements

There are also military personnel in mostly outdoor occupations who need consideration. San Antonio boasts among the highest percentage of citizens in active-duty military service than most other cities (Rodriguez, 2018). The Bureau of Labor Statistics segregates the workforce into civilian and non-civilian, but many active-duty service members spend considerable time outside. This is perhaps why San Antonio military bases reported a whopping 5,694 heat-related injuries in 2015 (Joint Base San Antonio, 2015).

Table 2: Days With a Heat Index Exceeding 100° at Local Military Bases in San Antonio
(Union of Concerned Scientists, 2019)

DAYS WITH A HEAT INDEX EXCEEDING 100°				
Local Military Base	**Historical Number of 100°+ Days**	**100°+ Days Expected Midcentury**	**Increase in Number of 100°+ Days**	**Increased Risk Factor**
Randolph Air Force Base	31	100	69	223%
Lackland Air Force Base	36	105	69	192%
Fort Sam Houston	31	101	70	226%

The Union of Concerned Scientists reported that Fort Sam Houston and Lackland Air Force base rank in the top ten military bases with the expected largest increase in days where the heat index exceeds 100° (F). (US Military on the Front Lines of Extreme Heat, 2019). These are known as "black flag days" (Werrell, 2019). Table 2 with all three San-Antonio bases demonstrates how this spike in black flag days more than doubles historical figures, theoretically doubling the risk of heat-illness. This table indicates an over 213% increase on average (223% median risk) that military personnel could suffer from heat-related illness.

Most Vulnerable Areas of the City: The At-Risk Region

There is a certain area of the City where the residents are least equipped to recover from climate-related disasters and health emergencies alike. A two-year study revealed that four zip codes have the highest concentration of risk factors leading to poor health outcomes. These are 78202, 78207, 78208, and 78211 (Asset Funders Network, 2019).

Disproportionate Lack of Social, Physical and Economic Equity

These zip codes were highlighted by the study authors as having two or more categories in which they fared worse than the city average: mostly poverty, unemployment, and health insurance coverage. The study also looked at high school graduation rates as well, a factor that could play into other health disparities.

All but 78211 had a higher percentage of people experiencing poverty, more than double the city average of 15%. 36% of residents in 78208 were living below the poverty line, 38% in 78202 and 39% of residents in 78207 were in dire financial need. With the exception of 78208, these zip codes reported nearly twice the rates of unemployment as the city (from 13-15% vs. the city average of 7%) which could explain why so many residents in these areas also lacked health insurance coverage: 78211 (30%) and 78202 (31%).

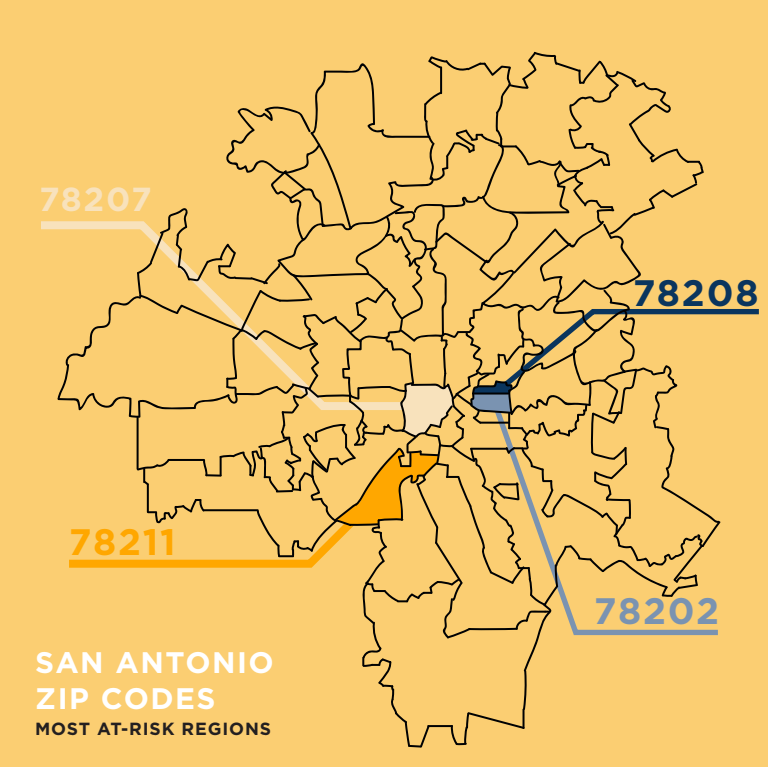


Figure 3: The At-Risk Region (Asset Funders Network, 2019)

When mapped (See Figure 3), these four zip codes are adjacent and in a specific area of the city: Center-South. This is the "at-risk region." This area is the most likely to suffer the most harm, while the least equipped to recover from the damage. In the following sections, we assess the impact from environmental factors like elevated temperatures and flood risk in this region. We also examine the impact on frontline communities throughout the City who are most likely to be harmed by these events, communities that make up a larger percentage of the total population of our City than elsewhere in the state.

Extreme Weather and Related Health Problems

Tornados, earthquakes, and hurricanes do often bring a death toll, but these are not the deadliest weather events. According to The National Oceanic and Atmospheric Administration (NOAA), heat is the #1 killer, followed by floods (2021). San Antonio has an increased vulnerability to both of these threats and the health problems they cause because of our warmer climate and landscape that lends itself to flooding. In the following sections, we detail who is most at risk and what issues to expect.

Heat Stress

San Antonio already boasts warmer temperatures year-round than northern cities do, but this means that already hot summers can only become more dangerous as temperatures rise. The Office of the State Climatologist at Texas A&M University published a report in 2020 that found the number of triple-digit days has more than doubled since the 1980s and could double yet again in fifteen years. In 2036, Texas can anticipate 21 days of 100°+ heat and San Antonio-specific projections are 24 additional days of triple digits by 2040 (SA Climate Ready, 2019). This means that the City of San Antonio's risk of more heat-related health crises can only be expected to increase, right along with the population. Furthermore, 37% of these are excess deaths due to climate change (Vicedo-Cabrera et al., 2021). Consequently, pre-existing conditions exacerbated by heat can be expected to increase, as well as new health problems caused by prolonged exposure to hot temperatures. Rising temperatures are also correlated with disease as well, and studies show a 10% increase in all causes of death during heat waves (Isaksen et al., 2015). We begin with looking at heatstroke, heat exhaustion, and other related illness, who these afflictions are likely impact and later, we look at the mental health toll and increase in crime and/or violence attributed to excessive heat.

THE ANTICIPATED INCREASE IN DAYS WITH EXTREME HEAT (I.E. "AT-RISK DAYS") IN 2036 IS 44, AND THIS YIELDS AN EXPECTED 170 MORE CASES OF HEAT-RELATED HEALTH ISSUES SUCH AS DEHYDRATION, HEAT CRAMPS, AND HEAT EXHAUSTION. THIS IS A 40% INCREASE IN HEAT ILLNESSES ATTRIBUTED DIRECTLY TO CLIMATE CHANGE.

Age and Occupation as a Risk Factor for Heat-Related Illness

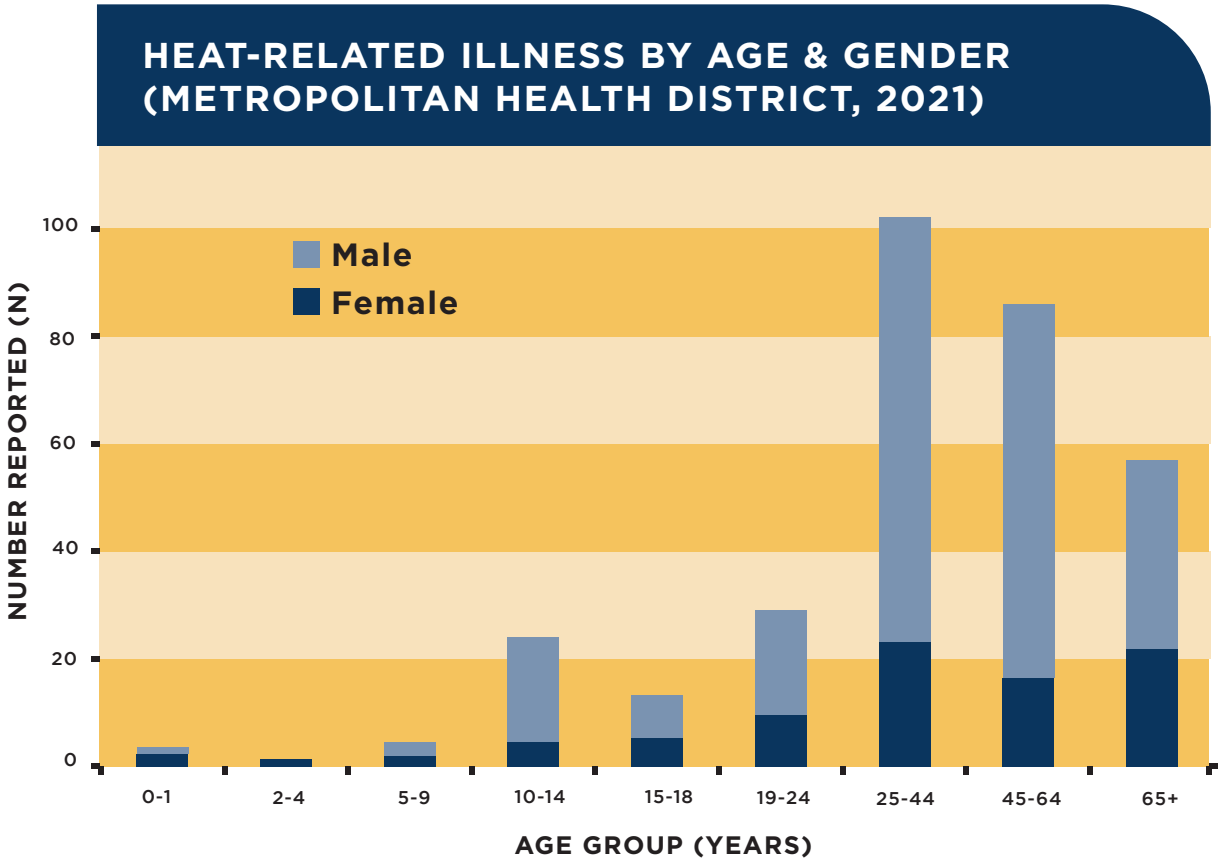
Heat is a concern for many people but primarily older individuals and those who work outside. According to the CDC, the heat seems to take the hardest toll on those who are retirement age (65 and older). An examination of mortality from 2004-2018 indicated that those age 65 or older succumbed to heat more often than younger groups (39% of those who died). But what is also noteworthy is that the next age cohort of people aged 45-64 still comprised 35% of heat-related mortality victims. This means that 74%, nearly 3/4 of the population have a greater mortality rate from extreme heat than their younger counterparts (Vaidyanathan et al., 2020).

However, San Antonio statistics differ when looking at total heat-health emergencies, not only fatalities. Four years of statistics from the city health department on heat-related emergencies show precisely the number and type of heat-related illnesses for years 2018, 2019, and 2020, as well as totals for each illness as of October 2, 2021 (City of San Antonio, Metropolitan Health District, 2021). They document dehydration, heat cramps, heat exhaustion, heatstroke, and fatalities (there were no deaths reported). When examined by gender and age, adult men from 25-44 are the most common victims of heat-related illness in every report.

The most likely explanation may be occupation.

These are working age, not retirement age people made ill by excessive heat and likely to be outdoor workers. That corresponds to the chart on gender and with city workforce demographics. The most recent report as of October 15, 2021 shows this discrepancy, and a chart from that report is offered as Figure 4.

Figure 4: Heat-Related Illness by Age and Gender (Metropolitan Health District, 2021)



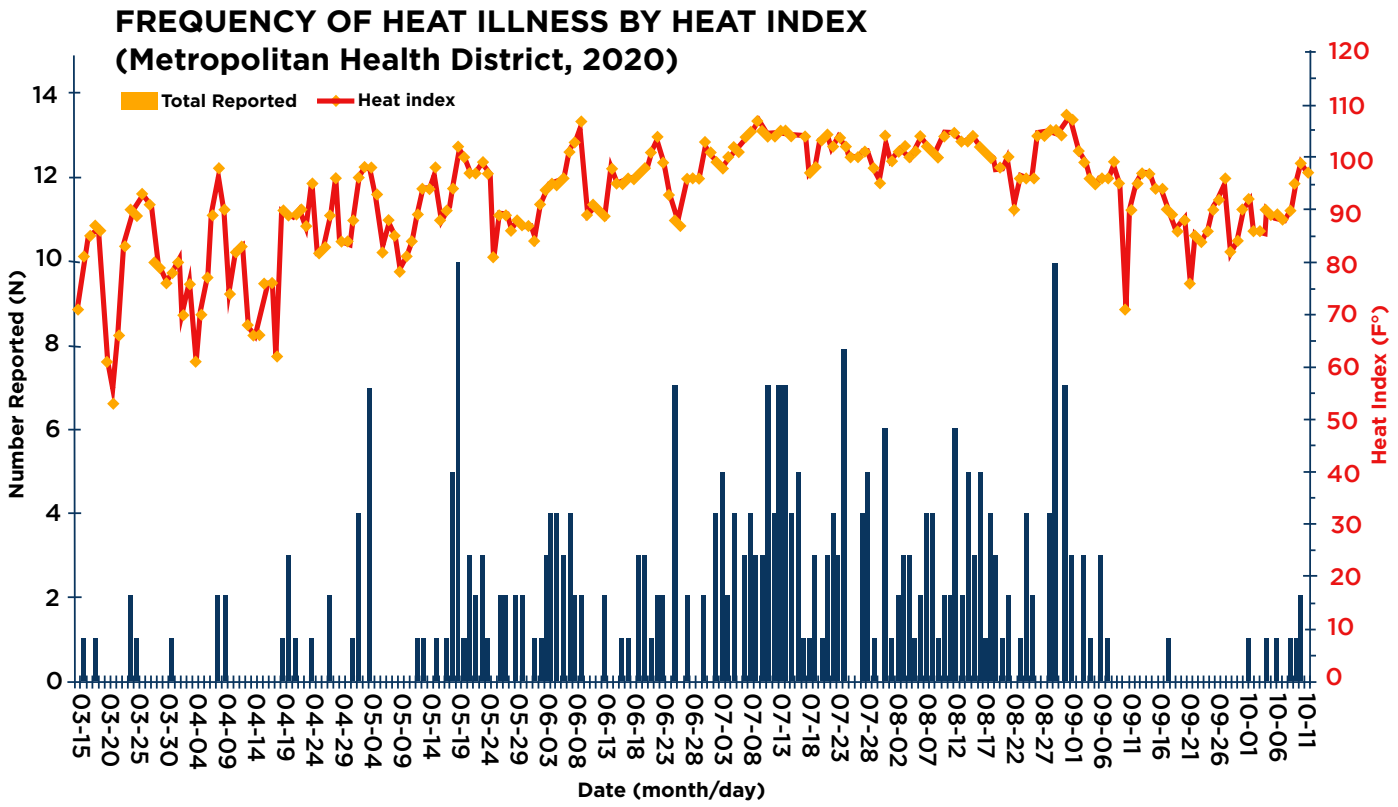
Source: South Texas Regional Advisory Council (STRAC, RescueNET Reporting).

Estimated Excess Cases of Heat-Illness from Climate-Change

To estimate just how much of an increase in incidents to expect data from San Antonio Metropolitan Health District was used to project the number of excess cases of heat-related illness in the city by 2036 if temperatures rise as the authors predict. Although most statistics focus on the added number of triple-digit days, the local data indicates that this would greatly underestimate total cases. Each report affirms that temperatures become dangerous to people's health in San Antonio before the heat index reaches 100°.

Figure 5 below from the 2020 annual report shows that cases begin to spike when the heat index enters the 80°s and become more frequent as the temperatures rise.

Figure 5: Frequency of Heat Illness by Heat Index (Metropolitan Health District, 2020)



Source: South Texas Regional Advisory Council (STRAC, RescueNet Reporting).

For this reason, using the increase in only triple-digit days would be inaccurate, and 90° days were used as the threshold. This number of at-risk days was determined from a 2019 report from the Union of Concerned Scientists. The historical number of days above 90° is 110, but this will increase to 154 by midcentury unless major steps are taken to halt climate change (Too Hot to Work, 2020). The weight of another 44 at-risk days was added to determine the excess morbidity as 170 cases connected to climate change- 40% more than would have happened if temperatures had stayed the same. All data from 2018 to 2021 is historical and used to calculate the projected rise in 2036.

Although a 40% increase may seem alarmingly high, this result is validated by other analyses in different locales. It is consistent with a recent study that estimated 37% of heat-related deaths are directly linked to climate change (Vicedo-Cabrera et al., 2021). These are deaths from heat-related illness alone, but studies show that heat can exacerbate and potentially cause other health problems. See Table 3 for this estimate.

Table 3: Heat-Related Illnesses, Historical and Projected

HISTORICAL DATA & PROJECTIONS: HEAT STRESS					
	2018	2019	2020	2021	2036
Total Heat-Releated Illnesses in San Antonio	273	369	323	303	595
					Excess Morbidities: 170 Percentage: 40%

Health Threats and Economic Burden of Energy Inefficiency in Poor Households

Those households in San Antonio who are least able to afford the costs of energy to keep cool are referred to by the scholarly community as "energy-burdened," meaning that they spend about 10% of their income on utility bills (Ahmed, 2017). A report from the Energy Institute at the University of Texas estimated in 2016 that a fifth of Texas families fall into this category. Economically-disadvantaged persons are also more likely to dwell in older, substandard housing that is poorly insulated and/or uses inefficient HVAC equipment and other appliances.

Upgrades and weatherization could potentially cut energy costs in half, but are financially out of reach for those families most in need. Researchers note that most energy-burdened homes are rented, and landlords lack economic incentives to lower their tenants' bills (American Council for an Energy-Efficient Economy, 2020). Fortunately, the federal government incentivizes upgrading to newer and eco-friendlier appliance models through tax credits and refunds, but this still does not provide the upfront capital for poorer families to take advantage of these options. Likewise, assistance programs have limited funding allocated to them as well.

The cost burden can potentially compel families to endure unsafe temperatures rather than incur a bill they cannot afford to pay. This creates additional health risks. Furthermore, families can find creative and potentially dangerous ways to heat or cool

their drafty homes. When the 2021 winter storm left millions of Texans without power, a report from the Texas Department of State Health Services indicates that 246 people died, most from hypothermia, sixteen of them in Bexar County (Martinez, 2022). However, nineteen people perished from carbon monoxide poisoning from using gas ovens, grills or their automobiles as heat sources when the electrical grid failed. Another ten were killed from fire-related injuries from improper use of space heaters or accidents from fires set to generate heat (Martinez, 2022).

Makeshift climate control can be dangerous at both ends of the extreme weather spectrum. The CDC and WHO both warn that fans become ineffective once the heat index tops 99, yet fans are often sought as budget-friendly alternatives to air conditioning. (Park, 2019) The consequences of unsustainable utility costs can lead to disconnection and this is a common reason for child welfare authorities to remove children from their homes (Williams-Tack, 2021). This is an emotional trauma that can potentially be mitigated by continued aid for low-income families to make energy-efficient updates to their homes as well as subsidize energy costs during dangerous weather. This might also curb greenhouse gas emissions that exacerbate warmer temperatures and poor air quality due to ground-level ozone.

Behavioral Threats of Extended Heat: Crime and Intimate Partner Violence

Hot weather and crime are positively correlated, particularly violent crimes. Scientists predict that every 1° Celsius increase in temperature can lead to an average 6% increase in homicides (Mares & Moffett, 2015) and a recent projection suggests an additional 2.3 to 3.2 million violent crimes by 2099 depending on the rate of greenhouse gas emissions (Harp & Karnauskas, 2020).

Those most likely to bear the greatest burden on increased violence are women (Wachholz, 2013). One study found a confirmed correlation between increases in intimate partner violence (i.e. domestic violence) precipitated by consequential days of heat

exceeding 34° Celsius of 93.2° F (Sanz-Barbero et al., 2018). In the day following the heat wave, police reports increased and three days later, there was a significant increase in female homicides by male partners.

San Antonio is presently battling disturbing rises in the number of such crimes. In 2020, San Antonio deaths from domestic violence increased 31% from the prior year (Barrera & Salazar, 2021). In total, 2020 numbers for family violence homicides in Bexar County was 36, 20 of which were women who were murdered by their male partners. This is 55.6%. (Tellez, 2021). Experts estimate that 1 in 3 women in San Antonio suffer from family violence (Ramos, 2021). The increased heat from climate change can potentially exacerbate this existing issue.

Flooding

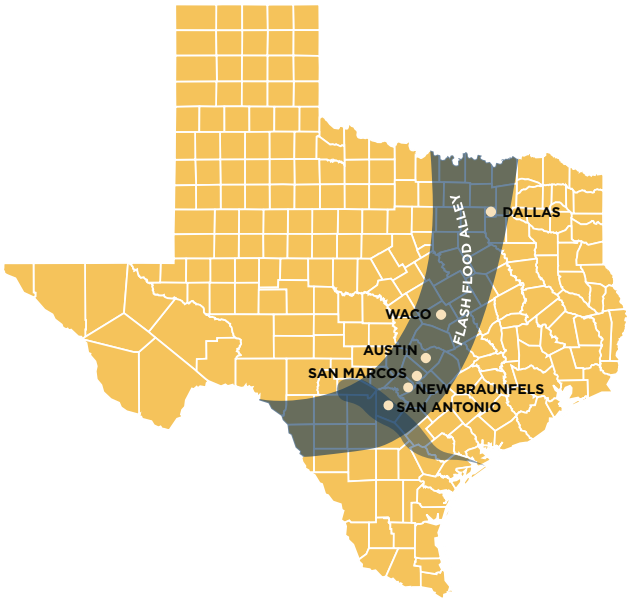


Figure 6: FLASH FLOOD ALLEY (San Antonio River Authority, 2021)

The Office of Climatology at Texas A&M projects a 15% increase in the number of urban floods due to climate change, but this is more threatening to coastal communities, low-lying areas, and here in San Antonio (Texas 2036, 2020). We live in a region known as Flash Flood Alley (See Figure 6), a belt across Texas where flooding is more frequent and can be more severe. The San Antonio River Authority explains why this area is so susceptible to flash floods, stating that rainfall and drainage off of this landscape, also known as the Balcones Escarpment, combine to make this part of Texas one of the most flood-prone regions in North America.

Figure 7 shows how these floods translate into fatalities concentrated mostly among counties in the Flash Flood Alley, including Bexar County.

The most infamous flood in San Antonio city history was 100 years ago as of September 9 but floods endure as a health and safety threat to San Antonians now just as they did in 1921, with climate change aimed to make this threat far more dire. A woman and her five-year-old perished from a flood as this report was being written (Associated Press, 2021). To demonstrate the prevalence of flood deaths in Flash Flood Alley, Figures 7 and 8 are transposed to illustrate the number of fatalities is concentrated in this area. Figure 8 overlays Flash Flood Alley map with flood fatalities.

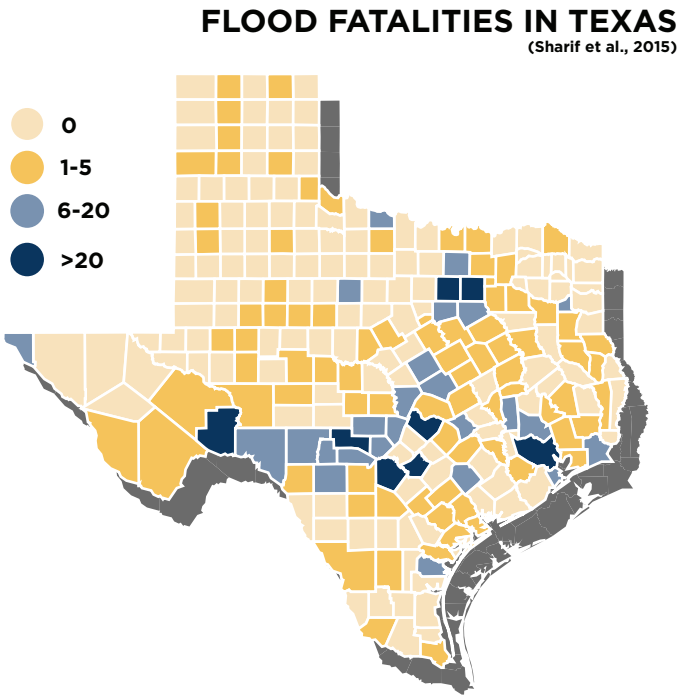


Figure 7: Flood Fatalities in Texas (Sharif, et al., 2015)

FLASH FLOOD ALLEY/ FLOOD FATALITY OVERLAY

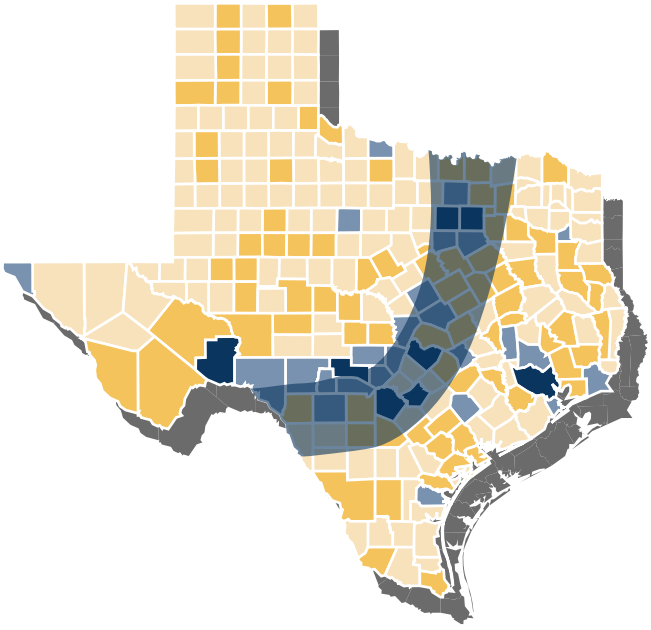


Figure 8: Flash Flood Alley/Flood Fatality Overlay

Estimated Flood Danger from Climate Change

Texas ranked first in the number of flood fatalities between 1958-2008 and in San Antonio specifically, the death toll continues to rise (Sharif et al., 2015). Even when just looking at the excess injuries and deaths that can be expected from flooding itself, the 15% increase in flooding events is expected to cost an additional two fatalities and three injuries. This is calculated by comparing the historical sums per decade up until 2020 (the last full year of data), controlling for expected population increases, and then adding the factor of .15 for the anticipated increase in the frequency of floods (See Table 4).

FLOODING FATALITIES & INJURIES

	2000-2009	2010-2019	2020-2029	2030-2036	EXCESS MORTALITY /MORBIDITY
FLOOD EVENTS	120	159	172	183	24
FATALITIES	11	6	11	11	2
INJURIES	29	0	19	27	3

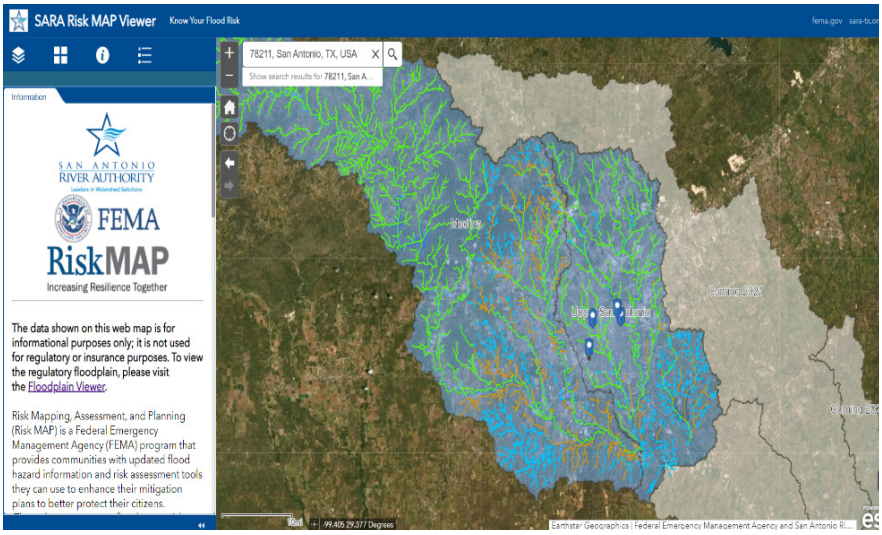
Table 4: Excess Injuries and Fatalities from Increased Flooding

Most of these deaths were from vehicles swept away on low-lying roads. Sharif et al. reported that in 76.5% of lives lost to floods, the victims died in a vehicle (2015). First Street Foundation estimates that 1,361 miles of roads within San Antonio are at risk of becoming impassable due to flooding and could be dangerous to those to still attempt to navigate them. Flooding can also prevent ambulances from getting to those in need (First Street Foundation, 2017) and a meta-analysis of 113 studies found that poisonings, gastrointestinal, skin, and soft tissue infections, diabetes-related complications, and leptospirosis increased shortly following storms and floods (Saulnier et al., 2017).

Frontline Communities and the At-Risk Region

The infamous flood of 1921 is said to have taken its greatest toll on the poorest parts of our city (Graybill, 2021). History could repeat itself, since the at-risk region, those least equipped to recover from a flood, are nonetheless still in the middle of a watershed according to the latest FEMA floodplain maps. Figure 9 plots the four previously identified zip codes on this map.

Figure 9: The At-Risk Region in a Floodplain (San Antonio River Authority, 2021)



These areas are not at a greater risk of flooding since, as you can see, the city, in general, is in a watershed and also in Flash Flood Alley. But this region was specifically examined for how many roads in each zip code were labeled as having higher-than-average risks for roads becoming submerged, impassable, and altogether dangerous.

Assessing the Risk of Flood-Disabled Roads in Vulnerable Communities

The methodology used was to compare the expected depth of flooding to the operational threshold of the road using the projected amount of floodwater to reach the center of a road, how much of the road was covered, and mostly: how deep those floodwaters are expected to be in that particular area. While the risk is listed as “moderate, increasing” for most of the zip codes in the region, the risk in 78208 was labeled as “major, increasing.”

Table 5 shows these rankings for each zip code as well as the projected number of miles impassable, the total number of road miles, and what percentage of the zip code's road will be affected. This analysis shows that the percentage of road miles disabled in each zip code is higher than the city average, except in 78202, where it is 2% less. In spite of that, the average number of road miles lost to flooding in the at-risk area is still 6% more than the city as a whole. Each zip code that is expected to fare worse on other outcomes from climate change can also expect over a quarter of their roads closed from floodwater. In 78211, it is significantly more: 31%. That means around 1/3 of their infrastructure is inhibited.

Table 5: Percentage of Roads Disabled by Flood Events (Flood Risk, 2021)

PERCENTAGE OF ROADS DISABLED BY FLOOD EVENTS

LOCATION OF FLOOD-VULERNABLE ROADS	FLOODRISK.COM RANKING	ESTIMATED MILES OF IMPASSABLE ROADS DUE TO FLOODWATER	TOTAL ROAD MILES	% OF ROAD MILES DISABLED BY FLOODS	DEGREE ABOVE / BELOW CITY AVERAGE (20%)
City of San Antonio	Moderate, increasing	1361	6750	20%	———
78202	Moderate, increasing	12	67	18%	=2%
78207	Moderate, increasing	54	225	24%	+4%
78208	Major, increasing	10	37	27%	+7%
78211	Moderate, increasing	53	173	31%	+11%
At-Risk Region	———	129	502	26%	6%

In terms of human cost, this means an increased risk of dying in flood-related accidents for those in this area. These miles of impassable roads could easily inhibit rescue vehicles and ambulances from getting to those in imminent danger. However, it is possible that these citizens were already at an increased risk, to begin with since low-income people are less likely to have a sufficient stockpile of water, food, and medicine to wait out a storm.

For example, Hurricane Harvey took an estimated 70 lives, 81% by those driving in floodwaters, but 6% were due to an inability to access life-saving medications or treatments

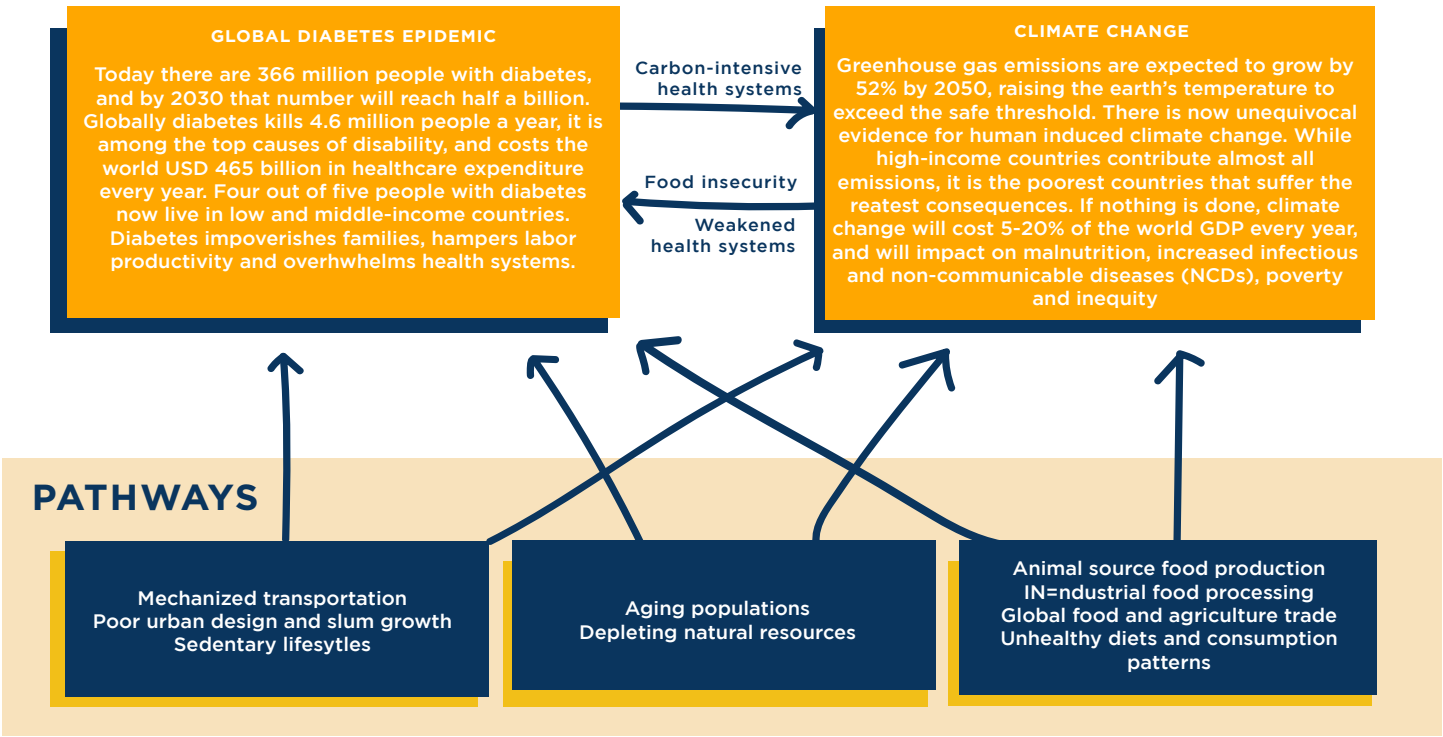
(Jonkman et al., 2018). These basic but critical needs can compel citizens to brave the roads out of pure necessity. Cutting off access to food, medicine and emergency services threatens human lives, but those in disadvantaged areas could easily be in greater peril. The aftermath of lost wages from days unable to work or businesses closed by impassable roads can present their own risk as well.

Food Insecurity

Ironically, the increase in precipitation that causes flash floods is not expected to aid agriculture. Rather, experts warn of an increase in drought severity that can impede food production. Local projections from 2019 SA Climate Ready report anticipate 10% less rain by the end of the century. Climate change is already lowering the nutritional value of food due to increases in CO2. Increased CO2 levels have been shown to lower the protein content of grains. Likewise, micronutrient contents like calcium, potassium, magnesium, phosphorous, iron have decreased in many crops because carbon dioxide levels have risen to 550 parts per million (Myers et al., 2014). Climate change is also reducing crop yields domestically and worldwide (Ray, 2019).

This is a long-term concern for humans as a whole, but nutritional needs and food insecurity already burdens many San Antonians as is, and it is also a significant factor in our city's most overwhelming health problem: diabetes. It is also supported by scientific literature, which affirms and explains the connection between food security, diabetes, and climate change. Figure 10 from the International Diabetes Federation illustrates the direct and indirect dependencies of this world crisis.

Figure 10: The Food Insecurity/Diabetes Connection
(International Diabetes Federation, 2020)



Food Deserts and Disease Prevalence

San Antonio also suffers from widespread food deserts, areas that lack markets selling fresh fruit and vegetables. In urban food deserts, low-income people live between more than a half-mile or a mile from the nearest source of healthy food, making convenience stores often the only accessible option for grocery purchases. In Bexar County, food deserts were identified in more than 11 zip codes (Molina, 2019). Furthermore, the At-Risk region is hit quite hard as Figure 11 demonstrates. Food deserts, as well as the at-risk region, are mapped. Simply overlaying the above

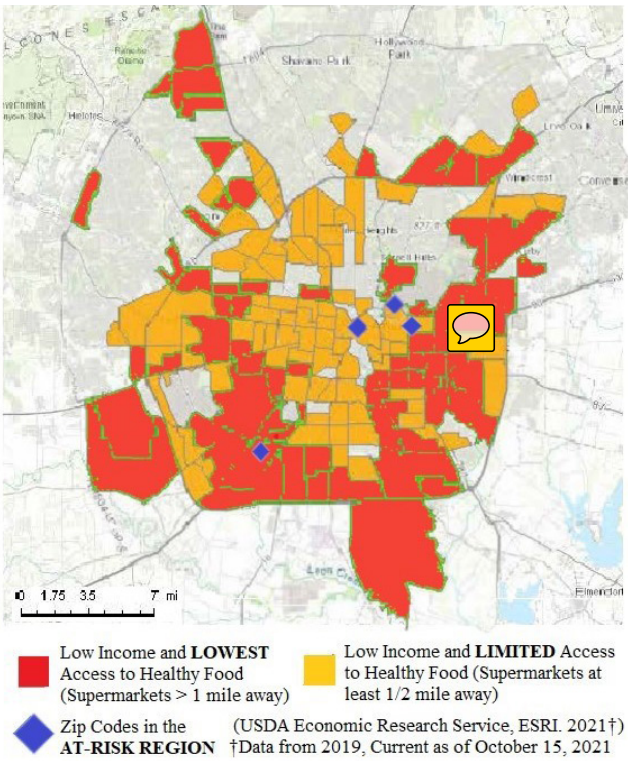


Figure 11: Food Deserts and the At-Risk Region (USDA, 2021)

map of in-patient diabetes hospitalizations (Figure 12) over this map of food deserts, the correlation between food insecurity and diabetes is evident in Figure 13.

Figure 12: Bexar County In-Patient Hospitalization Rates (American Community Survey, 2017)

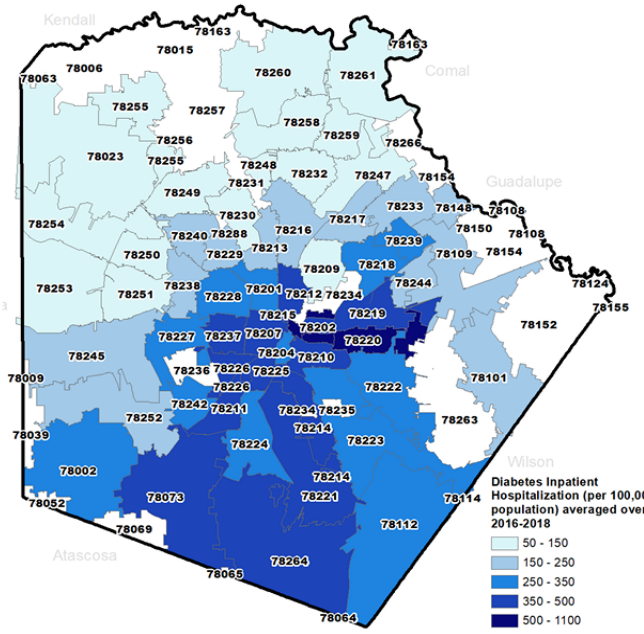
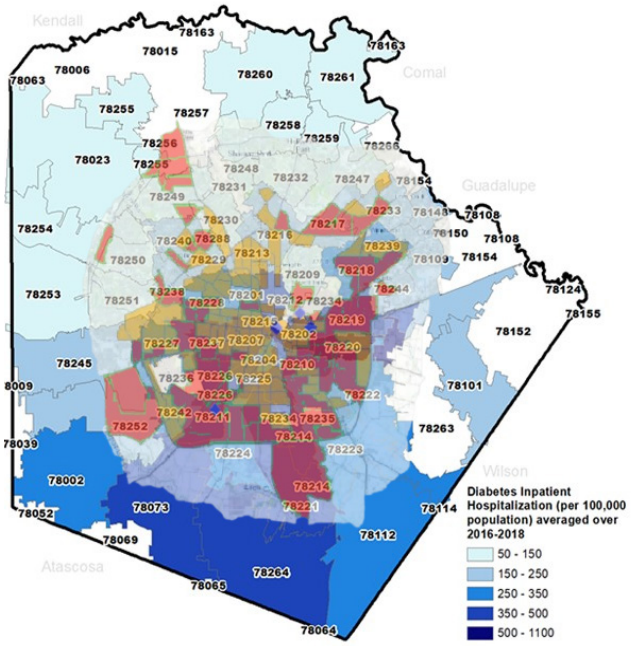


Figure 13: Diabetes Map and Food Deserts Map Overlay



Diabetes and Frontline Communities

The local diabetes epidemic is also disparately hard on frontline communities. Figure 15 demonstrates how disproportionately the Black and Hispanic communities suffer from this disease. Figure 16 further illustrates this disparity with regard to hospitalization rates. While it is unknown exactly how much climate change can exacerbate this crisis, it is clear that damage is not equitable as is, and would only get worse due to climate change if efforts are not taken to reduce this harm. One study found that excessive heat increased mortality rates from all causes by 10% across the board (Isaksen et al., 2015). Texas can anticipate 88 additional days of extreme heat by mid-century. When this was factored in, climate change may cost another 20 lives to diabetes in 2036 alone.

Figure 15: Diabetes Mortality in Bexar County by Race and Sex (Texas Department of State Health Services, 2020)

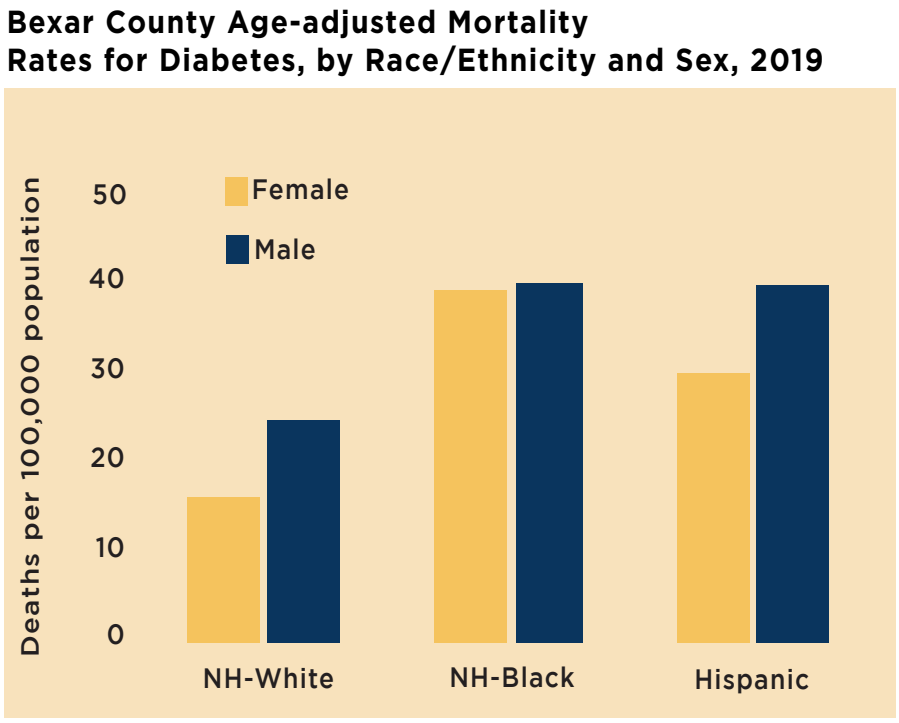
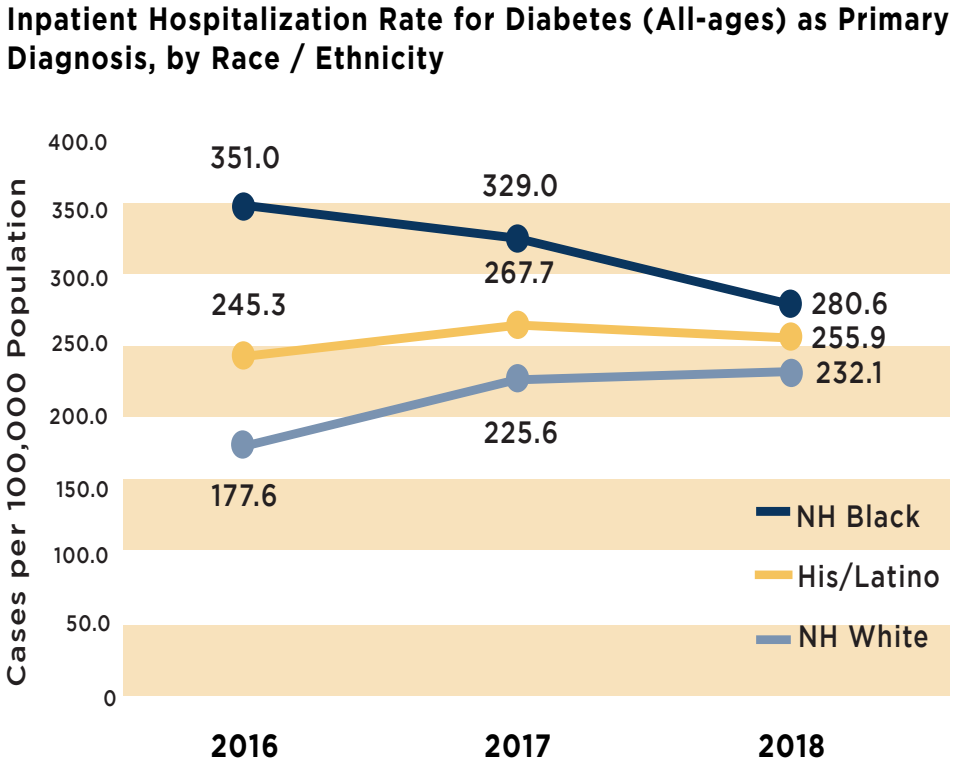


Figure 16: Diabetes Hospitalization Disparity by Race (Texas Department of State Health Services, 2020)



Excess Mortality and Morbidity Health Conditions Affected by Climate Change

There are virtually no health conditions that are not affected by the environment, but some are more affected than others (Stanford University, 2019). The warmer climate is fertile ground for infectious diseases and vector-borne diseases. Flooding also creates a breeding ground for hosts like mosquitos to spread Malaria, Zika, and West Nile Virus, in addition to contaminated water and enabling gastrointestinal ailments like cholera, dysentery, and typhoid (Climate Change and Infectious Diseases, 2021).

While we know climate change exacerbates these issues, we do not know to what degree in order to project how it would impact San Antonio. However, we do have sufficient data to predict the prevalence of other outcomes as well as the communities most affected. This next section explains the connection between climate change and other concerning health outcomes for which data makes estimations possible. The top 3 areas of concern are listed in Table 5 with an explanation to follow.

Table 5: Top 3 Priority Areas

PRIORITY AREA	Excess Morbidity by 2036	Percentage Increase	Excess Mortality by 2036	Percentage Increase
1. ASTHMA / RESPIRATORY CONDITIONS	17,928	75% People of Color	209	25%
2. HEAT ILLNESS	170	40%	UNABLE TO CALCULATE	
3. MENTAL ILLNESS	UNABLE TO CALCULATE		137	40%

Asthma, Allergies and Respiratory Conditions

Asthma, allergies, and respiratory conditions are aggravated by pollen, particulate matter, and ozone (Ziska et al., 2019). One study found a 25% rise in asthma deaths due entirely to pollution (Taylor & Marsh, 2018). Days with higher-than-average pollen have been shown to increase asthma hospitalizations 1.45-fold (Osborne et al., 2017). Climate change has extended the number of such days by 20 each year (Anderegg et al., 2021). Black and Hispanic San Antonians already suffer from asthma far more than their non-Hispanic white neighbors (San Antonio Metropolitan Health Authority, 2021). Figure 17 below shows both the diagnosis rates and hospitalization rates.

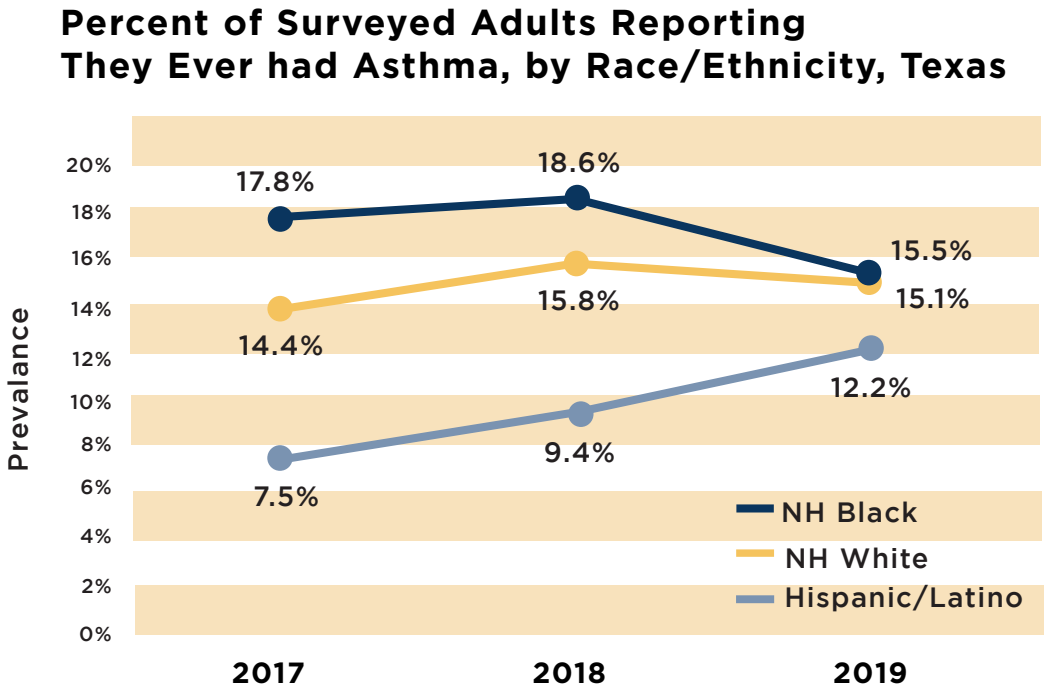
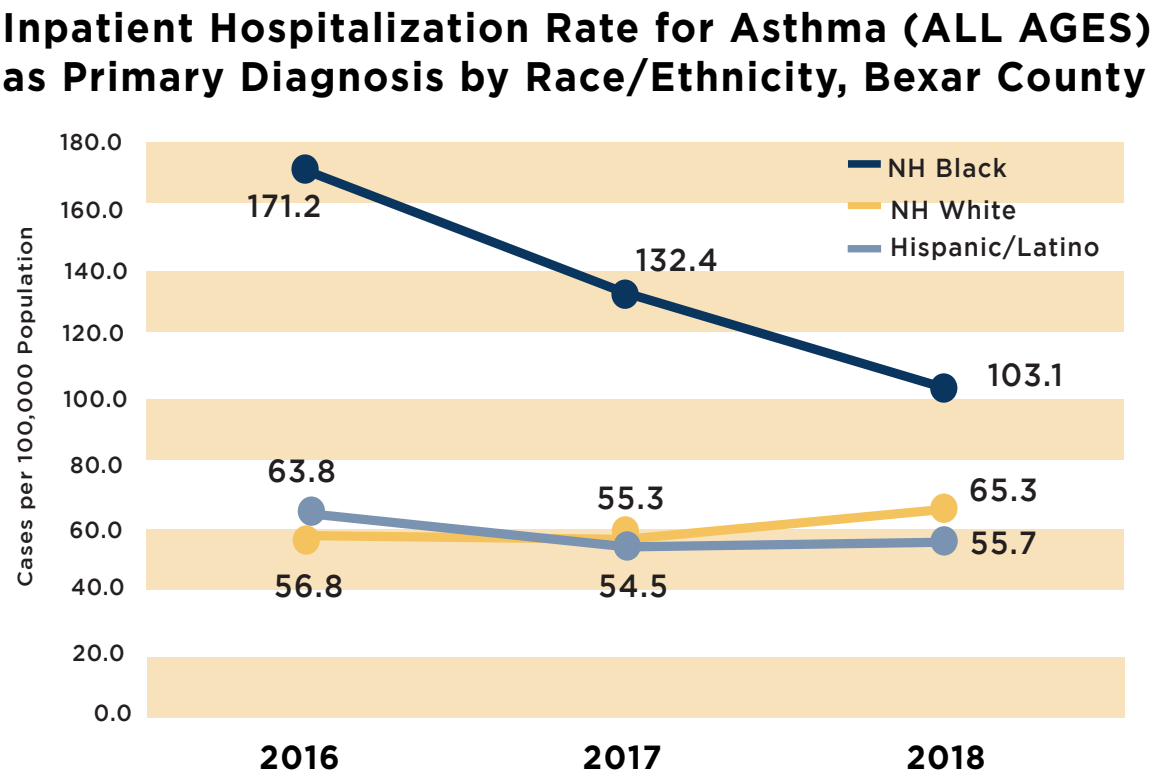


Figure 17: Asthma Disparities by Race (Texas Department of State Health Services, 2020)

When the added risk of hospitalization is factored in, climate change increases morbidity by 17,928 cases, over 75% of whom are people of color. Respiratory ailments rank 6th in the top causes of death in Bexar County in 2019 (San Antonio Metropolitan Health Authority, 2021). Figure 18 shows how the severe cases tend to favor frontline communities.

Figure 18: Asthma Severity by Race (Texas Department of State Health Services, 2020)



Climate change can also cost an additional 209 lives in 2036 due to heat alone. When the 88 additional days at 10% greater risk was calculated, climate change may cause 25% more deaths from respiratory conditions (see Table 5).

The COVID-19 Pandemic and the Role of Climate Change on Infectious Disease

Frontline communities, particularly persons of color have borne and currently bear a greater burden than their white neighbors concerning the coronavirus pandemic (Despres, 2021). Hispanic patients were four times more likely to be hospitalized and overall, black patients were five times as likely as their white counterparts to end up in the hospital from COVID-19 (Marquez et al., 2020). Environmental factors play a role in risk-level for morbidity and mortality when it comes to COVID-19. Studies suggest also that excess pollen increases COVID-19 infection rates by 44% (Damialis et al., 2021) and climate change increased the number of days with excessive pollen by 20 per year (Anderegg et al., 2021). Likewise, air pollution was recently shown to increase death from COVID-19 by 9% on days when ozone or particulate matter exceeded healthy levels (Petroni et al., 2020).

As of January 7, 2022, Bexar County has documented 365,178 confirmed cases of COVID-19 (Surveillance - Case Numbers, 2022). When accounting for the additional 38 pollen days experienced since the first COVID-19 case on February 12, 2020 and the added 44% infection rate on those additional pollen days, this results in 9293 potential excess cases in Bexar County that can potentially be linked to climate change (Sabawi, 2020). When the same calculation is done yet employs the number of deaths COVID-19 since the first fatality from the virus on March 20, 2020 (King, 2020), the 19 days of unhealthy levels of pollution (San Antonio Air Quality Alert Days) between then and January 10, 2020; at an increased mortality rate of 9% per day results in 13 lives lost out of the total 4991 reported COVID-19 fatalities (Surveillance - Case Numbers, 2021). San Antonio is among the most polluted cities, and this may play a role in the number of cases and deaths endured during the coronavirus pandemic (Bruess, 2021).

Scientists also predict more pandemics to come. Higher temperatures nurture existing threats and extreme weather conditions foster danger by imposing contaminants into food and water supplies. but there is also a threat of new diseases fostered by warmer climates. Microbes that lead to disease can adapt to rising temperatures more so than human

immune systems can evolve to fight off these pathogens (Casadevall, 2020). Changes to animal habitats from encroaching urbanization also increase the chances of vector-borne diseases from closer proximity between humans and infected animal hosts (Climate Change and Infectious Diseases, 2021).

Mental Health, Suicide and Violence

One of the most alarming findings when examining the mental health effects of climate change was the threat of additional suicide. The American Psychiatric Association (APA) recognizes that climate change is a threat to residents' mental health (APA, 2020). Furthermore, the APA found that people with mental health disorders are disproportionately impacted by the consequences of climate change. Climate change-related impacts can lead to job loss, family displacement, or loss of social support and community resources —all of which have mental health consequences and can make coping a greater challenge.

Rising Temperatures and Suicide

Rising temperatures pose their own unique danger to mental well-being. Violence increases during hot days, not only toward others but also towards self (Cooper, 2019). Burke et al. (2018) also found a correlation with extreme temperatures. When controlling for population growth, the sum totaled 137 additional suicides in 2036. This equates to a 40% increase in suicides during this time period as a result of climate change impacts.

Pollen Counts Connected to Self-Directed Violence

Additionally, higher pollen counts and increased incidences of self-directed violence (including suicide) are well-documented (Khazan, 2017). Here in Texas, researchers in Dallas found that non-fatal suicide attempts and self-directed violence were correlated to tree pollen counts (Jeon-Slaughter et al., 2016). Tree pollen was also linked in another study to an alarming two-fold increase in suicides among young women and four times the increase in

older women (Postolache et al., 2004).

The scientists behind that study theorized that allergens travel from the nose and trigger responses from small protein cells (cytokines), and this inflammation disrupts healthy mental processing and inspires impulsivity. Increased temperatures increase pollen counts and another study found a 6.4% increase in suicides on days when pollen counts were excessive (Qin et al., 2013). The sum of these studies concludes that the link between climate change and suicide is one that requires close surveillance, regardless of exactly why self-directed violence increases as temperatures rise.

Recommendations and Best Practices

Taking steps to limit emissions can help alleviate all key health outcomes in this report, but these actions are already underway. Their success is vital for a host of reasons, but also because of the immediate threat anticipated from higher temperatures alone. The number of excessively hot days decreasing would decrease the risk of heat illnesses. Likewise, respiratory antagonists would decrease, lowering the number of hospitalizations from asthma and other lung disorders as well as the number of suicides. Mental health, as related to climate change can be aided by assuring citizens that steps are being taken to arrest the impacts and assist them with the consequences. The thought of or concern for climate change can trigger stress or "eco-anxiety," and this can be mitigated by policies that reassure citizens that bold steps are being taken (APA, 2020). Continuing efforts to arrest climate change and preserve the environment is crucial to likewise limiting these health-related concerns.

The influence of climate change on health is complex, but planning ahead will strengthen the development of a resilient city and reduce the risks of morbidity and mortality for residents. There are two ways to approach this goal: 1. Curbing climate change and 2. Hazard mitigation planning to control the damage it wreaks.

While the former is superior (to prevent these issues altogether), this is not something San Antonio can accomplish through public health interventions alone. The greenhouse effect is a global concern, and air pollution does not stop at the city limits sign. There are actions that the City of San Antonio is taking to promote clean air and do its part in lowering global emissions, but many of the consequences from worldwide inaction on climate change will still reach our citizens. The World Economic Forum's Outbreak Readiness and Business Impact white paper suggests a cooperative approach to climate change mitigation; governments, civil society organizations, businesses, and the general population should look for opportunities to create shared value to cooperatively "support capacity to manage the risk and impact of outbreaks." (World Economic Forum, 2019). Therefore, it is wise to prepare for these consequences, and solicit cooperation from as

many local organizations, businesses, and neighboring cities as possible.

Infrastructure Changes to Mitigate Flood Damage

First, THC suggests civil engineering changes for roads at elevated risk of becoming dangerously impassable due to floods. Flood Risk, an initiative of the First Street Foundation can offer a list of the 1,361 roads identified on its website Flood Factor (2017). It is advisable, to begin with, the roads in the at-risk region and other lower-income areas of the city.

Bexar County does an excellent job monitoring flood conditions on roads and alerting citizens to dangers on its website BexarFlood.org. The City can help by ensuring low-lying roads are not the only route for citizens and emergency vehicles. If structural changes to protect vulnerable roads are not possible, perhaps additional and more visible safety alerts such as barricades and flashing lights can be utilized to deter drivers from high-risk areas and new roads can be constructed that are less flood-prone or provide an alternative detour away from danger. Making these necessary changes is something completely within the City of San Antonio's capacity and does not require any citizen participation from individuals or businesses in order to be successful. It is perhaps the simplest but most assured way to prepare for the health impacts of climate change. We encourage the City of San Antonio to continue aggressively pursuing the strategies in the SA Climate Ready plan: identify alternative routes in these vulnerable areas and perhaps increase the capacity of roads where traffic must be diverted to evacuate citizens safely during floods or other natural disasters.

Continued Surveillance of Vector-Borne Diseases

THC also applauds current efforts by Bexar County to trap and test mosquitoes for vector-borne illnesses. One trap recently found a case of West Nile this past summer (Morgan, 2021). This type of surveillance is vital to warn citizens and determine when and where to deploy mosquito control efforts. One study in Africa found that insecticide

treated bed nets lowered malaria cases by 40% (Lafferty & Mordecai, 2016). Efforts undertaken here in the United States have almost completely eradicated Malaria from our country, but experts warn that the warming, more tropical climate is inviting a resurgence as well as new threats like Dengue Fever. Vigilance to enforce property codes that forbid standing water as well as diligence to patrol public spaces for mosquito breeding grounds is both wise and necessary. Early detection and intervention are recommended to protect the citizens of San Antonio.

Protect Green Spaces

The absence of green spaces has been shown to drastically decrease mental and emotional well-being (Callaghan et al., 2021). Access to parks and other natural environments has been shown to decrease incidences of anxiety and other mood disorders (Nutsford et al., 2013). The absence of natural environments has perhaps the worst effect on children. Consider this report from 2019: "This nationwide study covering 900,000 people shows that children who grew up with the lowest levels of green space had up to 55% higher risk of developing a psychiatric disorder independent from effects of other known risk factors." (Engemann et al., 2019).
Furthermore, the presence of green spaces promotes mental health perhaps just as much as their absence degrades it. A recent review of 21 studies showed and marked decrease in childhood and adolescent depression among youth
in greener environments. (Vanaken & Danckaerts, 2018). Adults also benefit from lower stress levels surrounded by trees and greenery (Nutsford et al., 2013). The City of San Antonio can promote mental health and wellness and potentially curb the growing threat of suicide by prohibiting over-development of vacant lands and establishing more greenbelts and public parks.

"Children who grew up with the lowest levels of green space had up to 55% higher risk of developing a psychiatric disorder…" (Engemann et al., 2019).

Regulating Labor Conditions for Outdoor Workers

According to climate projections, the degree of heat and frequency of excessively hot days is expected to increase. While the City of San Antonio has a heat plan that increases public awareness of the danger and provides cooling locations for citizens to seek respite, there is still a concern for those expected to work, especially the fifth of San Antonio residents who work outdoors. These jobs require San Antonians to risk their health providing for their family or suffer economic hardship when they do not work in dangerously elevated temperatures.

The City of San Antonio can impose regulations on businesses to protect these workers. Ordinances can prohibit exposure to the elements when the heat index exceeds a certain threshold and/or subsidize companies to provide paid time off to outdoors employees when it is not safe to work. Federal agencies have recommendations for employers. This is an excellent place to start, yet the guidelines are underwhelming.

These recommendations assume their employees are all healthy, hydrated, physically fit, and younger than 40. For example, the National Institute for Occupational Safety and Health (NIOSH) at the CDC does not recommend modifying work schedules to account for extreme temperatures unless the heat index reaches 100° and the workload is moderate, rather than light. When the heat index is over 100° it's recommended to provide fifteen-minute breaks per hour: forty-five minutes of work, and fifteen minutes of rest. This increases to thirty minutes of rest each hour of work once the temperature reaches 104° and rest time incrementally increases until a heat index of 105°, after which they caution against any work at all. (National Institute for Occupational Safety and Health, 2021).

THE CITY OF SAN ANTONIO CAN POTENTIALLY CURB HEAT ILLNESS BY REQUIRING EMPLOYERS TO FOLLOW PROTECTIVE GUIDELINES FOR THE FIFTH OF SAN ANTONIO RESIDENTS WHO WORK OUTDOORS. ORDINANCES CAN PROHIBIT EXPOSURE TO THE ELEMENTS WHEN THE HEAT INDEX EXCEEDS A CERTAIN THRESHOLD AND/OR SUBSIDIZE COMPANIES TO PROVIDE PAY TO OUTDOORS EMPLOYEES WHEN IT IS NOT SAFE TO WORK.

Enhance Assistance Programs for Low-Income Citizens with Excessive Energy Burden

San Antonio can mitigate the financial burden and health risks faced by low-income citizens unable to afford climate control costs during extreme weather. If this is done with prevention, there is an added benefit of decreasing pollution from unnecessary and inefficient energy consumption.

Energy costs can be lowered by weatherizing homes and reducing the need for wasted, excess energy. It stands to reason that those low-income persons without the means to afford high energy costs likewise lack the means to weatherize, insulate or otherwise renovate their homes. Furthermore, most of the 3% of San Antonio households who qualify as energy-burdened are not homeowners at all. Renters have an energy burden that is 13% higher than those who own their homes (American Council for an Energy-Efficient Economy, 2020).

The SA Climate Ready plan outlines strategies to improve energy efficiency for energy-burden households and those at risk of displacement (2019). These might be enhanced by leveraging other efforts by state and federal groups. The recent infrastructure package has increased allocations to federal agencies like the Department of Energy and the Environmental Protection Agency, both of which have programs to help homeowners and landlords make energy-

saving upgrades to their properties (DOE Upgrades One Million Homes as Bipartisan Infrastructure Deal Provides Massive Investment in Energy Efficiency, 2021). Perhaps the City of San Antonio can make infrastructure improvement loans to cover up-front costs in exchange for citizen cooperation in obtaining these refunds to repay the loan. Likewise, the City of San Antonio could extend property tax abatements to landlords of multi-family units who make energy improvements.

Geographically, prior research has helped isolate areas in greatest need to target relief efforts. Citing Tim Barr's May 2021 report to the Climate Action SA Coalition about policies to promote justice for the energy-burdened inspired reporter Greg Harman to map the five neighborhoods in San Antonio with the greatest energy burdens (2021). The most impacted is Brady Gardens, followed by Dellview, Maverick, Elmendorf/Las Palmas and finally Greater Gardendale. Outreach efforts can begin here, since these residents pay over 14% of their incomes (on average) just for energy alone (Harman, 2021).

Figure 19: SADC Strategies (San Antonio Diabetes Coalition, 2021)

Address the Social and Environmental Risk-Factors for Diabetes

Rising temperatures have also been tied to the diabetes epidemic and THC is also pleased to facilitate the San Antonio Diabetes Collaborative (SADC) in the fight against diabetes in our City. SADC was founded at the San Antonio Metropolitan Health District as a response to the overwhelming need to join healthcare professionals together in order to fight the scourge of diabetes in

the Alamo City. SADC has been active for 8 to 10 years under the direction of community health leaders but has recently taken on a new direction under the facilitation of THC by employing a collective impact model. Figure 19 details the group's three-pronged strategy.

This new approach is based on a renewed commitment to community-led change, fueled by stories from citizens with lived experience: San Antonians who can attest to what it is like to live with diabetes and even overcome it through major lifestyle changes. SADC focuses on prevention by identifying high-risk demographic groups of adults ages 19-45, primarily people of color in under-resourced communities, who have a low income as well as low to moderate education levels and employs a three-faceted strategy: diabetes prevention, patient care delivery coordination (connecting clinical services to evidence-based programs and finally, influencing policy changes that promote diabetes prevention by addressing the environmental risk factors that foster this disease.

Prioritize Food Insecurity Initiatives

Figure 19. SNAP Participation vs Diabetes Prevalence in Bexar County an **by Census Tract, 2017**

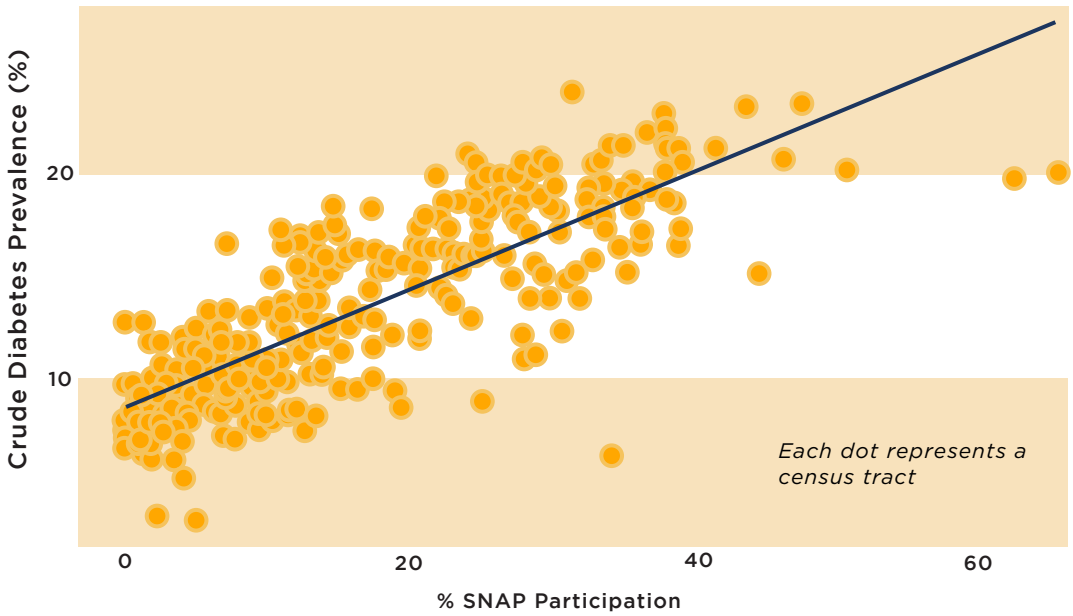


Figure 19: SNAP Participation and Diabetes Prevalence (Metropolitan Health, 2020)

Nutrition plays invaluable role in these efforts and others to prevent diabetes since one environmental factor with a clear and established link to developing diabetes is food security. Food security clearly impacts dietary habits that contribute to disease rather than health, yet the primary method with which

governments attempt to alleviate food insecurity is the Supplemental Nutrition Assistance Program (SNAP), also known as food stamps.

There is a clear correlation between SNAP participation and diabetes, as demonstrated in Figure 19. Some argue that the fact that SNAP can be used for sugary beverages and candy is what explains this relationship, yet that fails to paint a complete and accurate picture. The purchasing habits of non-SNAP participants and SNAP participants on sodas and candy are relatively the same (Whitmore-Schanzenbach, 2017), meaning that perhaps other social determinants of health are to blame for the diabetes disparity among low-income citizens. Food deserts can easily play a role in this inequity.

Enhance the VIVA SA Healthy Corner Stores Initiative with Data-Driven Techniques

The City has made tremendous strides to offer fresh fruits and vegetables in food deserts around the City with initiatives like VIVA SA Healthy Corner Stores, a collaborative effort to stock convenience stores with healthy alternatives. The program is universally well-regarded, but data is lacking on how effective the program is at changing dietary habits from primarily unhealthy, processed food to include more produce. Reports focus simply on whether or not the program is achieving its goal of increasing access to healthy food, and this fails to acknowledge that access itself is a necessary but not sufficient condition.

The option of healthy foods does not imply that people will take that option because there are more variables at play than access alone. For example, one study found that greater opportunity to purchase low-fat milk did not increase the likelihood that shoppers would choose low-fat milk, (Martin, et al., 2012). Another study found no difference in BMI or obesity prevalence between groups of youth with access to healthy corner stores and those without (Lent et al., 2014) Studies elsewhere have looked at purchasing habits and found that the increase in fruit and vegetable consumption was relatively nominal. The likelihood of purchasing fruit increased by 13%, vegetables by 16%. SNAP participants did purchase produce 1.7 times more often than those without benefits but the fact that produce is more

expensive than processed foods was one reason given by consumers for why they did not purchase more fruits and vegetables.

Scholars point out that benefit levels are just too low to supply a healthy diet (Coleman-Jensen et al., 2011). Produce can be more expensive and it is also highly perishable, meaning that the budget of SNAP benefits that participants are given can be stretched farther by choosing cheaper, highly-processed foods over more expensive healthier options that spoil more quickly. Researchers have found promising strategies to encourage SNAP participants to use their benefits on produce by supplying coupons or rebates to lower the cost. In Massachusetts, a refund for 30 cents on every dollar spent by SNAP participants on fresh produce increased produce purchases by 25% (Whitmore Schanzenbach, 2017). Washington D.C. launched a program called "5-for-5"- a voucher redeemable for $5 in produce for every $5 spent using SNAP benefits. Over 76% of these coupons were redeemed and 77% of shoppers indicated that they had increased their consumption of fresh produce due specifically to this program (Snelling et al., 2020). A common theme in studies is variety: increasing the number of different types of fruits and vegetables increased their consumption (Langellier et al., 2013).

Conduct a Comprehensive Evaluation of Existing Efforts in Order to Implement Informed, Evidence-Based Improvements

San Antonio may consider such an idea, but the first step is a proper program evaluation. Thus far, policy analyses in San Antonio have looked exclusively at the number of participants and ways to increase this total. One study out of Austin's University of Texas School of Public Health interviewed participants to assess their opinion of the store owners on how to improve implementation and in so doing, recruit more store owners to participate (Janda & Van Den Berg, 2020). Other reports focus on the economic impacts, but most cities appear to gauge success by outputs alone (the number of stores, districts, or partners involved), not health outcomes for participants: improved eating habits, lower body mass index (BMI), fewer cases of diabetes to name a few. Studies are insufficient, not just here in San Antonio but across the board. Logically, people cannot benefit from nutritious foods if they do not consume

them, and they cannot consume them if they do not buy them, and they cannot buy them if programs like VIVA Healthy Corner Stores did not make this all possible, but absent from the literature are evaluations that connect these processes to the ultimate goal: better health.

Merely measuring the purchases of healthy food does not prove it was consumed. Some shoppers admitted to buying fruits and vegetables, but not getting around to eating them before they began to spoil. And even the highest-quality research reviews on programs like VIVA SA Healthy Corner Stores stop far short of what is needed to know if the program is a win for public health. For example, the 5-for-5 program evaluation established 1. that people took advantage of the coupons to buy more produce, 2. That these shoppers actually consumed the produce they bought, and 3. That this dietary change was attributable to the program (Langellier et al., 2013). Nonetheless, the final step is missing. That is, determining if consuming more produce actually made these shoppers healthier than they otherwise would have been. Studies on both implementation and outcomes are needed to determine if this program is effective and if so, how effective it is, as well as process monitoring to ensure that potentially poor outcomes are due to the program itself rather than the consequence of failures with implementation.

The literature is woefully inadequate with connecting this program to its ultimate intention, but THC is willing to partner with San Antonio Metro Health and the Food Policy Council to conduct a complete and thorough evaluation that addresses all the factors required to accurately gauge program successes. This will provide the answers we need for continuous improvement while furthermore, filling a gap in literature so that other cities can use the knowledge we produce to enhance their programs as well. While subsidizing produce purchases with rebates of coupons could potentially do tremendous good, more research on the program here in San Antonio is required before it would be wise to make any changes. At the bare minimum, a comprehensive program evaluation is needed to establish baseline data in order to know how much that effort did or did not increase produce purchases, consumption and health.

In addition to the strategies to promote agriculture detailed in the SA Climate Ready

plan, THC suggests these actions to enhance those initiatives. THC also encourages new leadership at the Food Policy Council become very familiar with the SA Climate Ready plan to coordinate their efforts. THC plans to brief all partners on the plan and how we can collectively promote the established mitigation and adaption techniques while continuing to adopt new approaches as we learn more about the needs of San Antonio residents and how we might go about assisting them through the perils of the climate crisis.

Conclusion

In sum, protecting public health from the dangers of climate change is a collective effort, but one that requires a diligent commitment to research. The Health Collaborative stands ready and eager to aid in this endeavor through research, service coordination, and community advocacy to assist our neighbors in preserving our vital planet and the life-giving resources it provides.

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