Chapter 11

Environmental Health and Climate Change

Photo Courtesy of Discover Durham

This chapter includes:

- Lead Poisoning
- Extreme Heat
- Wildfire
- Severe Storms and Precipitation
- Public Health Emergency Preparedness

Section 11.01 *Lead Poisoning*

Overview

Lead poisoning remains a major environmental health concern in the United States (U.S.). Inhalation is the most common route of exposure in adults, while children are most commonly exposed to environmental lead through ingestion or inhalation, with ingestion of chips and dust from lead paint the most common source.[1] Exposure can also occur from contaminated soil from gasoline emissions, as lead was an additive in gasoline until the late 1970s, as well as historical incinerator operations.

According to the U.S. Department of Housing and Urban Development (HUD), about 34.6 million homes contain lead-based paint, including 18.2 million homes with significantly deteriorated lead-based paint, 21.9 million homes with dust lead hazards, and 2.4 million homes with soil lead hazards.[2] There is no known safe blood lead concentration. However, it is known that as lead exposure increases, the range and severity of symptoms and effects also increase. Lead exposure in young children and pregnant women can cause serious health effects and can affect almost every organ and system in the body.[3] During pregnancy, lead is released from bones and is used to help form the bones of the developing fetus. This risk increases if the pregnant mom is calcium deficient. Lead can also pass from a mother to her unborn child through the placenta.[4] The most important step caregivers, parents, doctors, and others can take is to prevent lead exposure before it occurs.

The current reference level at which the Centers for Disease Control and Prevention (CDC) has recommend public health actions be initiated is 3.5 µg/dL.[5] Lead poisoning is preventable, yet the negative health effects of lead poisoning can be life-long, so prevention of lead poisoning is crucial. Primary prevention and secondary prevention are tools used to prevent childhood lead exposure before any harm occurs. Primary prevention includes the removal of lead hazards from the environment before a child is exposed and is the most effective means of prevention. Secondary prevention including blood lead testing and follow-up remains an important safety net for children who may already be exposed to lead.

Lead can affect anyone, but children less than six years old are at increased risk from the deleterious effects of lead because their nervous system has not yet fully developed. Children absorb four to five times as much ingested lead as adults from a given source, with the gastrointestinal tract being the major route of absorption.[6; 7] Children's brains and nervous system are more sensitive to the damaging effects of lead. Young children are particularly vulnerable to lead hazards present in their surrounding environment because they can expose themselves to the harmful effects of lead through normal behaviors such as putting their hands and other objects in their mouths.[8]

City Parks

In July of 2023, Mid Atlantic Associates conducted soil assessments for five City of Durham Parks. In August of 2023, a soil assessment report from Mid-Atlantic Associates showed that soil samples from five parks in Durham, Walltown, East End, East Durham, Lyon, and Northgate, had at least one soil sample that measured greater than the Environmental Protection Agency (EPA) threshold. One of the potential lead sources at these parks was lead-contaminated material from historical incinerator operations. Fencing and detailed signs were installed around the impacted areas and one playground was closed.[9]

In response to public concerns, City of Durham officials, in conjunction with Durham County Department of Public Health officials, conducted a town hall meeting on June 29th, 2023. The officials fielded questions and introduced a representative from Mid Atlantic Associates, Inc., an environmental consulting firm retained by the City to conduct an additional assessment of the parks to include confirmatory laboratory analytical testing.

On August 1st, 2023, Durham County Environmental Health staff, along with NC Department of Health and Human Services Occupational Health & Epidemiology staff conducted a field survey of Walltown, East End, and East Durham Parks. The survey was conducted in an effort to evaluate potential risk. In almost all open and accessible areas heavy vegetative cover in the form of thick grass was observed. Additionally, all children's play areas were covered with greater than 6 inches of mulch. Both meet or exceed the clearance standards pursuant to G.S. 130A-131.9C (15A NCAC 18A .3105) for bare soil lead concentrations greater than 400 parts per million. In light of these observations, staff felt the risk of poisoning was very low. However, it cannot be said that a risk does not exist.

North Carolina Department of Environmental Quality (DEQ) conducted a third field survey in January 2024. Results of the survey have not been released but DEQ is working closely with the City of Durham, NC DHHS Occupational Health & EPI, and Durham County Department of Public Health to address the issue in an effective and responsible manner.

Food Contamination

Although uncommon, lead can also contaminate food during production, processing, packaging, preparation, or storage. In October 2023 three brands of applesauce thought to be responsible for the lead poisoning of at least 354 children in 41 U.S. states were recalled.[10] The source was thought to be cinnamon contaminated with extremely high concentrations of lead, which was added to the applesauce in a facility in Ecuador.[11]

The Food and Drug Administration public health alert was updated on November 3rd, 2023, to include various apple cinnamon fruit pouches and requested each state to voluntarily visit Dollar Tree stores to verify that all lots of WanaBana Cinnamon Apple Puree had been removed from shelves and was not being offered for sale. On November 13th, 2023, Durham County Environmental Health staff made visits to all ten Durham County Dollar Tree locations. Four three-pack boxes were identified at one location. The product was removed from the sales floor immediately. No other recalled product was identified at any of the other nine locations.

On December 8th, 2023, NC DHHS Division of Public Health's Environmental Health Section formally requested Local Environmental Health staff from across the state make visits to Dollar Tree stores known to have received recalled product. Six of the ten Durham Dollar Trees were officially cited as having received tainted product. Durham County Environmental Health staff visited the six locations on the same day but did not find additional products.

One confirmed lead poisoning case was potentially caused by the child consuming WanaBana recalled product. The confirmed poisoning was reported to Durham County Environmental Health prior to the recall and four investigation visits were made without success in identifying the source. It was later discovered that the poisoned child consumed several pouches of the product daily and thus became poisoned.

Two other children from a separate household had elevated blood lead levels, EBLLs, after their mother learned about the recall and had the children tested. Both children consumed the recalled product on a regular basis. Durham County Environmental Health obtained several packages of the recalled product from the mother and provided it to DHHS State Laboratory for testing.

Controlled Burn

In July of 2023, a controlled burn of a house conducted by the Durham City Fire Marshal's Office deposited burn debris to surrounding properties in Durham. The vintage structure contained lead-based paint and extreme heat generated during the burn caused paint chips and other debris to drift and deposit across several streets and properties northeast of the burn site. Concerned residents requested evaluation and remediation as necessary. After careful assessment by the North Carolina Department of Health and Human Services Epidemiology/Occupational Health and Health Hazard Control Unit and Durham County Department of Public Health Environmental Health Division, the risk of lead hazard to these properties was determined to be very low.[12]

Healthy People 2030 Objectives

The Healthy People 2030 Objectives included a goal to reduce blood lead levels in children one to five years from 3.31 µg/dL to 1.18 µg/dL.[13]

Secondary Data

Secondary data shows an upward trend of parents getting their children tested for lead. The data also shows a downward trend of elevated blood lead level cases. Continued education and screenings may keep the trends going in the right direction.

Children Ages 1 and 2 Years Tested for Lead Poisoning in Durham County 2017-2019

Year	Target Population	Number Tested	Percent Tested	Lead ≥5	Percent ≥5
2019	8,333	4,558	54.7	23	0.5
2018	8,528	4,126	48.4	40	1.0
2017	8,577	4,192	48.9	37	0.9

Table 11.02(a) Ages 1 and 2 Years Tested for Lead Poisoning in Durham County[14]

Interpretations: Disparities, Gaps, Emerging Issues

Lead poisoning poses risks to children and pregnant women who live or frequent homes that were built before 1978.[15] Pregnant women, refugees and children adopted outside of the U.S. are also at risk for higher lead exposure. Many adults and children don't realize that lead may be present in their homes. Lead-based paint and lead dust inside and around homes are the most common and dangerous source of lead exposure.

Lead has been found in other sources including contaminated drinking water, spices, toys (including some toy jewelry), lead-glazed cookware, consumer products, folk medicine and in foods (sometimes used as a food additive or cosmetically for religious reasons).[16-20] Workers in certain industries such as battery manufacturing, auto mechanics, lead smelters, home improvement contractors, crafts and artistry, recyclers of metal and electronics and people who frequent gun ranges are at higher risk for lead exposure.[21]

- Elevated blood lead levels in children can contribute to:[22-26]
  - Learning problems (lower IQ, attention-deficit/hyperactivity disorder (ADHD))
  - Reduced attention span
  - Behavioral problems (e.g. Juvenile delinquency/criminal behavior)
  - Delayed growth
  - Hearing problems
  - Anemia
- In pregnant women, lead exposure can:[27; 28;29-31]
  - Increase risk for miscarriage
  - Cause a premature birth and low birth weight
  - Increased risk of preeclampsia

Recommended Strategies

- Increase lead screening in children who are most at risk from lead poisoning. Testing for lead poisoning should target children between 12 -24 months who live in communities with a high percentage of houses built before 1960 and a high number of children with elevated blood lead levels. In addition, children, and adolescents under age 16 who enter the U.S. as an immigrant, refugee, or international adoptee should be tested at the time of arrival to the U.S.
- Educate residents who live in pre-1978 housing to use certified lead-based paint renovator and firm per North Carolina Rules 10A NCAC 41C .0900.
- Require proof of NC compliant lead-remediation training before issuing a permit for work that is likely to disturb paint in housing built before 1978.
- Collaborate with City of Durham Community Development Department and Durham Housing Authority to adopt HUD lead poisoning prevention policies to non-HUD rental properties. One study found that people who were living in HUD-assisted homes had lower levels of lead in their blood compared with those who were not.[32]
- Conduct lead dust testing in specified rental units, such as those with code violations and high tenant turnover. Partner with Neighborhood Improvement Services Housing Inspectors to implement lead dust testing for pre-1978 homes with code violations.
- Require use of NC certified firm & renovators on city/county pre-1978 housing contracts.

Current Initiatives & Activities

Durham County Department of Public Health (DCoPH)
The Health Education and Community Transformation Division offers free lead poisoning education and onsite testing for children six-months to six years old. The Women's Health Division provides blood lead testing to prenatal clients. The Nutrition Division provides nutritional counseling related to calcium and iron intake and referral to the WIC Program, as needed. The Environmental Health Division also offers and assists with conducting environmental investigations for children under the age of six and pregnant women that have two tests of an elevated level of 5 µg/dL within a 12-month period and provides nutritional counseling. https://www.dcopublichealth.org/

North Carolina Childhood Lead Poisoning Prevention Program (NC CLPPP)
NC CLPPP currently coordinates clinical and environmental services aimed at eliminating childhood lead poisoning. The program provides technical assistance, training and oversight for

local environmental health specialists, public health nurses, laboratory technicians and private medical providers to assure healthy and safe conditions. https://ehs.dph.ncdhhs.gov/hhccehb/cehu/

North Carolina Healthy Homes Outreach Task Force

The North Carolina Healthy Homes Outreach Task Force is a group of local, state, and federal health and housing agencies working to implement healthy homes programming for vulnerable populations in the state. This group meets quarterly, engaging new partners from local health departments and state agencies and sharing information and ideas for incorporating outreach opportunities in targeted communities. https://nchealthyhomes.com/task-force/

Partnership Effort for the Advancement of Children's Health (PEACH)

PEACH works to create healthy homes in Durham, North Carolina, and addresses community health and economics by creating a sustainable workforce to reduce environmental hazards in the community. http://www.peachdurham.org/

City of Durham

The City of Durham is required to test for lead and copper every 3 years. Durham maintains a sampling pool of more than 200 homes throughout Durham which were constructed between 1983 and 1985 for triennial tests. During a testing year, samples are collected from the volunteer pool and analyzed to ensure on-going compliance with established levels. The City of Durham city has also taken additional steps to add corrosion inhibitor to drinking water to minimize the leaching of lead into tap water. https://www.durhamnc.gov/1156/Lead-in-Drinking-Water

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Section 11.02 *Extreme Heat*

Overview

Excessive heat kills more people in the U.S every year than all other types of severe weather.[1] The term "excessive heat", also called "extreme heat", is defined as two or more days of temperatures above 90°F.[2] The impacts of excessive heat is amplified by high humidity and full sun exposure. Under these conditions, the human body needs to work harder to maintain a normal body temperature because the evaporation of sweat is slowed. This leads to heat exhaustion, heatstroke, and possibly death.[3] Anyone can be affected by extreme heat, but the hazard often disproportionately impacts certain populations based on their physical characteristics or inability to escape the heat. Climate change is projected to increase the number, severity, and duration of extreme heat events.[4] New research shows that high overnight temperatures can have a higher negative health impact than daytime temperatures. There has been more research recently on the impact of heat on both pregnancy and mental illness. More people are expected to be affected by extreme heat due to climate change, but individuals, organizations, and agencies can help people adapt.

Secondary Data

The health impacts of extreme heat are already significant and are expected to become worse as climate change drives temperatures higher. Between 2010 and 2020, there were an estimated 12,000 premature deaths in the United States due to extreme heat, more than all other extreme weather hazards combined including tornadoes, flooding, hurricanes, wind, cold, lightning, and winter storms.[5] There are an estimated 3,000 heat-related illness emergency department visits every summer in North Carolina.[6] Currently, approximately 250 heat-related deaths occur annually in North Carolina.[7] There were 74 heat related Emergency Room visits in Durham County in 2022 and 50 such visits in 2023. This represents a little more than 0.11% of all Emergency Room visits.[8]

Often called a silent killer, extreme heat approaches without the dramatic warning signs of other storms such as whipping winds, heavy rains, or rushing rivers. Instead, periods of extreme heat feel like ordinary hot days until the unusually hot temperatures begin to affect the body. In mild cases, extreme heat causes dehydration and lack of energy. In more severe cases it causes heat exhaustion, heatstroke, hyperthermia, and in the worst cases, death. Extreme heat deaths occur not just on the hottest days, but at warm temperatures as well.[9] When night temperatures stay above 75°F, it is harder for the human body to cool down, increasing the chances of adverse heat effects.[10] This is particularly concerning in areas of energy poverty where individuals may lack efficient air conditioning or housing insulation. Extreme heat also makes pre-existing conditions such as mental illness, asthma, diabetes, and cardiovascular disease worse.[9]

Heat exposure has different impacts across Durham County. In urban areas, temperatures stay warmer overnight due to the "urban heat island" effect.[11] A heat-mapping campaign in July 2021, measured a 10.4°F maximum intensity difference between the hottest and coolest areas of Durham.[12] This is caused by certain areas having more heat-trapping buildings and paved surfaces as well as the lack of vegetation. Building materials like brick, concrete, and asphalt absorb heat during the day and release it slowly overnight to the surrounding air. This means that these areas do not have a chance to cool off before the sun comes up again. Fewer trees, meadows, and vegetative ground cover in urban areas mean less natural cooling. Plants create natural cooling systems. Water that evaporates from plant leaves during photosynthesis harnesses heat energy that transforms liquid water into vapor, cooling the plant's surroundings.[13] Additionally, plants create pockets of shade and microclimates

that circulate cooled air as a result of the evaporation process.[14]

Periods of extreme heat are sometimes accompanied by power blackouts due to high demand for energy or other weather-related hazards such as hurricanes and thunderstorms.[15] In these situations, all residents of Durham would be at high risk for heat health problems. During COVID-19 or possible future pandemics, the use of air conditioning in shared indoor rooms or cooling stations may present a secondary health risk of contracting a serious virus or disease.[16]

Under different greenhouse gas emissions scenarios, Durham County is projected to experience 60 to 70 extreme heat days over 90°F a year by 2030, increasing to 95 to 120 days by 2080 (Figure 11.01(b). Durham County is also projected to experience approximately 10 nights over 75°F a year by 2030, increasing by 20 to 60 nights by 2080 (Figure 11.01(c)).

Projected Days Per Year Above 95ºF, Durham County, 1950-2100

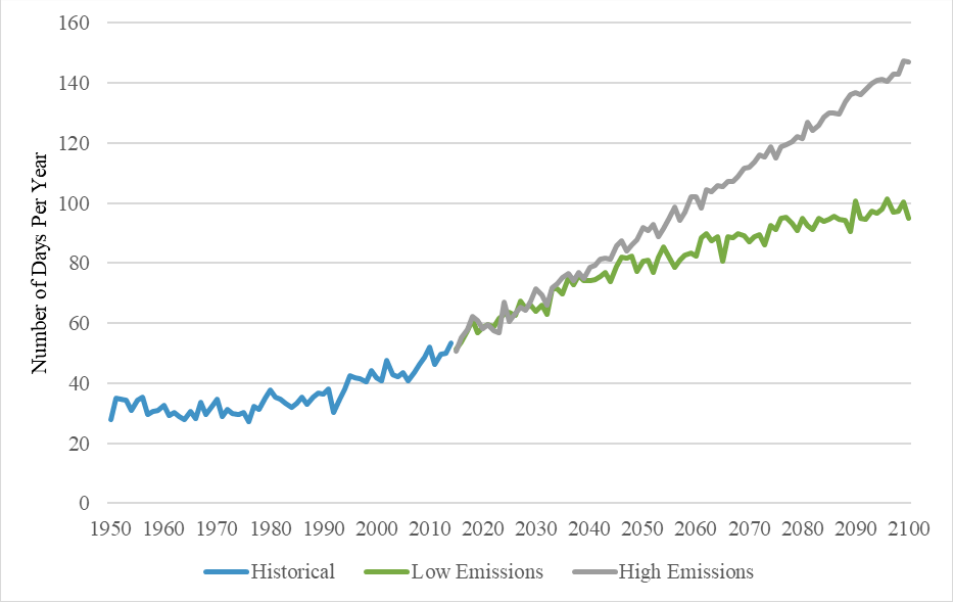

Figure 11.01(b): Projected Days in Durham County over 95 Degrees Fahrenheit

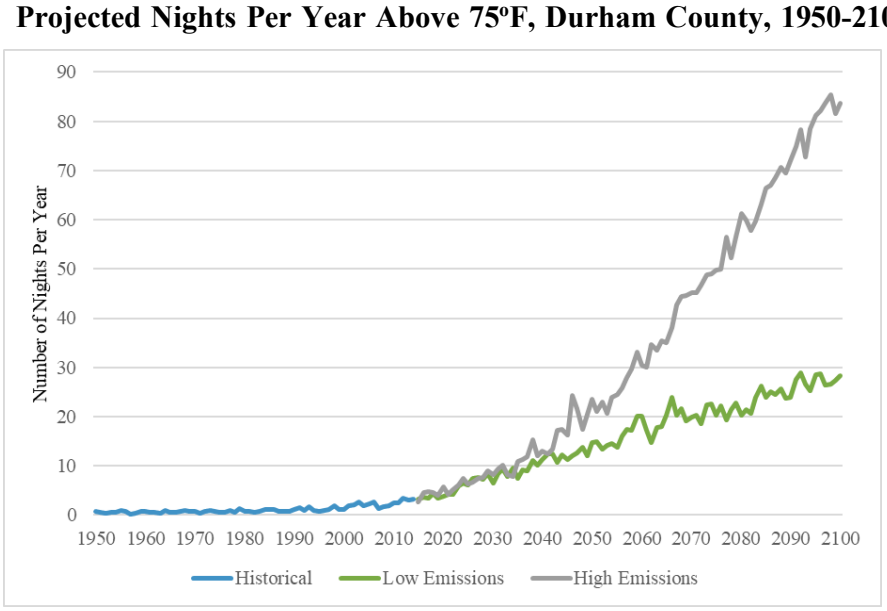

Figure 11.01(c): Projected Nights in Durham County over 75 Degrees Fahrenheit[17; 18]

Figure 11.1(b) shows the projected number of days per year that Durham County is expected to reach 95˚F or more. Figure 11.1(c) shows the projected number of nights per year that Durham County is expected to remain over 75˚F. The blue line represents simulated historical values. The green line and gray line represent average maximum daily temperatures if humans reduce greenhouse gas emissions to meet reduction targets or continue to emit high levels of greenhouse gases, respectively.

The increasing number of days with persistently high overnight temperatures are particularly concerning for health outcomes as well as increasing rates of preterm birth.[10] When overnight temperatures remain over 75°, the human body lacks the ability to recover from daytime exposures, especially for those who cannot afford to adequately cool their homes or lack access to air conditioning. This exposure further exacerbates health inequities.

Interpretations: Disparities, Gaps, and Emerging Issues

Extreme heat can affect anyone. However, certain demographics are more susceptible to its adverse effects.[19] The vulnerable categories encompass:

- Occupational Exposure: Those subjected to prolonged high temperatures in their workplaces, such as outdoor workers, are at a heightened risk.
- Pre-existing Health Conditions: Individuals with conditions like heart disease, diabetes, mental illness, or asthma face exacerbated threats as these conditions can deteriorate under heat stress. This also includes those who take certain prescription medications intended to manage a variety of chronic conditions.
- Mobility and Social Challenges: Certain groups, including those with physical disabilities or those experiencing social or language isolation, might face obstacles in relocating to cooler environments.
- Physiological Vulnerabilities: Specific demographics, such as individuals with severe obesity, pregnant persons, those under the age of four, or those above 65 years old, have bodies that may struggle to regulate temperature effectively.

Importantly, rural areas of Durham County are not exempt from the risks associated with extreme heat. In rural settings, the lack of immediate access to medical care, longer distances to cooling centers, and occupations that require prolonged outdoor exposure, such as farming, can exacerbate the effects of extreme heat. While urban areas have infrastructure challenges, rural communities grapple with accessibility challenges that require unique mitigation strategies.

When possible, people in the above categories should mitigate health impacts by avoiding exposure to extreme heat and finding a cooler environment. However, this is not possible for some residents, either because they cannot afford air conditioning and/or landlords do not provide it, their physical condition makes it difficult to move to a cooler environment, or because their transportation options or work conditions expose them to heat. During extreme heat events, Durham County Libraries typically serve as cooling centers, operating during daytime hours. Increasing temperatures, particularly overnight, may necessitate extending cooling center availability. The unhoused or those who have unstable housing may need increased access to shelter during periods of extreme heat. In the next decade, the ability to find a cooler environment will increasingly emerge as a determinant of health. Residents who do not have access to cooling resources such as air-conditioning, a cool car, or the ability to take a day off work on an extremely hot day are more likely to experience heat sickness or heat-related death.[20]

Historical practices such as redlining have left legacies of structural racism, rendering certain communities more susceptible to extreme heat owing to infrastructural inadequacies. These former redlined neighborhoods have fewer street trees and more paved surfaces, resulting in localized temperatures on average 7°F hotter than non-redlined districts.[21] Additionally, as a result of policies deliberately restricting access to financing to people of color, these neighborhoods have a higher number of non-white residents who live below the federal poverty line, cannot afford reliable air conditioning and rely on the bus or walking for transportation, even on extremely hot days.[22]

The Justice 40 Initiative (J40) is a federal government initiative to identify Disadvantaged Communities (DACs) and ensure at least 40% of federal funding for climate change, clean energy and energy efficiency, and other environmental projects is directed toward these DACs. In Durham County there are 20 census tracts out of 60 designated J40 DACs. These tracts include formerly redlined neighborhoods and non-urban tracts. More than 86% of the DACs and formerly redlined tracts have at least six out of twelve characteristics that lead to higher vulnerability to excessive heat. These characteristics include tree canopy coverage, housing units that are rentals, people of color, people without health insurance, households with no car, and families in poverty.[23] Place-based interventions to mitigate the effects of extreme heat such as planting trees and adding cooling stations should consider the diversity of DACs to ensure that the people most at risk receive appropriate support.

Recommended Strategies

Mitigate Exposure to Extreme Heat

- Develop and adopt a heat action plan outlining protocols and strategies for a timely and appropriate response when dangerous heat is forecasted.
- Adopt a county-wide standard for indoor temperatures, specifying a maximum permissible temperature for residences when the outdoor thermometer exceeds 90°F. This proposal mirrors existing regulations that set minimum indoor temperatures for colder temperatures.[24]
- Increase green infrastructure such as trees, meadows, vegetated areas, and green roofs,

prioritizing the historically redlined census tracts if this is also wanted by the communities in each census tract.[24]
- Create design standards, incentives, and education to increase light-colored cooling surfaces such as roofs, parking lots, plazas, etc.[25]
- Advocate for state and national requirements to protect outdoor workers' health and safety related to extreme heat.

Mitigate Health Impacts

- Implement a heatwave alert, education, and response system through the Durham County Emergency Management Division based on EPA guidance.[26] This includes partnering with formal and informal social service systems to educate the public about extreme heat dangers and mitigation techniques.[27]
- Establish Resilience Hubs in areas with high percentages of vulnerable populations to build physical and social resilience to extreme heat.
- Collaborate with the Durham healthcare community to connect residents to mitigation measures for extreme heat.
- Plan for long-term heat events with established cooling stations, shelters with overnight options, and enhanced social infrastructure.[28]
- Plan for additional funding for electricity assistance during heat waves and expansion of fan programs to include all vulnerable populations regardless of age.[29]

Current Initiatives & Activities

Operation Fan Heat Relief Program
The North Carolina Department of Health and Human Services provides free fans to senior citizens and eligible adults with serious health conditions. The Center for Senior Life administers this program in Durham County (919)-688-8247. https://www.ncdhhs.gov/divisions/aging-and- adult-services/operation-fan-and-heat-relief

Increasing Urban Forest Cover Through Tree Planting
The City of Durham, Keep Durham Beautiful, and Trees Durham collectively plant about 1,500 trees per year. The city's Urban Forestry Management Plan aims to increase the tree canopy from 42% to 45% and plant 85% of new street trees in areas that have been underserved. https://durhamnc.gov/DocumentCenter/View/32533/UFMP_GSD_9-18

CDC Communication toolkit on Climate Change, Extreme Heat
The Center for Disease Control provides information on heat stress illnesses and links to federal government resources on extreme heat.
https://ephtracking.cdc.gov/showHeatStressIllnessResources

NC Department of Health and Human Services
The North Carolina Department of Health and Human Services offers climate and health information on extreme heat. https://publichealth.nc.gov/chronicdiseaseandinjury/heat.htm

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Section 11.03 *Wildfires*

Overview

The risk of wildfires is increasing throughout the world due to climate change, increasing many public health hazards.[1] In Durham, these hazards include the physical and mental health impacts from fires that reach homes and residents as well as smoke from fires that occur anywhere in North America. According to the 2020 North Carolina Climate Science Report, "it is likely that future severe droughts… in North Carolina will be more frequent and intense due to higher temperatures leading to increased evaporation…[and] as a result, it is likely that the frequency of climate conditions conducive to wildfires in North Carolina will increase."[2] A 2023 Climate Central analysis of wildfire risk shows that North Carolina ranks fourth in the nation for total number of homes in the areas on the edges of forests and other vegetation that are greater risk if wildfires develop.[1] The Triangle Regional Resilience Assessment and the Eno-Haw Hazard Mitigation Plan both list wildfires as an increasing concern for Durham with an estimated economic damage to buildings at nearly $406,000,000 and multiple areas at medium to high risk of property damage.[3,4]

Secondary Data

North Carolina has experienced wildfires including two major wildfire events in the fall of 2016 near Asheville and in the summer of 2008 in the Pocosin Lakes National Wildlife Refuge.[5,6] Additionally, smoke from wildfires occurring outside of North Carolina impacted Durham's air quality. Since 2001, there has been a 77% increase in the daily population exposure to wildfire smoke in the United States.[7] Wildfire projections predict that by 2050, 80 million people in the U.S. will be regularly at risk.[7] The summer of 2023 was Canada's worst wildfire season on record, resulting in large smoke plumes that brought poor air quality to more than a third of the U.S. population, including Durham.[8]

Wildfires pose significant risk to human health. In some cases, the proximity to the fire itself may cause immediate injury and damage to housing infrastructure. As fires move into the area between human development and open land, (i.e. the wildland-urban interface) homes and other structures burned release additional toxic chemicals into the air, land, and water that can also have impacts on human health.[9] A majority of the risk comes from exposure to smoke or other byproducts of combustion.[9] Wildfire smoke contains air pollutants such as carbon dioxide, carbon monoxide, nitrous oxides, other organic chemicals and particulate matter.[9]

Particulate matter is the greatest health concern related to wildfires.[9] Fine particulates ($PM_{2.5}$) in wildfire smoke (wildfire PM) are associated with a range of health effects including excess deaths and respiratory outcomes such as reduced lung function, bronchitis, and the worsening of asthma.[10] Exposure to wildfire PM has also been associated with cardiovascular problems.[11] Particulate matter associated with wildfires has been shown to be more toxic than PM from other sources.[12] The majority of wildfire-related health research evaluates the short-term (days to weeks) exposure to wildfire smoke, with limited understanding of the potential health implications of repeated exposures to wildfire smoke over both many days and multiple fire seasons.[13]

While short and long-term exposure to fine particulates and possibly other harmful, but less studied byproducts of combustion during wildfires pose significant harm. Other psychological effects may also develop following large wildfires. Recent studies have noted an increase in post-traumatic

stress disorder, anxiety, and depression among others in both adults and children following large wildfire events.[14, 15]

NC Forest Action Plan

In December 2020, the NC Forest Service, along with numerous partners, updated the North Carolina Forest Action Plan.[16] This state wide assessment, along with its accompanying strategic plan and priority maps developed a broad and collective vision for protecting and enhancing NC forest values and benefits over a ten-year period. Specifically, goals two and three of the plan focus on increasing forest resilience from wildfires.[16]

Air Quality

During the summer of 2023, smoke from wildfires ravaging Canada traveled hundreds of miles across the Eastern United States to North Carolina producing hazardous levels of fine particulate matter ($PM^{2.5}$) compared to previous years during three different events[17,18,19] (Figure 11.3(a)). These three events produced elevated $PM_{2.5}$ greater than or comparable to a previous Canadian smoke event at the end of July 2021.[20] The significant degradation in Durham's air quality related to wildfire smoke events indicates that wildfires are a health issue for Durham even if they are located more than 1,000 miles away.[20]

Durham, NC, Daily Average $PM_{2.5}$, June-July, 2021-2023

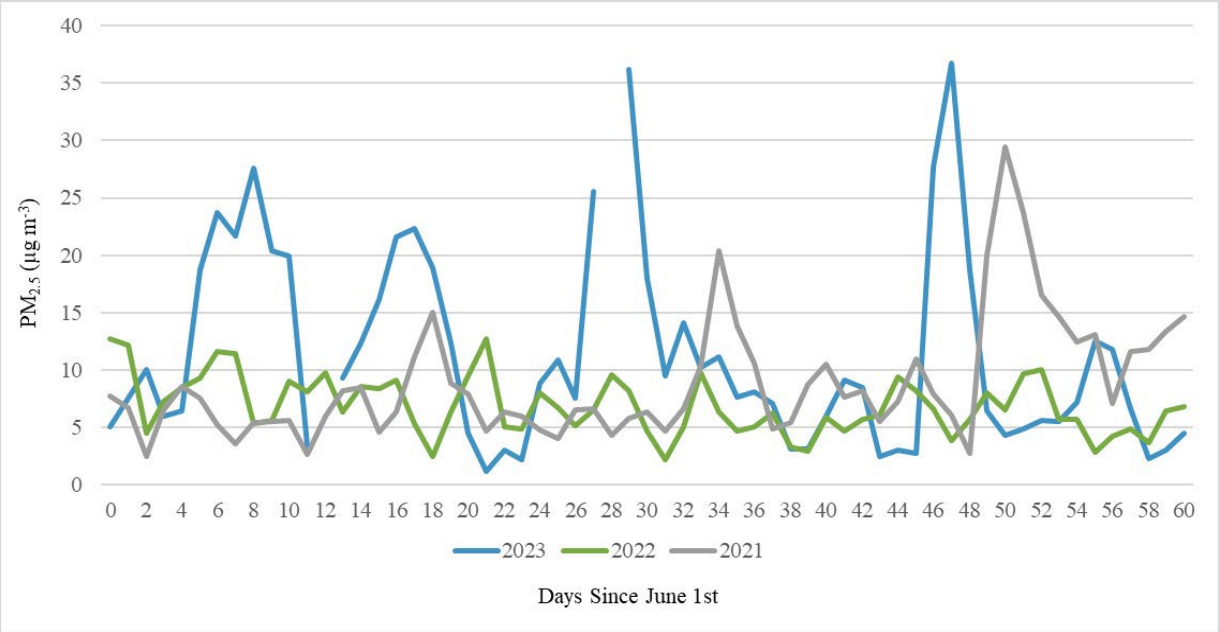

Figure 11.3 The daily average concentration of fine particulate matter during the months of June and July for 2021(wildfires), 2022 and 2023(wildfires) in Durham, NC.[21]

Interpretations: Disparities, Gaps, Emerging Issues

Several factors may make some individuals more susceptible to the effects of wildfire smoke including but not limited to age, health status, occupation, and housing status. Many studies examining wildfire smoke suggest that those living in locations with low socioeconomic status (SES) are at an increased risk of illness due to exposure to wildfire smoke. This is due to potential

increased exposure to wildfire smoke and higher prevalence of pre-existing conditions that can be worsened by wildfire-particulate matter.[22,23] Redlining policies across the country and in Durham denied wealth-generating opportunities to communities of color and undermined their physical environments.[24] This makes communities of color more likely to have poor housing infrastructure that may lack air conditioning.[24] Having housing with air conditioning has been known to reduce particle pollution such as wildfire smoke indoors, potentially reducing a person's risk of ill health effects. Therefore, those without access to air conditioning may have greater exposure to wildfire smoke.[13] Additionally, people of color and those living in low SES areas are also disproportionately affected by respiratory conditions, such as asthma, which may also put them at increased risk of health effects from exposure to wildfire smoke.[25, 26, 27]

All children, even those with no pre-existing illness or chronic conditions, are considered sensitive to air pollution, including wildfire smoke." This is due to children's still developing lungs, inhaling more air, and spending more time outside engaging in more physical activity.[28]

Recommended Strategies

- Develop a robust air monitoring system throughout the County along with a communication strategy for alerting residents.[29]
- Provide easy access to room "high efficiency particular air" (HEPA) filter machines for residents at risk to borrow during days when wildfire smoke and other air quality issues are severe.[30]
- Work with the Durham healthcare community to proactively develop disease management plans for patients more sensitive to the health impacts of wildfire exposure.[31]
- Establish Resilience Hubs in areas with high percentages of vulnerable populations to build physical and social resilience to air quality issues associated with wildfires.[32]
- Develop a communication plan for wildfire smoke events for reducing/mitigating exposure and that addresses special needs of at-risk life stages and populations.
- Create and promote safe public spaces for impacted people to go to during wildfire or smoke events.
- Practice safe forest management strategies.

Current Initiatives & Activities

NC Department of Health and Human Services offers climate health information on wildfires in North Carolina. https://epi.dph.ncdhhs.gov/oee/programs/climate.html

NC Forest Service tracks daily fire activity using a database known as the "Signal 14". The data from Signal 14 is a rapid approximation of wildfire occurrence.
https://www.ncforestservice.gov/fire_control/sit_report.htm

EPA Smoke Sense App increases awareness of the known health effects associated with exposure to wildfire smoke and advances the scientific understanding of that relationship. https://www.epa.gov/air-research/smoke-sense-study-citizen-science-project-using-mobile-app

Wildfire Smoke: A Guide for Public Health Officials is designed to help local public health officials prepare for smoke events, to take measures to protect the public when smoke is present, and to communicate with the public about wildfire smoke and health.

https://www.airnow.gov/publications/wildfire-smoke-guide/wildfire-smoke-a-guide-for-public-health-officials/

Indoor Air Quality (IAQ) Tools for Schools Action Kit shows schools how to conduct a practical plan to improve indoor air problems at little or no cost using activities and in-house staff.
https://www.epa.gov/iaq-schools/indoor-air-quality-tools-schools-action-kit

Climate Resilience for Frontline Clinics Toolkit provides resources for health care providers, patients, and administrators to prepare for climate-related hazards, including wildfires.
https://www.americares.org/what-we-do/community-health/climate-resilient-health-clinics/

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Section 11.04 *Severe Storms and Precipitation*

Overview

Storms bringing rain, snow, and wind are expected to increase in frequency and severity in the Piedmont Region of North Carolina as climate change accelerates.[1] Warmer air in the atmosphere holds more water, leading to more rain, wind, snow, or hail.[2] Large amounts of rain over a short period of time can lead to flooding, an increase in disease-carrying mosquitoes, water contamination, and mental health issues due to stress.[3] High winds topple trees and powerlines disrupting energy and transportation systems, leading to cascading impacts on the health and medical, energy, and transportation sectors.[4]

The NC Climate Science Report defines extreme precipitation events as days on which three inches or more precipitation falls over an area.[5] Rainfall can have a few separate extreme values including duration and intensity that are also significant. For example, flash floods can be dangerous even though the duration of the rainstorm is relatively short. At times, lower amounts of rainfall can fall on a smaller area in very short durations and create an extreme event. At other times, rain can fall continuously over an area for a long period of time. Both can accumulate water at the surface at a rate higher than what the ground can absorb. Vulnerability to these events is determined by several factors including the severity of weather events themselves, the built environment, and social and economic determinants of health such as income level, health insurance, and access to reliable transportation. Durham County is experiencing extreme precipitation events more frequently than historical averages and that trend is projected to increase in the next 30 to 80 years.[6]

Flooding causes the most adverse public health outcomes stemming from all extreme precipitation events that Durham might experience, which include fast, heavy downpours or prolonged periods of sustained rain. Human factors influence the severity of flooding including damage to or structural failures of dams and levees, altered drainage, and land-use patterns. Urban areas have a lot of impervious surfaces, which are surfaces that do not allow rainwater to soak into the ground, such as roads, pavement, parking lots, and buildings. This increases stormwater runoff and sometimes overflows storm drains. Infrastructure issues including clogged culverts, improperly graded asphalt, blocked drainage, and inadequate capacity of stormwater pipe systems also contribute to flooding.[7]

Flooding is currently ranked as the second most deadly weather-related hazard in the United States.[8] One hundred and eighty-one people died in North Carolina due to floods between 1959 and 2019, making it the state with the twelfth most flooding fatalities in the US.[9] Fifteen percent of those fatalities occurred between 2005-2019. The major hazards posed by flooding are the immediate threats to persons through fast-moving water and the debris carried in it. Flooding, especially flash flooding, can create emergency situations with very little warning. These events are especially dangerous to people in low-lying areas or areas with a large percentage of impervious surface.[10]

There are lingering health hazards posed by flooding that can be felt for hours, days, or weeks after the event. Flooded roadways present dangers for drivers who can misjudge the depth of the water or be swept into deeper water, leading to the vehicle being submerged, causing injuries and drowning deaths.[11] Water flooding or seeping into households, basements, and crawl spaces causes fungal or mold growth, which can make existing respiratory health problems worse. Additional issues include long-lasting power, infrastructure, and communications outages which can lead to

people having a lack of access to edible food and potable water or access to emergency services and relief. Excess standing water can provide more habitat for the water-dwelling larvae of insects like mosquitoes that can be disease vectors for serious illness including Zika, malaria, and West Nile fever, especially as warmer temperatures extend the range for those diseases.[12] The release of pesticides, animal waste, and hazardous chemicals into water sources can harm people and wildlife.

Flooding also impacts mental health. People who live in floodplains and fear the dangers presented by flooding or who have witnessed death or destruction during a prior flooding event can suffer from mental anguish, trauma, anxiety, and depression.[13] Mental health is an important component of health and the effects of living through, witnessing, or fearing a potentially life-threatening hazard because of where one lives can impact other determinants of health.

In addition to extreme precipitation, severe storms may lead to trees falling and power outages. Two people were killed by falling trees due to high winds in Durham between 2013-2023.[14] Extended power outages can have several public health impacts for sensitive groups including people dependent on electrically powered medical equipment or temperature-sensitive pharmaceuticals, those more sensitive to extreme heat or extreme cold, people susceptible to foodborne illness due loss of refrigeration for temperature-sensitive foods, and people who use combustion appliances in unventilated areas where carbon monoxide can concentrate.[15]

Secondary Data

Durham is experiencing more extreme storms and precipitation events, including a 129% increase in heavy precipitation events in the period from 2005-2014 compared to 1950-1959.[16] Durham is the 36th highest ranking city in the U.S. for extreme precipitation events overall, and the city with the 12th largest increase in these events over that time.[17]

Days with 1+ inch rain in 24-Hours in Durham County, NC 1950-2100

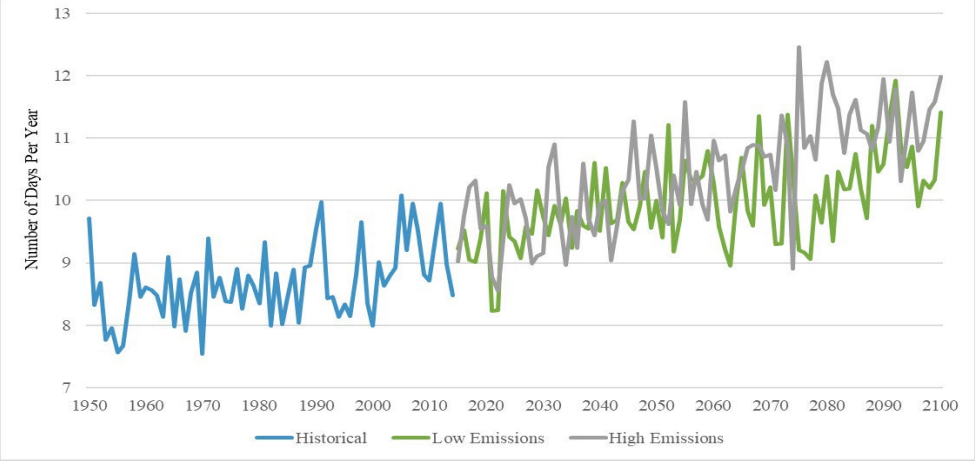

Figure 11.02(a) The number of days per year with 1" of precipitation or more over a 24-hour period for Durham County from 1950-2100.[18,19] The green and gray line show future projections based on scenarios in which humans reduce rates of greenhouse gas emission or continue to emit high levels of emissions, respectively.

Much of Durham County lies within floodplains or floodways and most census block groups are

ranked as "medium" or "high" risk for loss of access due to roads being either flooded or damaged during a high precipitation event.[20] The most affected areas were Braggtown, Southeast Durham, East Durham, Northeast Durham, and Southwestern Durham County. This affects public health by potentially making it harder for emergency responders to access the property and for residents to leave their homes to get food, supplies, and health care.

There are 112 dams in Durham County, of which 36 are listed as "High Hazard Dams" because a potential failure would likely cause loss of life and/or serious damage to structures and infrastructure.[21] Dam failures can cause flooding that is catastrophic and extremely hazardous downstream with fast-moving walls of water that can carry debris. The probability and severity of dam failure will increase with climate change.[22] Along with creating an immediate threat to human life, dam failures can also rapidly reduce or contaminate the potable drinking water supply in Durham County, creating a possible public health problem.[23]

Interpretations: Disparities, Gaps, and Emerging Issues

Impacts of extreme storm events are not evenly distributed throughout Durham County geographically or demographically. Rainfall varies across the County and local differences in topography, impervious surface coverage and the condition of stormwater infrastructure affect the impact of rain. Typically, areas with more pervious surfaces such as farms, parks, or other areas with unpaved soil or vegetation can absorb water that might otherwise cause a flooding event.

Approximately two percent (7,282 people) of Durham County residents live within a FEMA-designated flood hazard area.[24] Elderly people and children are more at-risk during flooding due to mobility issues and not understanding the risk associated with flooding. People living in poverty have fewer resources to mitigate flood risk and recover from flood damage or pay for health care associated with flood impacts.

Historical systematic racism has resulted in higher vulnerability to extreme precipitation events for certain populations in Durham. Eight historically redlined neighborhoods, clustered in the areas directly South, Southeast, and East of Downtown Durham have more risk of extreme precipitation events with lower than average tree coverage and higher than average impervious surface than the rest of Durham.[25] As in many Southern cities, formerly enslaved people were forced to settle in low-lying lands that frequently flooded and where mosquitoes were present because it was less expensive and considered undesirable by white landowners.[26] These neighborhoods, still predominantly lived in by people of color also have among the highest levels of poverty in the County. The average of 40.91% for people living in poverty in the eight census tracts is about 22% higher than Durham County's total average poverty level.[27] Along with being the most vulnerable to climate risk, the people living in these areas have the fewest resources available with which to combat the hazards from flooding or to recover after an event.

Recommended Strategies

- Conduct regional mapping assessment of stormwater conveyances and assess capacity.
- Create and implement green stormwater infrastructure programs and fee credit programs for stormwater retention.
- Expand education efforts to include citizen/community science efforts around local flooding such as NOAA Community Collaborative Rain, Hail, and Snow Network [28]
- Maintain and preserve upstream and urban forestry canopy and vegetation amounts in

areas where this has been neglected, including and especially formerly redlined neighborhoods.
- Establish Resilience Hubs in areas with high percentages of vulnerable populations to build physical and social resilience to extreme precipitation and storms.
- Develop and set standards for canopy percentage per neighborhood and for urban forestry levels.

Current Initiatives & Activities

City of Durham Stormwater Services
Provides services and public education to reduce the impacts of stormwater on people and the environment. https://durhamnc.gov/692/Stormwater-GIS-Services

Flood Inundation Mapping and Alert Network
Provides rain and stage gage data and flood alerts in real-time to support risk-based decisions. https://fiman.nc.gov/

Durham County Stormwater and Erosion Control Division
Provides services, enforces stormwater ordinances, and conducts public education on stormwater issues in the unincorporated areas of Durham County. https://www.dconc.gov/county-departments/departments-a-e/engineering-and-environmental-services/stormwater-and-erosion-control-division

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Section 11.05 *Public Health Emergency Preparedness*

Overview

Public health emergency preparedness focuses on the ability of public health agencies to plan for, respond to, and recover from emergencies that pose a risk to the health of the public. This is accomplished through planning, training, and exercising with other response partners and when an incident occurs, implementing the plan.

The Centers for Disease Control and Prevention (CDC) has "implemented a systematic process to assist state and local health departments with strategic planning by defining a set of public health preparedness capabilities. The resulting body of work, *Public Health Preparedness Capabilities: National Standards for State and Local Planning*, hereafter referred to as public health preparedness capabilities, creates national standards for public health preparedness capability-based planning and will assist state and local planners in identifying gaps in preparedness, determining the specific jurisdictional priorities, and developing plans for building and sustaining capabilities. These standards are designed to accelerate state and local preparedness planning, provide guidance and recommendations for preparedness planning, and, ultimately, assure safer, more resilient, and better prepared communities."[1] The fifteen Public Health Emergency Preparedness Capabilities are defined in *Public Health Preparedness Capabilities: National Standards for State and Local Planning*:[1]

1. Community Preparedness
2. Community Recovery
3. Emergency Operation Coordination
4. Emergency Public Information and Warning
5. Fatality Management
6. Information Sharing
7. Mass Care
8. Medical Countermeasure Dispensing and Administration
9. Medical Material Management and Distribution
10. Medical Surge
11. Nonpharmaceutical Interventions
12. Public Health Laboratory Testing
13. Public Health Surveillance and Epidemiological Investigation
14. Responder Safety and Health
15. Volunteer Management

COVID-19 Response

The Durham County multiagency response to COVID-19 has involved nearly all of the fifteen Public Health Emergency Preparedness Capabilities listed above. COVID-19 surveillance officially began at the Durham County Department of Public Health (DCoDPH) on January 27, 2020. On February 25, 2020, the DCoDPH incident management team was activated to respond to the COVID-19 threat. Durham County's first case of COVID-19 occurred on March 12, 2020. On March 16, 2020, Durham County Emergency Management Division (DCEM) activated the Durham County Emergency Operations Center inside the Health and Human Services Building to coordinate the growing response to COVID-19. In addition to reducing COVID-19 transmission by surveillance, contact tracing, testing, and screening, DCoDPH and DCEM also planned, coordinated, and performed many activities related to the COVID-19 response. These activities included:

- Supporting community efforts to meet food security and housing needs of vulnerable populations related to COVID-19
- Infection control and outbreak response to COVID-19 outbreaks within long-term care facilities and other congregate settings
- Facilitating, supporting, and providing guidance to the City and County reopening task forces
- Anticipating and planning for short- and long-term operational needs for the COVID-19 response
- Understanding and distributing COVID-19 specific guidance to staff, stakeholders, and the public.

Durham County's public health response to COVID-19 has been multifaceted, emphasizing surveillance and testing. During the acute phase of the response, DCoDPH strived to reach every COVID-positive resident of Durham County, collecting data on their contacts, travel, and employment, and assisting with isolation or quarantine needs. In 2020, Duke Health augmented contact tracing efforts, and DCoDPH partnered with state health services to boost staffing for these critical tasks. Specialized teams were also formed to handle outbreaks in high-risk settings like long-term care facilities.

Testing efforts were critical, with DCoDPH setting up community-based sites, particularly in hard-hit areas, to streamline testing accessibility. They tackled the heightened vulnerability of the unhoused to COVID-19 by implementing non-congregate sheltering and targeted testing strategies.

To inform the public, DCoDPH collaborated with Duke Health and DataWorksNC to launch the Durham County Coronavirus Data Hub, providing detailed, transparent data on local COVID-19 impacts. Continuous communication was maintained across various platforms, including social media and emergency alert systems, ensuring messages reached a broad audience and addressed the needs of communities of color disproportionately affected by the pandemic.

Food security was a significant concern, addressed through direct assistance and partnerships with local organizations to deliver food and supplies to those in isolation. In late 2020, the FDA's emergency use authorization of Pfizer and Moderna vaccines marked a turning point. Despite hesitancy due to the rapid development, DCoDPH was poised to tackle the logistical and operational hurdles of vaccination. By early 2021, in collaboration with Duke Health and Durham Public Schools, DCoDPH established a vaccination site focused on reaching marginalized populations, demonstrating a commitment to equitable health outcomes.

DCoDPH's diligence continued into the administration of updated boosters for the Delta and Omicron variants of COVID-19, following CDC approval in September 2022 and 2023, respectively.[2; 3] As of May 6, 2023, the final COVID case count from NC DHHS reported an estimated 104,443 laboratory-confirmed cases and 421 fatalities in Durham County.[4]

Primary Data

Evacuation and sheltering

“If you couldn’t remain in your home, where would you go in a community-wide emergency?”

In the Durham County County-wide Community Health Assessment Survey, participants most frequently responded that they would stay with a relative or friend if they had to evacuate (62.3%), followed by respondents who did not know (15.6%).[5] Emergency shelters were the choice of 12% of respondents. In the Comunidad Latina survey, 32.4% of respondents stated they would stay with a relative or friend, with 23.9% reporting that they would go to a disaster shelter.[6] About 23% of Comunidad Latina respondents were unsure of where they would go if they could not remain in their home.

Where would you go in a community-wide disaster, Durham County, 2022

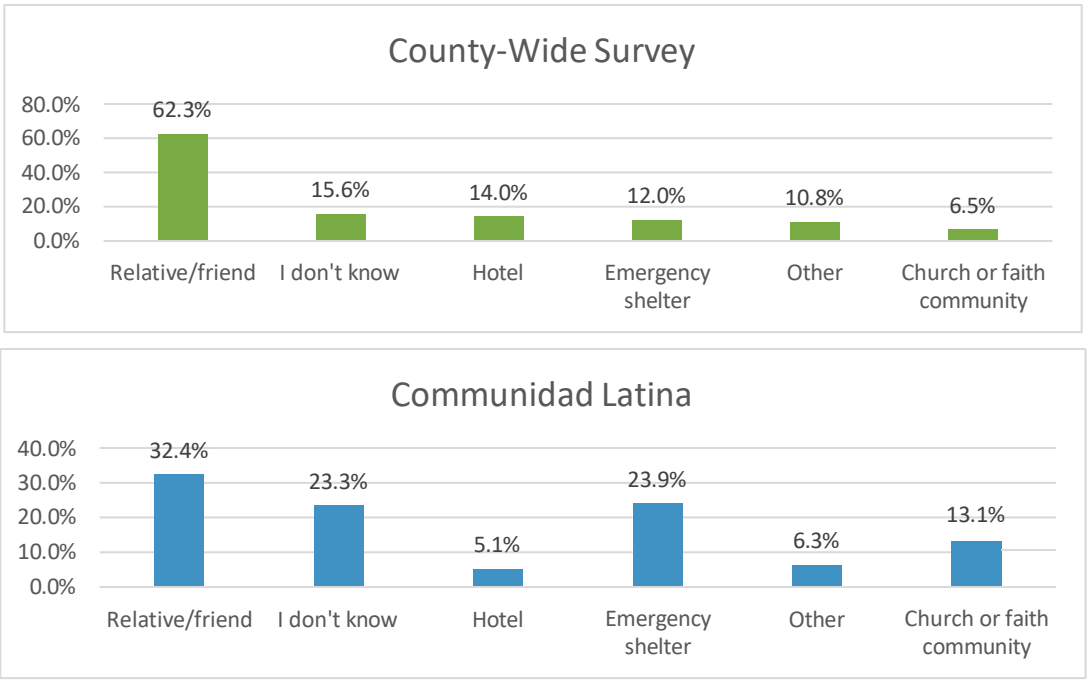

Figure 13.01(a): Where Would You Go in a Community-wide Emergency? County-wide and Comunidad Latina Sample Results, Durham County, 2022[5; 6]

"What would be the main reasons you might not evacuate or leave your home if asked to do so?"

Participants most often responded that they would leave if asked to do so (37.5%).[5] Other participants state that that they would not evacuate because of concern about leaving pets (19.9%), followed by concern about leaving property behind (10.7%) and concerns about personal or family safety (10.2%). In the Comunidad Latina survey, most people said they would leave if asked to evacuate (61.4%), with concern for property (11.4%) being the second most frequent response.[6]

Three-Day Emergency Kit and Plan

"Does your family have a basic three-day emergency supply kit and plan?"

Most participants responded that they have a three-day emergency response kit (55.5%).[5] Among whites, those that have or do not have a three-day emergency supply kit and plan are evenly split (50.0% each). People identifying as Black or African Americans respondents or "other" were more likely to report that they have an emergency supply kit (58.5% vs. 41.7%; 62.5% vs. 37.5%).

Sources of Emergency Information

"What would be your top two sources of information in a community disaster?"

The most reported first source of information in a community-wide disaster was friends, family, or word of mouth (27.6%) followed by TV (24.9%).[5] The most common second source of information during a community-wide disaster was internet or online news (44.5%) followed by TV (14%). Those that said 'other' mentioned the county website and those who answered social media mentioned Facebook, Twitter, Instagram, Reddit, and TikTok.

Top two choices for information about a community-wide disaster, Durham County, 2022

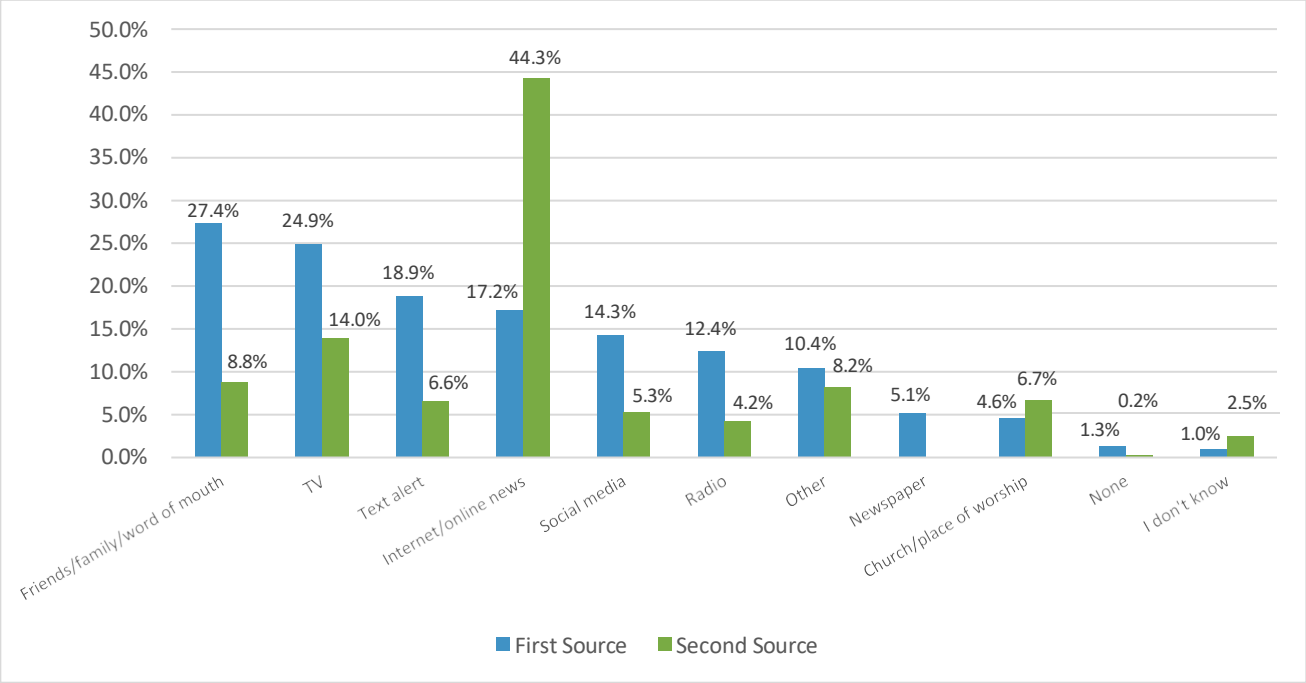

Figure 13.01(b): What would be your top two sources of information in a community-wide disaster? County-Wide Result, Durham County, 2022[5]

"Are you signed up for Alert Durham?"

Most participants were not signed up for AlertDurham (56.2%).[5] About one-third (32.9%) of respondents reported that they were signed up for AlertDurham (32.9%). AlertDurham usage did not vary significantly between races.

Interpretations: Disparities, Gaps, Emerging Issues

Examination of the 2022 Community Health Assessment Survey responses identified gaps related to community preparedness. As a frequent destination for respondents in both the county-wide and

Comunidad Latina survey, activating and operating emergency shelters are critical functions in Durham County's response to county-wide emergencies. Shelter planning, coordination and support fall under the CDC's Public Health Emergency Preparedness and Response mass care capability. The potential gaps identified fall into two broad categories: shelter capacity and shelter avoidance.

Shelter Capacity

A sizeable portion of respondents in both the county-wide and Comunidad Latina surveys stated that they would utilize an emergency shelter if a community-wide emergency forced them to leave their home (12% and 23.9%, respectively).[5; 6]

Shelter Avoidance

Reasons frequently given by respondents for not using an emergency shelter included concern about pets, perception about the seriousness of the situation, uncertainty about where to go, and concerns about personal or family safety. One critical emerging issue related to sheltering must be recognized, which is the ongoing COVID-19 pandemic. The COVID-19 pandemic is an issue that has required federal, state, local, and non-governmental organizations involved in emergency sheltering to implement control measures that can protect shelter residents from COVID-19. Sheltering during a surge in COVID-19 cases will pose additional challenges to shelter operations.

Recommended Strategies

- **Shelter Capacity** With a sizeable portion of respondents in both the county-wide and Comunidad Latina surveys stating that they would utilize an emergency shelter (12% and 23.3%, respectively), agencies involved with Durham County Mass Care planning, coordination and operations (e.g. Durham County Emergency Management, Durham County Department of Social Services (DSS), Durham County Department of Public Health, etc.) must incorporate high rates of shelter utilization into mass care planning and execution.[5; 6] Shelter planning and operation must also incorporate non-English language messaging to ensure the County meet the needs of the 8.7% of Durham residents who speak English less than "very well".[7] Current shelter plans incorporate translation services to serve the needs of non-English speakers, but it is critical that language does not become a barrier to shelter utilization.
- **Shelter Avoidance** Residents reported concern about their pets, perception about the seriousness of the situation, uncertainty about where to go and concerns about personal or family safety. These concerns highlight the importance of routine and crisis communications regarding emergency sheltering. Current sheltering plans make provisions for shelter users who arrive with pets, and law enforcement is provided at all shelters to ensure the safety of shelter residents. Communicating this information to residents would serve them well in a time of emergency. Timely and accurate communications will also be necessary to inform residents of the risks and challenges of any emergency situation and of steps that can reduce those risks, including using an emergency shelter.
- **Equity** Shelter planning, and emergency planning in general, must be developed to address inequities in vulnerable or historically marginalized populations. Future planning efforts should focus on how DCoDPH can best serve all Durham residents, using strategies such as trusted community communicators, inclusive planning groups, etc. Adding additional

preparedness questions to future community health assessments will aid DCoDPH in identifying and addressing inequalities preparedness and gaps in planning.

Current Initiatives & Activities

Durham County Department of Public Health The Durham County Department of Public Health has a full-time Public Health Preparedness Coordinator who develops Durham County Department of Public Health's plans for responding to public health needs after natural and man- made disasters, communicable disease outbreaks and any other event that requires public health preparedness capabilities. The Preparedness Coordinator also works to provide training and exercises, as well as outreach activities, for Durham County Department of Public Health, local community partners and community groups, and participates in the Durham County Local Emergency Planning Committee and the Duke Healthcare Preparedness Coalition. More information is available at https://www.dcopublichealth.org/services/environmental-health/public-health-preparedness

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