



Curriculum Units by Fellows of the National Initiative  
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## **Unequal Plates: Food Insecurity and Disease in Washington, D.C.**

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### **Introduction**

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“35 million people in the U.S. are hungry or don’t know where their next meal is coming from, and 13 million of them are children”.<sup>[1]</sup> Children in Washington, DC experience food insecurity and chronic disease risk in ways that are deeply shaped by where they live in the District, with stark contrasts emerging across wards that reflect longstanding inequities in access to resources, food, and healthcare.

As both a DC resident who has lived in Wards 1 and 7 and someone who has personally experienced childhood food insecurity, I have seen firsthand how access to nutritious food is not evenly distributed and how these disparities can shape daily decisions, stress levels, and long-term health outcomes for young people and communities at large.

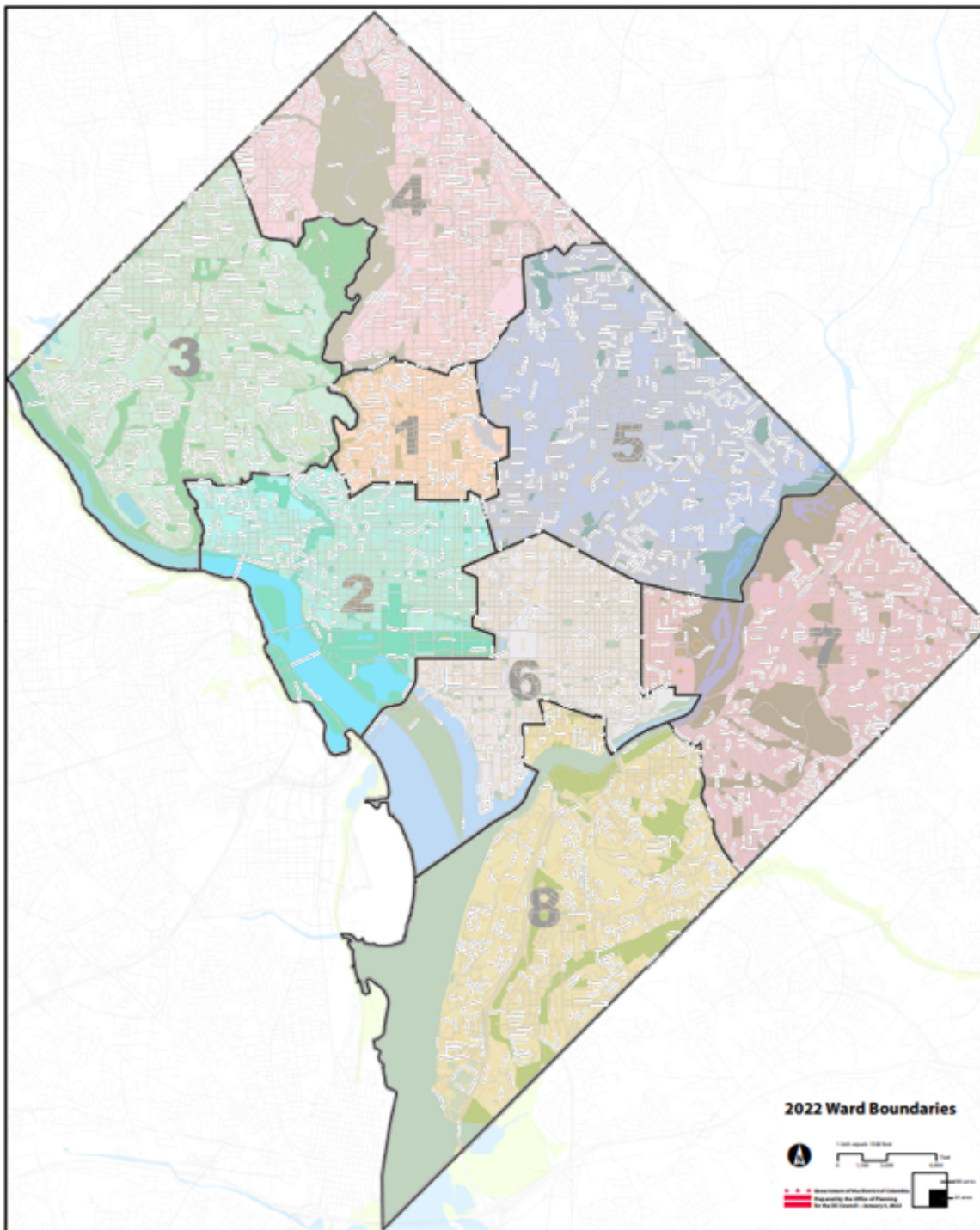


Figure 1: Ward Map of Washington DC, from DC Office of Planning.

In Ward 1, I was able to walk a few blocks in most directions and find abundant grocery stores and healthy food options, but as a current Ward 7 resident, there is only one grocery store for the entire area. That grocery store is not in a walkable area for the majority of Ward 7 residents and requires passing an abundance of liquor stores, junk food stores, and tobacco shops lining the street leading to it. This sharp contrast in proximity and accessibility to grocery stores and fresh food options causes difficulty in making healthy choices, contributing to higher rates of diet-related chronic disease, particularly for the most vulnerable communities.

## Rationale

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In my role as a Statistics teacher with an undergraduate degree in Health Policy & Management (Public Health), my lived experiences and observations of disparities in my students' access to healthy food has informed the research and curriculum unit I have developed. I want my students to use data to better understand health disparities in their own communities and feel empowered to do something to combat these outcomes. By statistically analyzing trends in food insecurity across DC, along with chronic health outcomes, students will better understand how this inequity biologically and measurably impacts the lives of DC youth and communities.

This unit is also deeply informed by my participation in the Yale National Initiative's Asking Questions in Biology seminar, which emphasized how scientific inquiry and discovery begins with meaningful, authentic questions. The seminar challenged us to think about biology not as a collection of isolated facts (knowledge), but as a discipline driven by curiosity, observation, and the desire to explain real phenomena in the world. That framing directly shaped how I designed this unit. Rather than giving students pre-determined questions or targeted statistical tasks, I want them to generate their own questions about food access, chronic disease, stress, inflammation, and the gut-brain axis. By integrating the seminar's approach to questioning with statistical analysis, this unit positions students to investigate how biology, environment, and policy intersect in Washington, DC. They learn that asking the right questions is the foundation of both scientific inquiry and social change.

## Demographics and Student Description

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I teach at Columbia Heights Education Campus (CHEC), located in Columbia Heights (Ward 1), Washington, DC. Columbia Heights is a diverse and gentrifying neighborhood in Northwest DC, with my campus being the largest school in the area. CHEC is a competitive 6-12th grade Project Based Learning (PBL) campus that draws students from each of DC's eight wards. There are approximately 1568 students at CHEC, with 68% of students identifying as Hispanic/Latino, 29% Black, 1% Asian, 1% White, and 1% Multiracial.[2]

Teaching at a PBL campus gives me a great deal of autonomy as it relates to how I teach units, as meticulously crafted projects and tasks are the primary drivers of instruction. This will be my first year solely teaching Statistics (general and AP), as I taught Precalculus, Algebra 2, and a section of Statistics in previous years. Most of the projects I implement with my students include a social justice component and an actionable deliverable so that they can use what they have learned throughout the unit to enact local change. While teaching at a campus whose cultural and economic diversity reflects the surrounding community is an amazing experience, it also causes inequities such as poverty, food insecurity, and chronic disease to be more evident, as disparities among the student population are more visible and impactful. My students notice these differences, and I find them to be most engaged instructionally when projects align with their lived experiences. I believe this curriculum unit will be relevant, standards-aligned, and empowering to my students as they analyze the link between food insecurity and chronic disease in their local communities. Taking this seminar's focus into consideration, this unit will also further build their sense of agency and help them understand how Statistics can be used to question, understand, and improve the world around them.

### Understanding Food Insecurity

Median Household Incomes by Ward and Grocery Store Locations

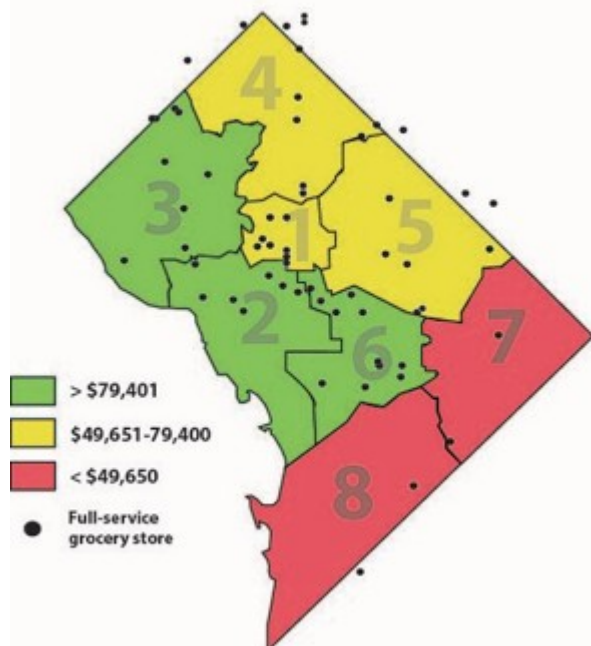


Figure 2: Median Incomes and Grocery Store Locations Across DC Wards. From the DC Office of Planning.

The U.S. Department of Agriculture (USDA) defines food insecurity as the limited or uncertain availability of nutritionally adequate and safe foods or the inability to consistently acquire acceptable foods.[3] Food insecurity may range from worrying about running out of food to skipping meals because there is not enough money to purchase food. Furthermore, in the case of urban cities such as Washington DC, food insecurity means having a lack of access to healthy food options in a walkable radius of your home.[4]

In Washington, DC, food insecurity remains a serious concern. The Capital Area Food Bank reports that more than one-third of DC residents experience food insecurity, a figure considerably higher than the national average.[5] Communities east of the Anacostia River (EOTR), namely Wards 7 and 8, experience the greatest burden of food insecurity and limited food access. Referencing the graphic below, created by DC Hunger, Wards 7 and 8 are two of the most populated areas of DC while having the highest poverty rates and fewest grocery stores. It is important to note that there are limited public transportation options in these wards as well.[6] As a Ward 7 resident myself, there is only one accessible grocery store which is a 25-minute walk away and to get to that store, I have to walk past 5 smoke shops and 3 liquor stores. These are the only things accessible in this area and while I am grateful to have the means to afford to make healthy food choices, the overwhelming majority of residents in this area do not.

It is important for educators to understand that food insecurity does not always mean starvation. Many food-insecure families consume enough calories but may rely heavily on inexpensive, highly processed foods because healthier foods are often less affordable or less accessible. As a result, food insecurity is often associated with obesity and chronic illness rather than being underweight.[7]

**Change in Number of Full-Service Grocery Stores and Poverty Rate in D.C. Overall and by Ward, 2024–2025**

| Ward        | Population     | Number of Full-Service Grocery Stores (2024)* | Number of Full-Service Grocery Stores (2025) | Number of Full-Service Grocery Stores in Pipeline (2024) | Number of Full-Service Grocery Stores in Pipeline (2025) | Median Household Income (2024) | Median Household Income (2025) | Difference in Median Household Income by Ward | Percentage of Individuals Below the Poverty Line (2024) | Percentage of Individuals Below the Poverty Line (2025) |
|-------------|----------------|-----------------------------------------------|----------------------------------------------|----------------------------------------------------------|----------------------------------------------------------|--------------------------------|--------------------------------|-----------------------------------------------|---------------------------------------------------------|---------------------------------------------------------|
| <b>D.C.</b> | <b>672,079</b> | <b>76</b>                                     | <b>80</b>                                    | <b>3</b>                                                 | <b>5</b>                                                 | <b>\$98,916</b>                | <b>\$106,287</b>               | <b>\$7,371</b>                                | <b>11.86%</b>                                           | <b>14.50%</b>                                           |
| 1           | 79,373         | 12                                            | 13                                           | 0                                                        | 0                                                        | \$120,010                      | \$126,387                      | \$6,377                                       | 8.58%                                                   | 11.60%                                                  |
| 2           | 78,878         | 14                                            | 13                                           | 0                                                        | 1                                                        | \$116,285                      | \$131,405                      | \$15,120                                      | 5.67%                                                   | 11.20%                                                  |
| 3           | 78,404         | 16                                            | 17                                           | 1                                                        | 2                                                        | \$147,968                      | \$141,849                      | (\$6,119)                                     | 2.44%                                                   | 7.40%                                                   |
| 4           | 85,587         | 11                                            | 11                                           | 0                                                        | 0                                                        | \$109,966                      | \$128,210                      | \$18,244                                      | 7.43%                                                   | 8.70%                                                   |
| 5           | 88,426         | 8                                             | 9                                            | 2                                                        | 0                                                        | \$98,326                       | \$97,817                       | (\$509)                                       | 9.16%                                                   | 14.70%                                                  |
| 6           | 84,004         | 9                                             | 10                                           | 0                                                        | 2                                                        | \$120,943                      | \$138,047                      | \$17,104                                      | 9.39%                                                   | 11.30%                                                  |
| 7           | 90,898         | 3                                             | 3                                            | 0                                                        | 0                                                        | \$49,814                       | \$69,109                       | \$19,295                                      | 23.85%                                                  | 22.40%                                                  |
| 8           | 86,509         | 3                                             | 4                                            | 0                                                        | 0                                                        | \$45,598                       | \$50,931                       | \$5,333                                       | 23.85%                                                  | 26.80%                                                  |

Figure 3: Changes in Grocery Stores from 2024 to 2025, by Ward. From DC Hunger.

### Food Deserts and Food Access: Rural and Urban Differences

The term food desert was first used in the early 1900s by the Scottish Nutrition Task Force.[8] They use the term food desert to describe areas where residents have limited access to affordable and nutritious food. The USDA measures food access primarily through proximity to supermarkets. It is key to note that the term food desert differs in definition when considering urban vs rural contexts.

#### Rural Food Deserts

In rural communities, food deserts are usually characterized by distance. Residents may live many miles from the nearest grocery store and often require reliable transportation to purchase food. Limited public transportation and lower population density can make frequent shopping trips difficult, causing families to rely on convenience stores or processed foods with longer shelf lives.

#### Urban Food Deserts and Walkability

Urban food deserts operate differently. Grocery stores may be physically closer, but healthy food remains difficult to access because of transportation barriers, neighborhood design, income limitations, or the overwhelming presence of convenience stores and fast-food restaurants. Washington, DC illustrates this contrast clearly, as 11% of the District is classified as being a food desert.[9] It is important to note that 35% of DC residents do not have a personal car and rely on public transportation, walking, or biking/rideshare to get around.[10] In Ward 1, where many residents can walk to multiple grocery stores, farmers markets, and healthy food retailers, nutritious food is readily available. In contrast, residents of Wards 7 and 8 often face long travel times to full-service grocery stores and are more likely to encounter liquor stores, corner stores, and fast-food establishments. Some researchers have begun using the term food apartheid rather than food desert to emphasize that unequal food access is largely a result of policy decisions, historical disinvestment, and structural inequities rather than geography alone. DC Hunger Solutions Director, LaMonika Jones, states that “We don’t use ‘food deserts’ because deserts are naturally occurring parts of our ecosystem”, highlighting the need for a more precise term ‘Apartheid’ to describe food-insecure areas of DC. The need for the usage of food apartheid can be justified by analyzing historical redlining in DC.[11]

## Historical Redlining in DC

Redlining, beginning in the 1930s, systematically denied mortgage lending and investment to predominantly Black and low-income neighborhoods across Washington, D.C and the broader United States. The Home Owners' Loan Corporation (HOLC) graded neighborhoods from "A" to "D," and those marked as "D", labeled "hazardous", were primarily Black communities. These designations were explicitly racialized tools that restricted wealth accumulation, halted commercial development, and prevented Black families from accessing the credit needed to purchase or improve homes.[12] As a result, redlined neighborhoods were locked into cycles of disinvestment that still manifests itself today.

A report by the National Community Reinvestment Coalition (NCRC) shows that historically redlined neighborhoods today exhibit higher poverty rates, greater racial segregation, and reduced capacity to recover from crises such as disease outbreaks, economic shocks, or natural disasters[13]. These patterns are not coincidental; they are the direct result of federal housing policies that shape the city's overall landscape. Redlining laid the foundation for the housing segregation visible today, but its impact grew after World War II through a series of post-war policies that accelerated White suburbanization and deepened racial inequities.

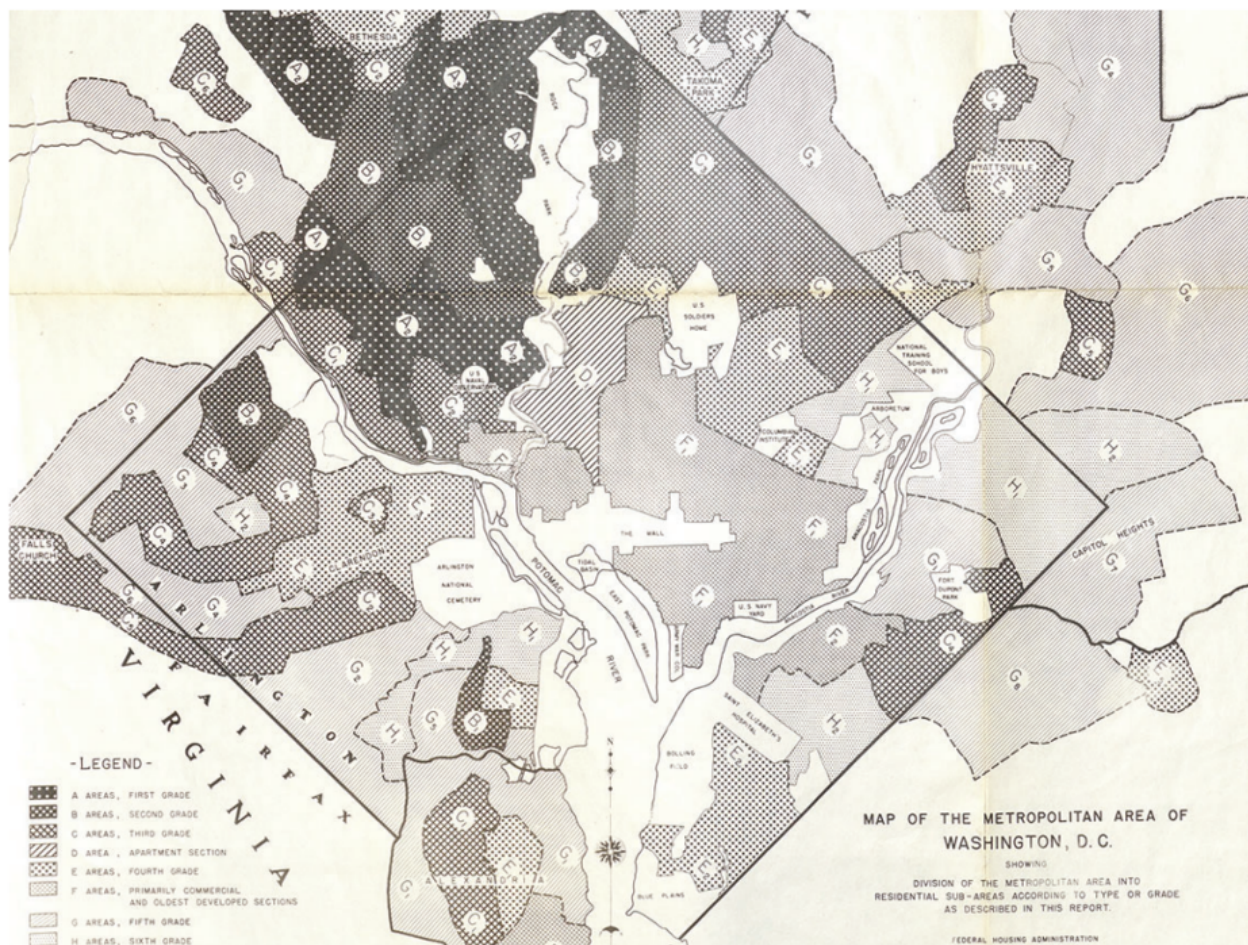


Figure 4: Map of Neighborhood Grading System Used to Determine Creditworthiness in Redlining Era (1930-1940s). From Mapping Segregation DC.

Following World War II, federal programs such as the GI Bill and Federal Housing Administration (FHA) loan guarantees made homeownership accessible to millions of White Americans. However, these benefits were

not granted to Black families. The FHA explicitly discouraged lending in racially mixed or Black neighborhoods, reinforcing HOLC maps and steering White homebuyers toward newly built suburbs in Maryland and Virginia.[14] These suburbs received significant federal investment in roads, schools, and infrastructure, making them attractive and affordable for White families. Meanwhile, Black residents in Washington, D.C. were excluded from these opportunities and were unable to obtain loans in the city's core neighborhoods. They were instead steered toward communities east of the Anacostia River, where public housing was concentrated, and livable infrastructure was limited.[15]

This movement drained economic resources from the District. As White residents left, tax revenue declined, commercial investment slowed, and public services deteriorated. By the 1960s and 1970s, the city's Northwest and parts of Northeast began receiving targeted redevelopment funds that attracted White residents back into DC. Intentionally, these investments did not extend to Wards 7 and 8. Instead, discriminatory lending practices, rising housing costs, and exclusionary zoning continued to push Black and low-income residents east of the river, reinforcing the geographic segregation created in the redlining era.[16]

The cumulative effect of these policies is visible today. Wards 7 and 8 experience limited food access, concentrated poverty, and chronic underinvestment in commercial and health-promoting infrastructure. These conditions directly contribute to the modern patterns of food insecurity and chronic disease documented throughout this unit. Although redlining is illegal today, its legacy remains embedded in the holistic landscape of Washington, D.C., shaping where grocery stores are built, where healthcare resources are concentrated, and where chronic disease burdens fall most heavily.

### **Who Is Most Vulnerable in Washington, DC?**

Food insecurity and chronic disease are not distributed equally across the District. As previously mentioned, residents of Wards 7 and 8 are among the most vulnerable due to the intersection of race, income, transportation barriers, and limited food access.

According to DC Hunger Solutions, Ward 3 has approximately fifteen full-service grocery stores, while Wards 7 and 8 each have only three despite serving large populations.[17] Despite having three grocery stores in Ward 8, most of the Ward is located 'East of the River' and has relied on a single supermarket. This supermarket tends to keep a comparatively lower amount of goods, many of which are locked away from easy consumer access due to claims of theft from the store.

The racial disparities are equally striking. A DC Food Systems Assessment found that approximately 47% of Black residents and 52% of Hispanic residents experienced food insecurity compared with only 14% of White residents. Researchers attribute these differences to historic redlining, racial segregation, and unequal investment in neighborhoods and community resources.[18]

Health outcomes mirror these disparities. Wards 7 and 8 experience the district's highest rates of obesity, diabetes, hypertension, and cardiovascular disease. Nearly 40% of residents in Ward 7 and 42% in Ward 8 are obese. Type 2 diabetes affects approximately 13.4% of Ward 7 residents and 19.7% of Ward 8 residents, compared with only 3.6% and 4.2% of residents in Wards 2 and 3.[19] The prevalence of food insecurity in Washington, DC has also drastically increased over the past five years due to the current administration's closing down of many government agencies that have resulted in mass layoffs of federal employees.[20] Abruptly having to find a new job in a climate where multiple other industries are experiencing layoffs/restructuring have led many families scrambling to find work and continue supporting feeding their families. Since 2022, 75000 more DC residents per year are now experiencing food insecurity.[21]

Additionally, the Trump-era cuts to the Supplemental Nutritional Assistance Program (SNAP), amounting to approximately \$180 billion dollars through 2035, have directly spiked food insecurity rates across the nation.[22]

These disparities affect lifespan. Residents of Ward 8 have a life expectancy approximately fourteen years shorter than residents of Ward 3, demonstrating how social determinants of health can influence outcomes across an individual's lifetime.[23]

### **Food Insecurity and Child Development**

Food insecurity can begin its effects on children from the time they begin developing in the womb. A mother experiencing food insecurity during pregnancy is at risk of not sufficiently providing the nutrients her unborn baby needs to grow and develop naturally. The result of this being, but not limited to, stunted growth, preterm birth, miscarriage, anemia, and increased risk of chronic disease development.[24] Furthermore, it has deep and measurable effects on child development, shaping cognitive, emotional, physical, and social outcomes that accumulate and persist over time. Although hunger is often understood as an immediate concern, its developmental consequences extend far beyond the absence of food.

In the short term, food insecurity disrupts children's ability to learn. Insufficient or irregular nutrition impairs concentration, memory formation, and executive functioning, making it difficult for students to sustain attention, process information, or engage meaningfully in classroom activities. In the long term, research consistently shows that children experiencing food insecurity face heightened risks of developmental delays, behavioral challenges, and poorer long-term health outcomes.[25]

### **What Teachers See in Schools**

For educators, one of the most important aspects of food insecurity is its impact on children and adolescents. Schools are often the first place where the effects of food insecurity become visible. Food insecurity can affect concentration, memory, attention, classroom behavior, and energy levels. Food insecurity is also associated with increased anxiety, stress, irritability, and symptoms of depression. In the classroom, a teacher may notice that food insecure students have trouble concentrating, low energy, headaches and stomach aches, higher absenteeism, and lower academic performance.[26]

School meal and snack programs frequently serve as a critical buffer against food insecurity, with many school districts moving towards free meals for all students. For some students, school breakfast and lunch provide the most reliable access to nutritious meals during the week, but more needs to be done to combat food insecurity outside of school hours. Without consistent access to nutritious food beyond the school day, developmental risks persist. Studies show that children who experience food insecurity during early childhood have lower educational attainment and poorer health outcomes in adulthood, even when food access improves later in life.[27] Additionally, children who experience food insecurity are at increased risk of obesity, diabetes, hypertension, cardiovascular disease, and poorer overall health later in life.[28] Repeated exposure to food insecurity can establish unhealthy dietary patterns, increase chronic stress, and alter biological systems during critical developmental periods.[29]

For schools like Columbia Heights Education Campus, where students come from all eight wards, these disparities are often visible within the same classroom. Some students arrive having eaten balanced meals while others rely heavily on school meals and convenience-store snacks. What I have noticed firsthand is that many of the students experiencing food insecurity solely rely on chips and candy as the primary basis of their

diet. These differences can influence both learning outcomes and long-term health trajectories.

## **Understanding Chronic Disease**

The Centers for Disease Control and Prevention (CDC) defines chronic diseases as conditions that persist for one year or more and require ongoing medical management.[30] Common chronic diseases include obesity, type 2 diabetes, hypertension, heart disease, stroke, and some cancers.[31] Diet is one of the strongest modifiable risk factors for chronic disease. Healthy and balanced diets are associated with lower disease risk, while diets high in processed foods, sodium, sugar, and fat increase disease risk. When families have limited access to healthy foods, they often rely on high calorie foods that meet immediate needs but may contribute to poor health over time. As a result, food insecurity becomes closely linked to chronic disease development.[32]

### **The Hunger-Obesity Paradox**

Food insecurity has been consistently associated with higher rates of obesity, particularly among individuals living in low-income households. Although the coexistence of food scarcity and excess body weight appears paradoxical, research demonstrates that food insecurity creates conditions that promote weight gain and the development of obesity over time.[33]

At the dietary level, food insecurity constrains household food choices, pushing individuals toward inexpensive and unhealthy foods. These foods provide more calories per dollar than healthier options, making them economically attractive.[34]

Additionally, food insecure and/or low-income households tend to dietarily operate on cycles of feast and famine. In periods of famine, typically at the end of the month or when paychecks or benefits run low, food intake is dramatically reduced. This changes in periods of feast, when paychecks or benefits are received, in which these same households tend to overeat.[35] These feast-famine cycles trigger metabolic adaptations such as reducing resting metabolic rates and increasing efficiency in fat storage.[36] As a result, the body begins to prioritize the conservation of energy and storing additional visceral (belly) fat, in anticipation of future famines.[37] As these cycles become normalized, adiposity is promoted, that is, the storage of excess fat.[38] Excess visceral fat is strongly linked to metabolic dysfunction. Even when total caloric intake is not consistently elevated, the poor nutritional quality of available foods encourages fat storage and disrupts normal metabolic regulation.[39]

### **Diabetes**

In addition to metabolic dysfunction, the possible downstream effect of food insecurity and the feast-famine cycle is insulin resistance.[40] Limited financial resources constrain dietary choices, leading individuals to rely on cheap and unhealthy foods. These foods cause repeated spikes in blood glucose, requiring the pancreas to release increasingly large amounts of insulin. Over time, cells become less responsive to insulin, resulting in insulin resistance, a central precursor to type 2 diabetes.[41]

Furthermore, food insecurity links to diabetes through chronic stress. Persistent worry about obtaining sufficient food elevates cortisol, a hormone that increases blood sugar, stimulates appetite, and promotes the excess storage of visceral fat. Elevated cortisol over long periods reduces insulin sensitivity and disrupts normal glucose metabolism. Stress also links to inflammation, a key factor in chronic disease acquisition.[42]

### **Inflammation: The Link Between Diet and Disease**

One of the most important biological mechanisms connecting food insecurity and chronic disease is inflammation. Inflammation is the body's natural immune response to injury or infection and is protective in nature. Inflammation is an immune system response that fights off infection, removes harmful substances and re-heals the body over time. However, when inflammation becomes chronic, it can damage healthy tissues and increase the risk of disease.[43]

An unhealthy and unbalanced diet can trigger chronic inflammation throughout the body. Frequent consumption of unhealthy foods can lead to insulin resistance, elevated blood pressure, vascular damage, and metabolic dysfunction. Over time, these effects contribute to obesity, diabetes, heart disease, and other chronic illnesses. Conversely, healthy foods such as fruit, vegetables, and whole grains contain antioxidants, fiber, and phytochemicals that help reduce inflammation and protect overall health. Unfortunately, these foods are often less accessible in food-insecure communities.[44]

### **The Gut Microbiome and the Gut-Brain Axis**

Recent scientific research has revealed another important pathway connecting food insecurity and chronic disease: the gut microbiome. The gut microbiome consists of trillions of bacteria, fungi, and other microorganisms living in the digestive tract.[45] These microbes help regulate digestion, metabolism, immune function, and mental health.[46] A healthy microbiome depends heavily on dietary quality.

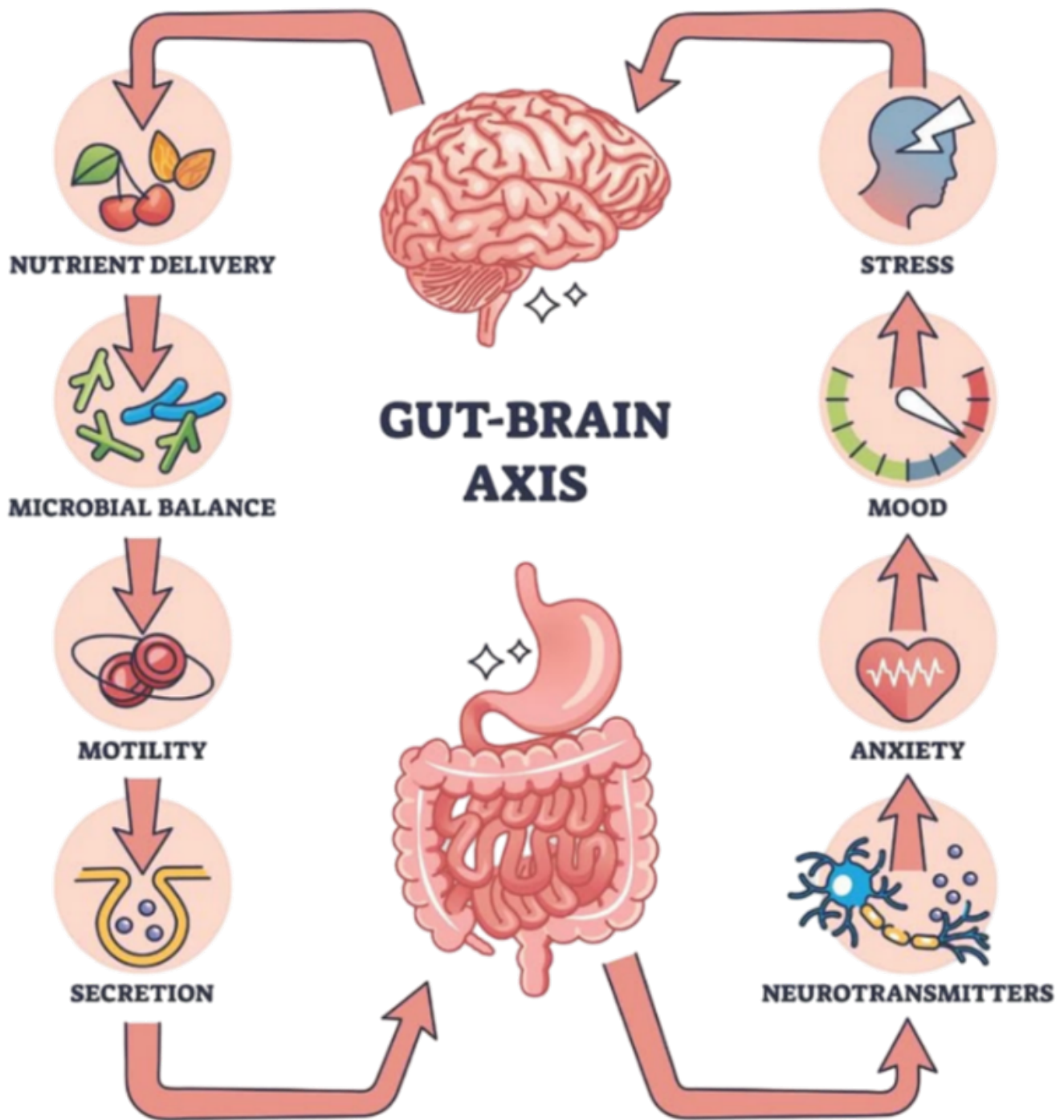


Figure 5: Diagram of Gut-Brain Axis Pathway. From Yeronga Chiropractic.

Diets rich in fiber from fruits, vegetables, and whole grains support diverse microbial communities, while highly processed diets tend to reduce diversity.[47] Food insecurity often leads to diets lower in fiber and higher in processed foods, increasing the risk of dysbiosis, or microbial imbalance.[48] Dysbiosis has been linked to obesity, diabetes, hypertension, mental health challenges, cardiovascular disease, and inflammatory conditions.[49]

The gut-brain axis functions as a two-way system in which the microbiome in the gut sends signals to the brain.[50] Simultaneously, the brain responds to external stressors, such as food insecurity, by sending signals back to the gut that impact microbiome composition and digestion. Researchers estimate that approximately 90 percent of the body's serotonin is produced in the gut, highlighting the important role that gut health plays in emotional regulation and mental health.[51]

Food insecurity disrupts this system in two ways. First, a poor diet alters the microbiome itself. Second, chronic stress affects gut function and microbial composition. Together, these factors can increase inflammation, worsen mental health, and elevate the risk of chronic disease.[52]

### **Linking Food Insecurity and Chronic Disease in Washington DC**

Patterns of food insecurity and chronic disease in Washington, D.C. reveal a stark and persistent geographic divide that aligns closely with the city's racial and socioeconomic landscape. As previously mentioned, data from the D.C. Department of Health, the D.C. Policy Center, and the Capital Area Food Bank consistently show that Wards 7 and 8, located east of the Anacostia River, experience the highest levels of food insecurity and the greatest burden of diet-related chronic disease.

In Wards 7 and 8, where approximately 22-24 percent of residents in Ward 7 and 30-32 percent in Ward 8 lack reliable access to adequate food.[53] These figures stand in sharp contrast to the citywide average of roughly 13 percent, and to Ward 3, where food insecurity affects only about 5 percent of residents.[54] These disparities reflect longstanding inequities in food access.

Chronic disease prevalence mirrors these food access patterns. Diabetes rates in Ward 8 reach 15-16 percent, and 13-14 percent in Ward 7, compared with 3-4 percent in Ward 3.[55] Obesity follows a similar trend: 42-45 percent of adults in Ward 8 and 38-40 percent in Ward 7 are classified as obese, compared with 12-14 percent in Ward 3.[56] Hypertension is also significantly more common east of the Anacostia River, affecting 40-44 percent of adults in Ward 8 and 38-41 percent in Ward 7, while only 18-20 percent of adults in Ward 3 experience the condition.[57] These disparities reflect the cumulative effects of limited access to nutritious foods, higher exposure to chronic stress, and reduced availability of preventive healthcare services.

The consequences of these inequities are reflected in life expectancy. Residents of Ward 3 live, on average, 86 years, while residents of Ward 8 live approximately 72 years, producing a 14-year life expectancy gap within a single city.[58] This gap is one of the most pronounced health disparities in the United States and highlights the extent to which food insecurity and chronic disease are positively correlated.

Areas with limited food access and higher poverty rates bear disproportionate burdens of diabetes, hypertension, obesity, and premature mortality. These patterns reflect not individual choices but the enduring effects of historical disinvestment, racial segregation, and unequal access to health-promoting resources. As such, addressing food insecurity in Washington, D.C. is inseparable from efforts to reduce chronic disease and advance health equity. It is my hope that through this curriculum unit, my students can begin to better understand this social justice issue.

## Teaching Strategies

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This curriculum unit, to be implemented at the start of the school year, seeks to educate and empower my students to use Statistics to question, challenge and better understand the world around them. Given the disparities previously outlined, this unit seeks to offer a powerful opportunity for students to interrogate inequity using quantitative reasoning. Because CHEC students come from all eight wards and already observe differences in food access among their peers, instruction that connects statistical concepts to their lived experiences can deepen both engagement and understanding. The goal is not only to teach statistical methods, but to help students recognize how data reflects structural conditions such as redlining, food apartheid, and chronic disease burdens across Washington, DC.

### Site Visits

This unit will begin with my students visiting and volunteering at the Capital Area Food Bank. Most of my students are seniors who need to complete community service hours prior to graduating, so this experience will be mutually beneficial for all parties. This organization works directly with DC's most vulnerable communities to provide food access and resources to households. Additionally, these conduct thorough research on food security in DC and publish their findings annually in their Hunger Report. My students will spend a half-day learning directly from the center and participate in volunteering in the food packaging/distribution process. It is my intent that this will instantly engage students in the contents of this curriculum unit, build their awareness and empathy towards the severity of inequity as it pertains to access to food, and begin generating questions that will be addressed through the data analysis conducted.

### Ward-Level Datasets

One effective strategy is to anchor instruction in authentic, ward-level datasets. This data would be provided to students to ensure accuracy and reliability. Research clearly demonstrates that Wards 7 and 8 experience the greatest burden of food insecurity and limited food access, while Ward 3 maintains the lowest rates of food insecurity and chronic disease. These contrasts provide rich opportunities for students to practice descriptive statistics, correlation analysis, and data visualization.

### Student-Driven Inquiry

Instruction will be structured around student-inquiry, a key tenet of a PBL curriculum unit. Because students notice disparities in their own communities, they will be encouraged to formulate research questions that matter to them. Questions such as *How does proximity to grocery stores relate to diabetes rates across wards?* or *Is there a statistically significant difference in hypertension prevalence between food-secure and food-insecure neighborhoods?* allow students to take ownership of their learning while practicing hypothesis testing, confidence intervals, and regression analysis. This approach positions my course as an opportunity to view statistics not just as a math class, but as a tool to understand and contextualize the world around them.

### Surveying/Neighborhood Audits

In addition to the quantitative data we will be analyzing, we will also utilize qualitative data to further aid in exploring inequity. Everyone's lived experiences differ, particularly based on where you live in DC. Students will conduct neighborhood audits, document food environments, and interview family members about food

access. Results will be anonymized, categorized, and compared to statistical findings, reinforcing mixed-methods thinking and helping students think beyond the numbers.

## Mapping

Another strategy involves integrating mapping, which aligns with this unit's emphasis on geography, particularly the divide between neighborhoods "east of the Anacostia River" and those in Northwest DC. Students will create choropleth maps and use GIS-based maps to examine trends and prevalence across DC. Mapping chronic disease alongside food access helps students understand how place shapes health outcomes and reinforces the connection between historical redlining and present-day disparities.

## Statistical Reporting and Actionable Deliverable

Upon completion of this unit, I want my students to feel empowered to "do something" to address food insecurity. They will present their findings and propose a solution in the form of a policy brief that can be shared with key stakeholders in Washington, DC. Given that food insecurity is an issue that can impact everyone, these policy briefs could be shared to family members, school leadership, elected officials, and community organizations as a way for my students to feel heard and realize that they can be change agents in the world around them.

## Activities

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Over the course of three weeks, my students will use data to investigate how food insecurity and chronic disease intersect across Washington, D.C.'s eight wards.

### Week One: Building Context and Understanding Descriptive Statistics

I begin the unit by taking my students to the Capital Area Food Bank. This visit is intentional as I want them to see the scale of food insecurity in DC firsthand, prior to receiving datasets. They will spend time learning from staff, volunteering in food packaging and distribution, and hearing about the communities most affected by hunger. This experience immediately sparks questions about equity, access, and health that will guide their statistical inquiry throughout the unit.

Back in the classroom, we shift into better understanding descriptive statistics. Students explore ward-level datasets that include food insecurity rates, grocery store access, poverty levels, and chronic disease prevalence. They will calculate measures of center and spread, compare distributions across wards, and begin to see how sharply Wards 7 and 8 differ from wealthier wards like Ward 3. Students also create bar charts, boxplots, and choropleth maps, while learning how historical and current DC patterns show up in data. By the end of the week, they will have built both personal and statistical foundations around the issue.

### Week Two: Connecting Data to Place

In the second week, students step into the role of community researchers. They will conduct neighborhood audits, either physically in their own communities or virtually using online maps, to document food retailers, walkability, and transportation barriers. This qualitative work is essential because it helps students connect

the numbers they see in datasets to the lived realities of DC residents, including their own peers.

Students then integrate their observations with quantitative data, strengthening their ability to interpret real-world datasets. They will create comparative graphs and maps that highlight disparities in food access and chronic disease. This week reinforces that statistics is a tool for understanding the world they move through every day, and it becomes more meaningful when tied to their lived experiences.

### **Week Three: Linking Food Insecurity to Chronic Disease**

During the third week, we move into correlation and regression analysis. Students construct scatterplots and calculate correlation coefficients to examine relationships such as grocery store proximity and diabetes rates or food insecurity and hypertension. They build linear regression models, interpret slopes and intercepts, and evaluate model fit using  $R^2$ . These skills allow them to move beyond describing data to analyzing how variables relate to one another.

We also spend time discussing confounding variables, causation versus correlation, and the limitations of observational data. These conversations matter because they help students understand why chronic disease patterns cannot be explained by individual choices alone. By the end of the week, students have the statistical tools needed to investigate their own research questions and begin forming evidence-based interpretations of DC's health landscape.

### **Week 4: Statistical Reporting and Reflection**

In the final week, students will refine their own research questions and conduct full analyses using descriptive statistics, correlation, regression, and inference tools such as confidence intervals. They synthesize their findings with insights from the food bank visit and neighborhood audits, producing a mixed-methods statistical report that includes graphics, interpretations, and a brief policy recommendation grounded in their data. This recommendation will be shared with a local change agent (principal, school board, congressperson) so that my students' voices are heard.

The unit concludes with student presentations. Students share their findings, explain the statistical reasoning behind their conclusions, and articulate how structural determinants of health shape measurable outcomes across DC. My hope is that students leave this unit not only with stronger statistical skills, but with a deeper sense of agency and awareness of the inequities affecting their community.

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## Appendix A: Implementing District Standards

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### Exploring One Variable Data

- **DAT-1.C:** Describe distributions using shape, center, and spread.
- **DAT-1.D:** Compare distributions using appropriate statistics.
- **DAT-1.E/F:** Calculate and interpret measures of center and variability.
- **DAT-1.G:** Identify outliers and unusual features.

Students begin by analyzing ward-level food insecurity rates, grocery store access, and chronic disease prevalence. They compute means, medians, ranges, and standard deviations to quantify how different DC's wards are from one another. When students compare Wards 7 and 8 to Ward 3, they are directly applying these standards to understand how inequity becomes visible through distributions. Outliers, such as Ward 8's extremely high obesity rate, become entry points for discussing topics such as the hunger-obesity paradox.

### Exploring Two Variable Data

- **DAT-2.A:** Construct and interpret scatterplots.
- **DAT-2.B:** Describe direction, form, and strength of relationships.
- **DAT-2.C:** Calculate and interpret correlation coefficients.
- **DAT-2.D:** Fit and interpret linear regression models.
- **DAT-2.E:** Evaluate model fit using residuals and  $R^2$ .
- **DAT-2.F:** Distinguish correlation from causation.

This unit centers on relationships: food insecurity and diabetes, grocery store proximity and hypertension, poverty and obesity. Students build scatterplots to visualize these connections, calculate correlation coefficients to measure strength, and fit regression lines to model how one variable relates to another. When students interpret slopes and  $R^2$  values, they are learning to quantify how issues such as redlining or limited food access show up in chronic disease patterns. The distinction between correlation and causation becomes another conversation piece about root causes of DC's health disparities.

### Collecting Data

- **DAT-3.A:** Identify observational studies and their limitations.
- **DAT-3.B:** Evaluate sampling methods and potential bias.
- **DAT-3.C:** Explain confounding variables.

Neighborhood audits, ward-level datasets, and the Capital Area Food Bank visit all reinforce that students are working with observational data. They learn to identify sampling bias and confounding variables such as transportation access, income, historical redlining, and neighborhood disinvestment. These standards help students understand why chronic disease patterns cannot be interpreted without considering historical context.

### Inferences for Categorical Data

- **INF-1.A:** Construct and interpret confidence intervals for proportions.

Students will test whether the proportion of residents with diabetes is significantly higher in food-insecure wards than in food-secure ones. They build confidence intervals around ward-level proportions and use hypothesis testing to determine whether observed differences are statistically meaningful.

### Inference for Regression

- **INF-3.A:** Perform inference for slope in linear regression.

- **INF-3.B:** Use regression output to draw conclusions.
- **INF-1.A:** Construct and interpret confidence intervals for proportions.

Students analyze whether food insecurity predicts chronic disease prevalence. They interpret regression output, test whether the slope is significantly different from zero, and draw conclusions about the strength of the relationship.

## Notes

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