INFORMING POLICY THROUGH DATA: FOOD INSECURITY AND WORSENING HEALTH OUTCOMES IN LOW INCOME OREGON POPULATIONS

by

JULIA LO

A THESIS

Presented to the Robert D. Clark Honors College
in partial fulfillment of the requirements for the degree of Bachelor of Science

Winter 2023

An Abstract of the Thesis of

Julia Lo for the degree of Bachelor of Science in the department of Biology
to be taken Winter 2023

Title: Informing Policy through Data: Food Insecurity and Worsening Health Outcomes in Low
Income Oregon Populations

Approved: _____*Mark Carrier, Ph.D.*_____
Primary Thesis Advisor

Food insecurity plagues the globe, affecting hundreds of millions of people. There are
many different levels of food insecurity spanning from acute to those living in deep famine. This
issue is one that needs to be solved globally but informed by community research and policy.
Further, food insecurity can exacerbate the challenges individuals and families experience,
especially regarding one's health. Emergency department visits tend to be some of the most
expensive utilizations of healthcare that individuals and the government are faced with in the
United States. To reduce spending in this sector it is important to understand the underlying
barriers reducing access to healthcare options outside of the emergency department. This thesis
explores community surveys surrounding food insecurity and health outcomes, defined by visits
to the emergency department, with the layer of demographics to understand the complexities and
relationships between food insecurity and health outcomes within Oregon low-income
populations. I hypothesize that there is a correlation between food insecurity and worsening
health outcomes and that this relationship will be more prevalent in systemically marginalized
communities within America. The work in this thesis suggests that being food insecure and
identifying as non-White are positively correlated with increased visits and probability of visiting
the emergency department within a year.

Acknowledgements

I would like to thank Zoe Major-McDowall through the Accountable Health Communities Project at the Oregon Health and Sciences University for helping me obtain this data. She provided me with a lot of support when I gathered the data through phone calls as well as supplying the master excel sheet with the survey responses. Additionally, I want to thank my primary thesis advisor Professor Mark Carrier for sticking with me throughout the entirety of this project despite it not being his main field of expertise. He sat with me for hours talking about the feasibility of this research as well as the realities of what this data can provide. I would also like to thank my Clark Honors College advisor Professor Trond Jacobsen. From the moment I met with him he was interested in the research I was doing and gave me a lot of confidence. He could sense my passion which solidified my commitment to this project. Lastly, I would like to thank Aidan Bergsman who taught me all the components of a regression analysis. Without him I would not have been as successful in finding the significance within my data.

Thank you to the Clark Honors College program for pushing all of us students to take this on. I have learned so much from this experience and feel so lucky to be able to write a thesis as an undergraduate student.

Table of Contents

List of Figures

Introduction

Food insecurity is a huge problem across the globe. According to the United Nations World Food Programme, 828 million people go to bed hungry every night.[1] Additionally, 349 million people face acute food insecurity across the globe while 49 million are on the edge of famine.[1] There are many factors that have caused this including, but not limited to, the COVID 19 pandemic, the ongoing war in Ukraine, economic crises across the globe causing increases in food prices, widespread supply chain disruptions, and weather-related disasters. Across the globe, the biggest drivers of food insecurity include climate shock, conflict, and increased fertilizer prices.[1] Food insecurity in America and Oregon reached lows in 2019, but this progress was quickly erased by the pandemic. In Oregon, COVID 19 brought a resurgence of food insecurity after a 5-year decline from 2014 to 2019.[2] 2020 estimates predict that 1 million Oregonians face food insecurity equating to 24% of the state population.[2] Feeding America estimated that in the United States in 2020, national food insecurity was 45 million or 14.3%.[3] These estimates illustrate that Oregon's food insecurity problem is worse than the national average which confirms the urgency of this problem.

The United States Department of Agriculture defines food security as "access by all people at all times to enough food for an active, healthy life".[4] Informed by this definition, food insecurity can be conceptualized on three basic aspects: availability, access, and utilization.[5] Availability is necessary but not sufficient for access to nutritious food which is in turn necessary but not sufficient for the healthy utilization of food.[5] These three pillars are all necessary to understand and solve the issue of food insecurity.

Determining how to measure and use data surrounding food insecurity has been a long-standing research question as policy makers struggle to tackle this problem. One method to

measure food insecurity has been created by the Food and Agriculture Organization of the United Nations (FAO). This method uses calorie estimates on a per capita basis, household income and expenditure services, individual dietary intake, and experience-based food insecurity measurement scales.[6] This method is less expensive than other methods but does not consider dietary quality, therefore ignoring the prevalence of obesity in poor populations, and has a high degree of measurement.[6] Overlooking dietary quality ignores the utilization pillar of food insecurity, whereby nutritious foods are included in the diet. This can have negative consequences on estimates of food insecurity because it ignores the intricacies of malnutrition caused by obesity. Another common method is the use of household income and expenditure surveys. This method utilizes interviews of households on a multitude of different questions all surrounding food consumption and expenditure.[6] This method considers dietary quality, but it is difficult to standardize its methodology across locations, making it more feasible for a smaller scale study.[6] In addition to these benefits, it has been found that the best mechanisms of measuring food insecurity come from looking at household and individual data because they continually generate higher estimates of food insecurity, accounting for more food insecure individuals than studies derived from aggregate data.[5] This is an alarming finding that points toward the importance of screening individuals and families within our communities to tackle this issue of food insecurity rather than large scale aggregate estimates.

At the Oregon Health and Sciences University, I collected data on low-income populations in relation to their social needs and health outcomes, defined by how many times they had been to the emergency department in the previous year, using the household surveys method. This project was completed through the Oregon Accountable Health Communities, a federal government funded initiative, exploring the relationship between addressing health-

7

related social needs, which are closely tied to social determinants of health, and how access to resources addressing social needs can reduce medical expenditures in low-income populations, specifically Medicare and Medicaid beneficiaries. Through this data, I explore the relationship between food insecurity and worsening health outcomes within low-income Oregon populations. I hypothesize that food insecurity is an indicator of worsening health outcomes, creating a vicious cycle of lack of food coupled with expensive healthcare costs in these populations. Further, I hypothesize that more marginalized communities will face higher levels of food insecurity and in turn worse and more expensive health outcomes. This project will help to provide evidence about the prevalence of food insecurity and its relationship to healthcare to support how this issue can be tackled through Oregon policy changes.

Evidence-based public health decision making and planning such as this is important because it uses scientific data and engages the community.[7] The use of data helps to ensure high quality information is being used to inform public health decisions serving to increase effectiveness of solutions and reduce any unforeseen potential harm new programs could result in.[7] By using data to look at this public health issue of food insecurity coupled with health outcomes, better and more effective solutions can be reached.

This project is important to me because food has become a privilege rather than a right in certain populations. I want all people to have proper access to healthy food to support their wellbeing. I chose to look at food because it can often be the first item that some families stop purchasing when faced with limited income. Payments like rent and utilities must be paid in full each month while food is a variable cost. This project will help provide evidence about the prevalence of food insecurity and its relationship with health outcomes to support policy changes to benefit Oregonians. Food insecurity is a huge issue in Oregon that needs to be supported by

our government if change is going to happen. Because food is a necessity for all individuals it is of the utmost importance that we take action backed by evidence as soon as possible.

Why food?

Food security has many implications for one's quality of life. This section explores different ways that food insecurity can exacerbate already delicate situations. Specifically, because food is a variable cost, as opposed to rent or mortgage payments which have fixed amounts and payment deadlines, it can be the first to go when an individual runs out of money for the month. An individual can choose to forego a meal but cannot pay half the rent if they are hoping to have a roof over their head. Because of this food insecurity and financial situations can often be correlated. Additionally, the nutrition levels and amount of food one eats can have different health implications. Eating too much or too little, eating the wrong types of foods or not receiving proper nutrients can have negative effects on our bodies. This next section will go into more detail surrounding current literature on the different implications of food across our lives.

There is a strong relationship illustrating that hunger rates decline sharply as incomes rise.[8] Even with this strong relationship, one study has suggested that there is a lack of one-to-one correspondence between poverty-level incomes and hunger.[8] Despite this finding, income is a clear determinant of food insecurity across the globe. The data collected from OHSU models this relationship. The graph below (figure 1) illustrates that as income increases the percentage of food insecurity decreases for the population screened. This again points to the inverse relationship, that may not exist in a one-to-one manner but is still present.
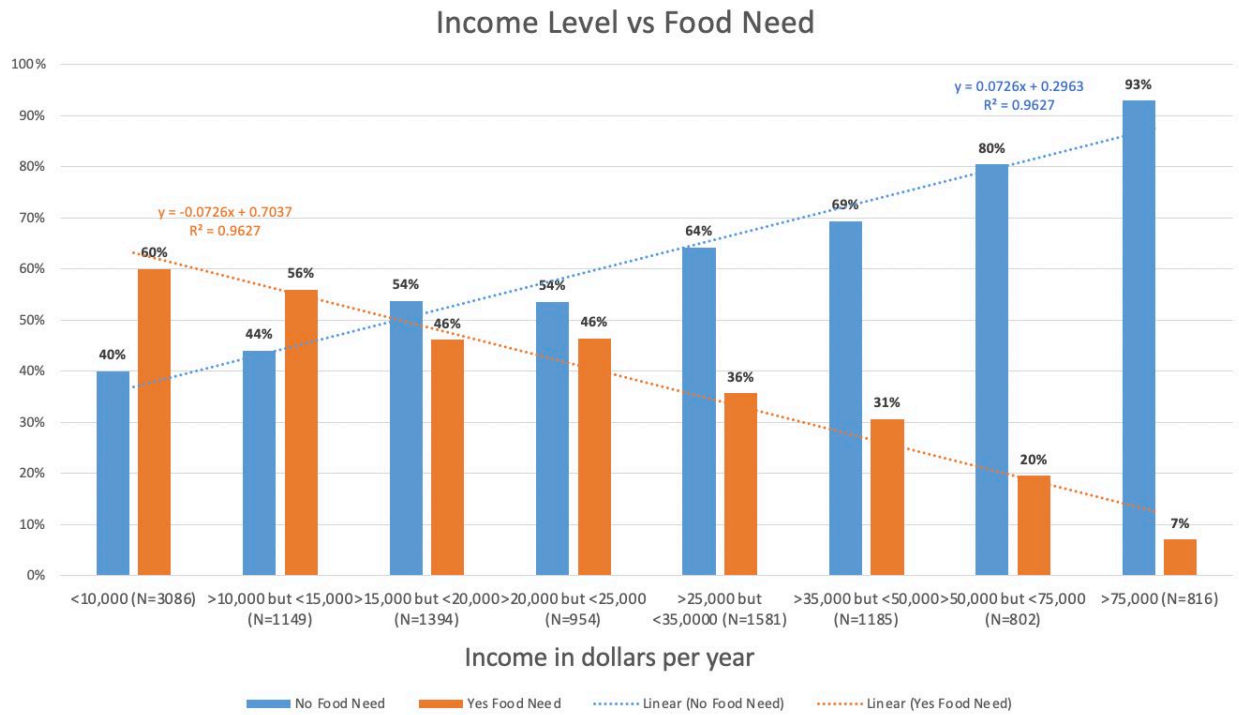
Figure 1: This figure shows the relationship between income level and food insecurity. Income increases along the x-axis. As income increases the proportion of those facing food insecurity decreases. This population was the entire Medicaid population screened. I excluded data from those who chose to not answer the income question.
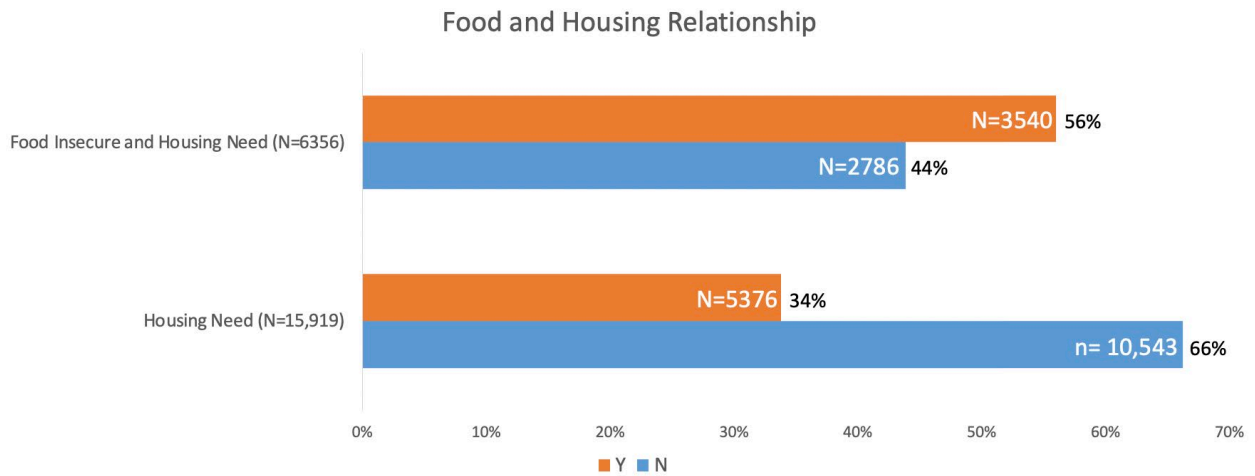

Figure 2: This figure shows the relationship between housing and food insecurity. The top two bars represent individuals who have a food need. The Y means that they have a housing need, and the N represents no housing need. The bars below represent the base case for housing needs in the Medicaid population. Those who have food insecurity are more likely to face housing needs as well.

Another study by Bernell et al, has pointed to the inverse relationship between housing affordability and food insecurity.[9] Specifically, this study suggests that food insecurity is not a product of individual choices but rather a more complex problem resulting from issues like disparities in the context of the local community food infrastructure, including things ranging from housing to social support. The relationship between housing and food insecurity for the OHSU data sampling is illustrated in figure 2. Those individuals who are food insecure are more likely to have a housing need than the entire low-income Medicaid population screened (represented by the lower bars, figure 2). Taking both the study by Bernell and the graphs created from the OHSU data, having a lower income plays a significant role in the myriad of issues that are correlated with food insecurity.

Poverty level is another widely used measure of economic situation but is imperfect to examine the relationship I am investigating in this thesis. Studies have found that despite food insecurity and poverty being two separate experiences, they can be linked together in many cases. For example, the prevalence of food insecurity drops from 35.1 to 4.9 percent when a household is 1.85 times above the federal poverty rate.[10] However, more than half of food insecure households at the time of this study were not in poverty and more than half of households in poverty are not food insecure.[10] Additionally, poverty can be a correlated factor to worsened health outcomes measured as increased visits to the emergency department, lack of strong nutrition, increased chance of injury or increased incidence of chronic diseases.

In 2018, the American Community Survey (ACS) measured poverty levels by age and sex in the United States versus Oregon. It was found that 16% of children under 18 were living in poverty in comparison to 12% of adults within Oregon.[11] Looking at national levels, 18% of children and 12% of adults live in impoverished conditions, reflecting similar numbers statewide

and nationally.[11] Trends from 2005-2018 have shown an increase in poverty during the 2008 recession with a decline starting in 2011, for both adults and children.[11] Because of the pandemic, it can be expected that poverty rates have increased significantly for all populations, but the data has yet to be solidified. This thesis is serving to elucidate how food insecurity can be an indicator of worsened health outcomes within low-income communities, however, making the important distinction that being low income or in poverty is not the cause of their food insecurity but an additional experience that can exacerbate food insecurity.

Aside from economic implications, there are important health consequences surrounding this issue. For example, undernutrition and malnutrition can be caused from unhealthy foods that can lead to food insecurity.[12] Undernutrition is defined as insufficient caloric intake while malnutrition refers to micronutrient deficiencies that can happen with undernutrition, sufficient caloric uptake, or obesity.[5] Obesity has become a growing issue in poor populations shown by excessive caloric consumption associated with mild to moderate levels of food insecurity.[6] Some populations can receive sufficient caloric intake, or even excessive levels, but can still face food insecurity pointing to the intricacy of this problem. This returns to the discussion of the three pillars necessary for food insecurity: availability, access, and utilization. The case of malnutrition and undernutrition can be a result of lacking any one of these pillars whether there is availability and access but not healthy utilization or lack of availability and access which means there would be no way to properly utilize these foods to support a healthy diet.

There have been numerous studies surrounding negative health outcomes and their relationship to food insecurity. For example, a study using data from the National Health and Nutrition Examination Survey of 1994-2004 found that children aged 12-15 are 2.95 times more likely to be anemic if they face food insecurity in their households.[13] The survey was made up of

families from around the United States and is continuously conducted by the National Center for

Health Statistics (NCHS) through the Centers for Disease Control and Prevention (CDC).

Another study used data from a 10 year longitudinal survey, the Canadian National Longitudinal

Survey of Children and Youth (NLSCY), to observe the link between asthma and food insecurity

in Canadian children.[14] They used varying levels of food insecurity and created a variable to

determine repeated hunger patterns in the individuals surveyed over time.[14] They found that

children aged 10-15 (n=5089) in households with food insecurity were 1.41 times more likely to

have asthma.[14] Another study by Whitaker et al. looked at 2870 mothers of 3 year old children

across 18 major US cities with varying levels of food insecurity.[15] The mothers were then

surveyed for major depressive episodes or generalized anxiety using the Composite International

Diagnostic Interview-Short Form.[15] They observed that food-insecure mothers tend to have

higher rates (2.2 increase) of mental health issues.[15] Lastly, a study carried out linear/logical

regression analysis of data from the Third National Health and Nutrition Examination Survey

(1988–1994) and the Nutrition Survey of the Elderly in New York State (1994) to examine the

relationship between food-insecure elderly people and their nutrient intake.[16] They found that

most elderly adults did not take in enough nutrients, and those who were food insecure were 2.33

times more likely to report fair or poor health status and in addition had a higher nutritional risk

due to lower intakes of nutrients than non-food-insecure elderly adults.[16] Overall, these studies

illustrate that across all ages, food insecurity is correlated with worsened health status.

Two studies, more specific to my research, look at the relationship between emergency

department visits and food insecurity. The first study by Berkowitz et al., found that food

insecurity was associated with significantly more emergency department visits, hospitalizations

and days hospitalized.[17] Additionally, food insecurity was associated with increased odds of

being in the top 10% of healthcare expenditures leading to higher costs for individuals who can't afford it.[17] A second study by Miner et al. concluded that a significant proportion of the Hennepin County Medical Center's emergency department population experience food insecurity and hunger.[18] Both studies provide models to base the premise of my project on by illustrating that food insecurity is associated with increased emergency department visits.

Resources (SNAP)

The largest federal nutrition assistance program is the Supplemental Nutrition Assistance Program, better known as SNAP. SNAP provides food benefits to low-income individuals and families on an electronic benefits transfer (EBT) card that gets refilled every month.[19] Eligibility for SNAP is determined on multiple different aspects including the state in which you reside, bank account limits, household income, and number of people in the household. The maximum monthly allotment for one person is $250 and increases incrementally as more and more people reside in the household. SNAP benefits can be calculated by multiplying net income by 30% (rounding up) and then subtracting that 30% of net income from the maximum allotment for the household size. This metric comes from the idea that households are expected to spend around 30% of income on food each month.

Surprisingly, one study found that there is no relationship between extent of state-level participation in food stamp programs and food security outcomes.[10] In general, they find that food stamp recipients tend to have higher levels of food insecurity than low-income non-recipients which they attribute to self-selection within people who have the greatest need for nutritional assistance.[10] More positively, they found that economically vulnerable families (not high income and not poor) had the most to gain from these programs by reducing food insecurity when accessibility to those programs is increased. Overall, increased access to food stamps for near-poverty individuals serves to moderate food insecurity. This suggests that the population would benefit from an increased cutoff for food stamps as well as more support for the lowest income individuals.

Social Determinants of Health

Social determinants of health are different factors within lived environments that can affect a wide range of health and life outcomes.[11] Social determinants of health include social, economic, or environmental conditions affecting the health of individuals and communities. It is important to understand that social determinants are created by the systems of power, are shaped by the amount of money and resources a person has and can be supportive or unsupportive of health. Social determinants are not behaviors by people but unavoidable situations that can influence health and quality of life. The distributions of these across communities can lead to clear health disparities. Some social determinants of health (SDOH) include access to food, safe housing, consistent transportation, lack of violence, education, literacy skills, etc.[11] The Accountable Health Communities project screens low-income Medicaid covered individuals for SDOH and then provides resources to mitigate these conditions. The Accountable Health Communities model has been integrated in 28 different organizations across the United States, with the Oregon Health and Sciences University (OHSU) in Portland being the only location on the west coast.[20] This model is based on evidence that addressing health-related social needs (food, housing, transportation, utilities, and safety) will lead to more positive health outcomes and ultimately reduce healthcare costs.[20] The primary question in this project is: does screening for health-related social needs with tailored navigation and connection to resources address the patient needs and lower health care costs? In this project, we were able to collect data through phone calls and screenings of these populations for the social needs of transportation, safety, housing, assistance with utilities and food. By wide margins, the biggest needs were always food and housing for the Medicaid population.

The data I have looks at social determinants of health (food, transportation, housing, utilities, and safety) across all of Oregon with additional data based on demographics such as zip codes, income level, race/ethnicity, and age. In this study, there are very specific definitions on each social determinant of health. Food insecurity is defined as being worried your food would run out before having money to buy more or having your food run out before there was money to buy more. Housing insecurity is defined as not having a steady place to live or having problems within the house such as: smoke detectors not working, mold, water leaks, lack of heat, or oven and stove not working. Transportation insecurity is defined as not having a method of transportation to get to activities needed for daily living (grocery shopping, medical appointments, work, etc.). Utilities insecurity is defined as having the electric, gas, oil or water company threaten to shut off services. Lastly, any safety concern is defined as physical or emotional abuse whether this includes threats, insults, swearing, or harm.

If the member qualifies (based on answers provided), we can also offer navigation where they will have tailored help from a case manager for a year. The qualifications to gain a case manager include screening for at least one need, going to the emergency room 2 or more times in the past year and not living in a community dwelling (e.g., assisted living, penitentiary, rehab center, etc.). If the member doesn't qualify for navigation, we are able to offer resources for these individuals through 211info. This service aggregates resources for social determinants of health across all of Oregon. From this project at OHSU, we have been able to screen over 20,000 members in Oregon and provide resources and navigation to those who qualified.
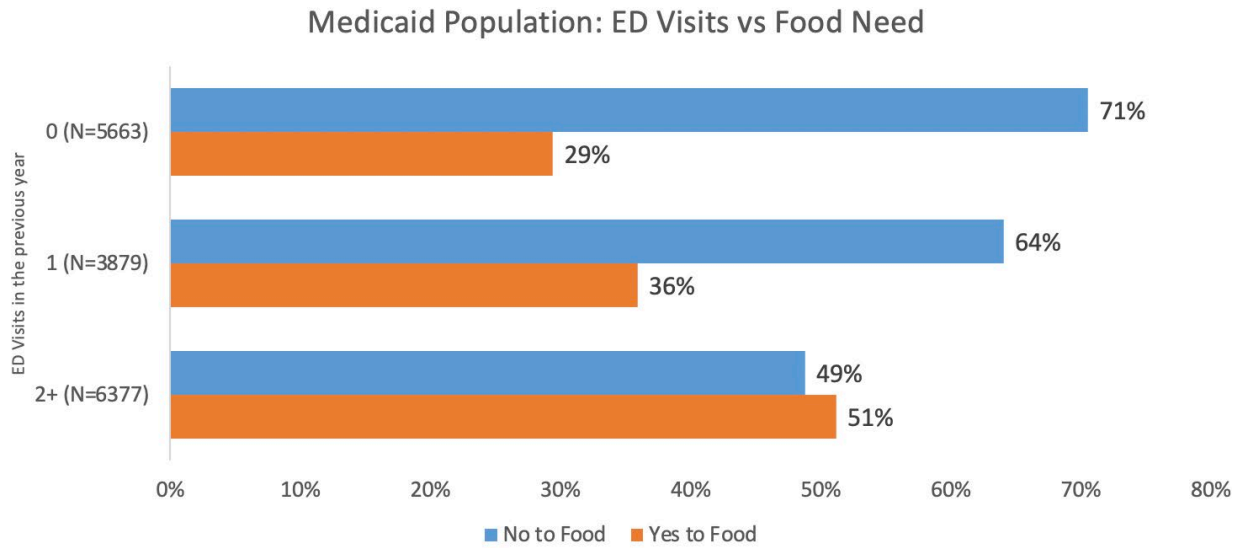
Data from OHSU

This next section explores the data I have gathered from my work at the Oregon Health and Sciences University (OHSU). This data consists of over 22,000 screenings done from 2018-2021. I have 23 columns of data with 21,907 rows. I will not be using all the columns of data to answer my question. I use the state column, which ensures that the patient surveyed is from Oregon. I will then be using the "A Food" column. This column contains a "Y" or "N" depending on if the patient has food insecurity. The next column I will use is "ED Visits" which contains how many times the patient has been to the emergency department in the past year (0, 1 or 2+ times). This will serve as my health outcome variable with 2+ ED visits being the worst health outcome. Those who have been to the ED 0 or 1 time in the past year, in this study, are defined as those who are using the emergency department for acute injuries and therefore aren't regular users. In other words, the 0 and 1 timers are not going as a substitute for a primary care physician but rather for an emergency. 2+ ED visits is characterized as visiting the emergency department for more chronic injuries rather than acute. Research has shown that a large proportion of healthcare costs are generated by a small proportion of patients due to emergency department visits, inpatient hospitalizations or long lengths of hospital stay.[21] Emergency departments guarantee treatment to patients that come in, making this a common space for low-income groups to get treatment despite it being more expensive. Then I will be using the "Ethnicity" column which states if the patient is of Hispanic or Latin origin. I will be using the term "Latinx" to describe this population throughout this thesis because it does not have any gender connotations.[22] I will not be observing ethnicity based on gender and therefore want to ensure all identities are included when I am viewing this data. Within this survey, Latinx is defined as identifying as Mexican, Mexican American, Chicano, Cuban, Puerto Rican, or any

other Hispanic, Latino or Spanish origin. I chose to look at the Latinx population because this is the largest population, after the White population, within Oregon and it is continually growing. I will be using the "Year of School" column which contains information on the highest level of schooling the patient received. Oregon sits at a very low ranking within the United States for K-12 public schooling which is why I want to examine this relationship. Specifically, I want to compare those who have finished high school (and thus gone through public schooling in Oregon), gone to some college or finished college. Lastly, I will be using the "Type" column which contains if the patient is a Medicaid or Medicare insurance holder. The main criterion for Medicaid is being low-income while Medicare is geared toward elderly populations. I will be only focusing on the Medicaid population.

My first step in this research project will be to establish that there is a correlation between increased ED visits and food insecurity. After this is visualized, I will examine this relationship across populations with my main question being: do ED visits and food insecurity stay correlated across different low-income populations in Oregon? I will compare the ED visits of different populations (race, ethnicity, gender, and level of schooling) faceted by food insecurity to understand if food insecurity continues to be correlated with ED visits. I hypothesize that the correlation between food insecurity and ED visits will remain consistent across all populations while more marginalized populations (lower schooling level, Latinx populations, etc.) will face higher proportions of food insecurity because these groups tend to be systemically marginalized through our government and society at large.

Figure 3 - Base Relationship: Food Insecurity and ED Visits

Medicaid Population: ED Visits vs Food Need

ED Visits in the previous year	No to Food	Yes to Food
0 (N=5663)	71%	29%
1 (N=3879)	64%	36%
2+ (N=6377)	49%	51%

■ No to Food ■ Yes to Food

This graph represents the base relationship. This is establishing the correlation between food insecurity and emergency department visits. This graph includes the entire Medicaid population screened in Oregon, regardless of if they said yes to having any need (food, housing, transportation, utilities, or safety). As the number of emergency department visits in a year increases (from 0 to 2+) the incidence of food security decreases. Therefore, as the number of emergency department visits per year increases, the incidence of food insecurity increases. This illustrates a positive correlation between increased emergency department visits and increased prevalence of food insecurity. The next sections explore how this relationship holds or is exaggerated in different population groups.

Figure 4A - Race and Food Insecurity
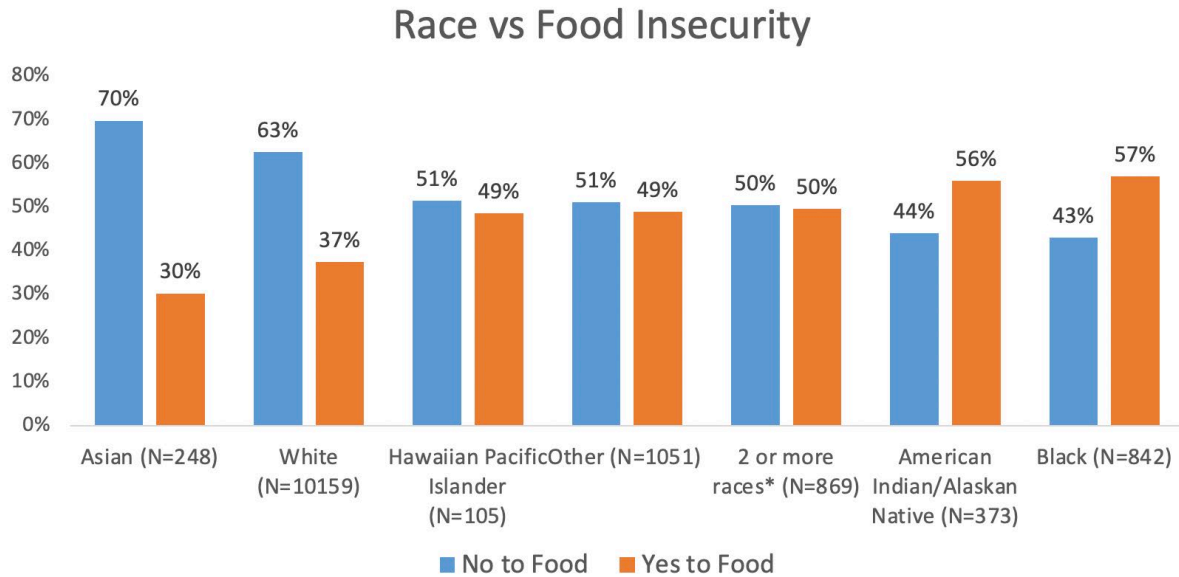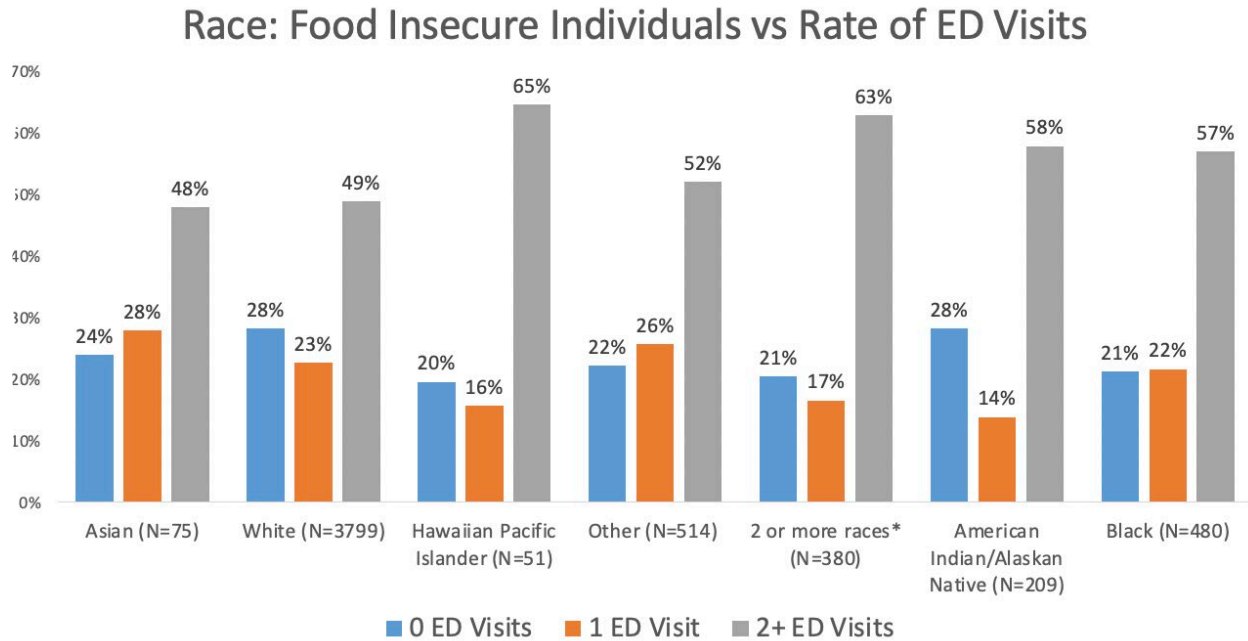
Race vs Food Insecurity

Figure 4A graphs the relationship between race and food insecurity. The different races are shown along the x axis while the percentage of their population saying yes or no to a food insecurity question is on the y axis. This graph has been organized so that as you move from left to the right the incidence of not having a food need decreases which in turn means that the incidence of food insecurity increases from left to right. The most important aspects are the differences between races. On the right side the lowest incidence of food insecurity is observed in Asian populations while the highest prevalence food insecurity is viewed in Black populations. This is important because it informs how policies should be created to serve the populations who would benefit the most. Additionally, it can inform which groups to reach out to create plans to mitigate food insecurity (i.e., Black based organizing groups rather than Asian). The White population, which has by far the largest sample size, is shown to have higher rates of food insecurity than the Asian population. After this, the Hawaiian Pacific Islander, Other, 2 or more races, American Indian/Alaskan Native and Black populations all have higher rates of food insecurity.

Figure 4B - Race and Food Insecurity by ED Visits

Race: Food Insecure Individuals vs Rate of ED Visits

■ 0 ED Visits ■ 1 ED Visit ■ 2+ ED Visits

*2 or more races: anyone choosing 2 or more options for race of any combination

This graph depicts the subset of the Medicaid population of people who had a food need, meaning they answered yes to either or both food insecurity questions. This graph shows that across all races, food insecure individuals are more likely to have gone to the emergency room 2 or more times in the past year. All populations are affected in similar ways, with the highest prevalence of 2 or more emergency room visits being in the Hawaiian Pacific Islander and 2 or more races category. Those going to the emergency department 0 or 1 time in the previous year, meaning they are going to treat an acute issue, have much lower rates of food insecurity across all races included in this graph. Overall, across all races, worsening health outcomes defined by increased emergency department visits is correlated with higher proportions of reported food insecurity.

Ethnicity vs Food Insecurity

According to the most recent Oregon census, 13.4% of the Oregon population is of Hispanic or Latinx ethnicity. This population makes up the largest ethnic minority demographic in Oregon and is continually growing. Because of this our state needs to continue to support and uplift this group through policy.

This graph above is looking at the incidence of food insecurity. The non-Latinx population has a much larger sample size at 10,340 but the Latinx population still has a strong sample size at 2,985. This graph illustrates that when looking at the entire Medicaid population there is a higher incidence of food insecurity in the Latinx population shown by the 44% saying yes to food in comparison to 40% in the non-Latinx population. This represents a very small increase in incidence of food insecurity.

Figure 5B - Ethnicity and Food Insecurity by ED Visits

Ethnicity: Food Insecure Individuals vs ED Visits

Legend: ■ 0 ED Visits ■ 1 ED Visit ■ 2+ ED Visits

Non-Latinx (N=4100): 28%, 22%, 51%
Latinx (N=1326): 30%, 23%, 48%
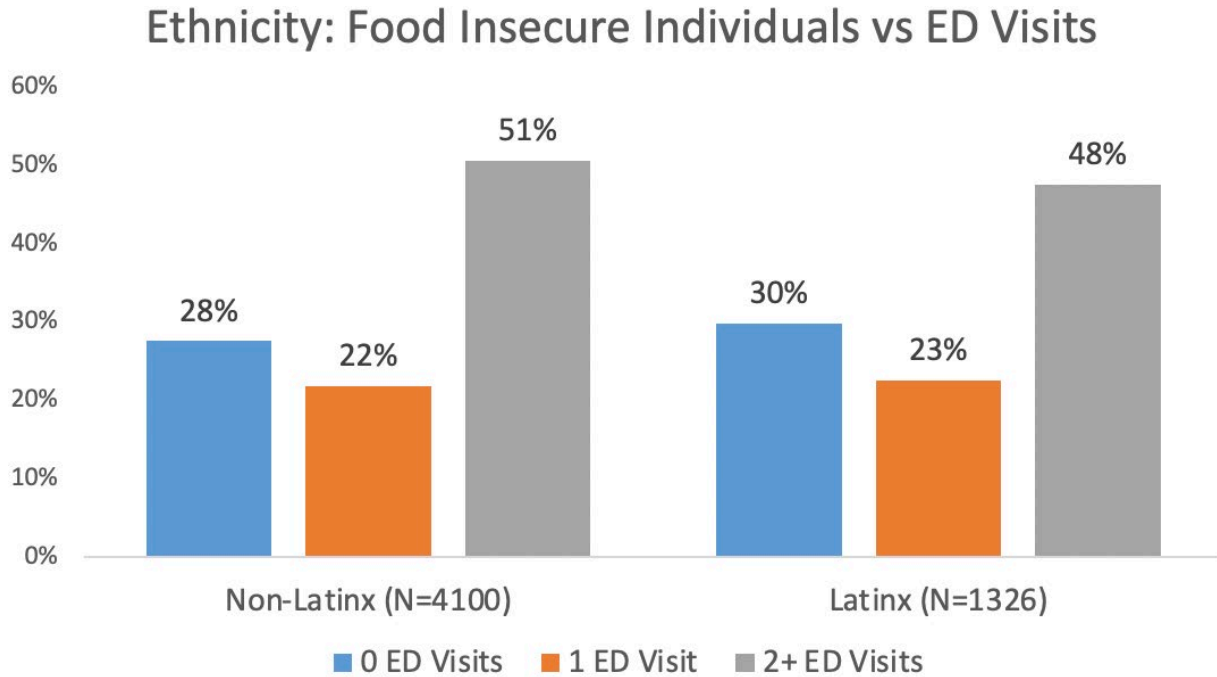
The graph above is now looking at only those who screened positive for a food need. This means that they answered yes to either or both food insecurity questions. This graph suggests that for both the Latinx and non-Latinx populations, those with food insecurity have higher rates of going to the emergency room 2 or more times in a year. Overall, both food insecure populations show increased proportions of going to the ED 2 or more times in a year.

Figure 6A – Self-Reported Gender and Food Insecurity

Gender vs Food Insecurity
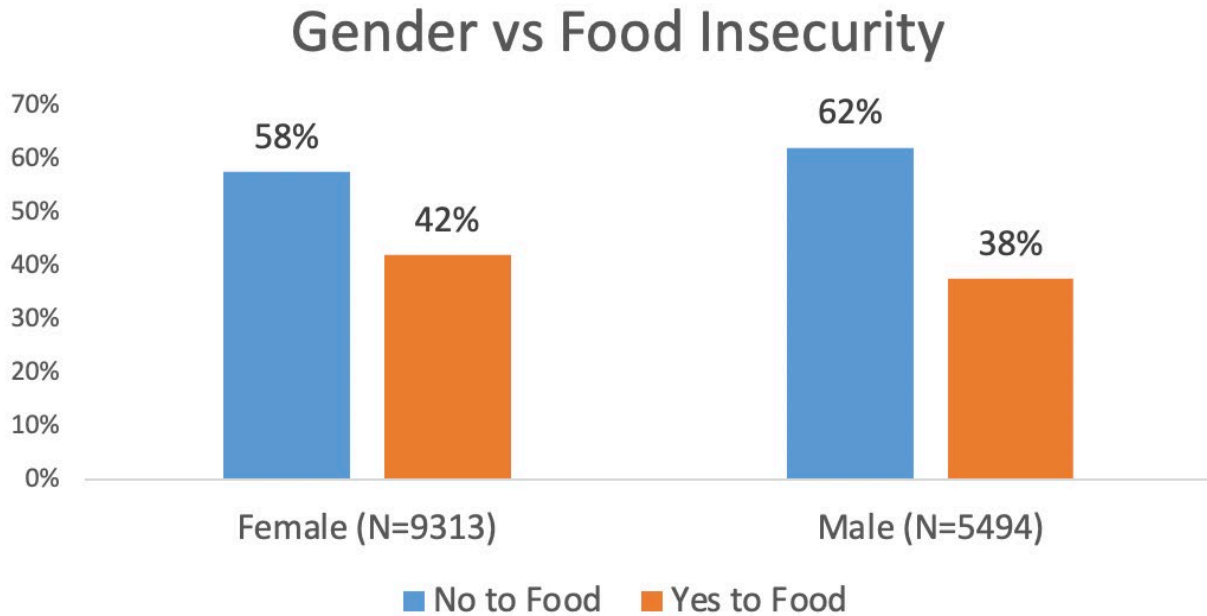
This graph depicts the relationship between gender and food insecurity. This survey only collected data based on the binary definitions of gender: female and male and had an option for the client to not respond. Responses to the gender question were self-reported and may include transgender individuals identifying as their chosen gender as opposed to their sex assigned at birth. In addition, there was a blank option which allows individuals to skip this question if they do not feel represented by the answer choices. Because the blank option does not differentiate between those who simply didn't answer the question and those who didn't answer due to not being defined under binary definitions, I chose to not include the data.

Looking at the male and female data alone in the entire Medicaid population, there is a higher prevalence of food insecurity in females. There are a few different explanations for the increased amount of food insecurity in female populations which will be explored further in the discussion section. Some include the existing wage gap between men and women and the higher financial struggles women tend to have as single parents.

26

Figure 6B – Self-Reported Gender and Food Insecurity by ED Visits

Gender: Food Insecure Individuals vs ED Visits

Female (N=3927): 0 ED Visits 28%, 1 ED Visit 23%, 2+ ED Visits 49%
Male (N=2071): 0 ED Visits 24%, 1 ED Visit 21%, 2+ ED Visits 55%

■ 0 ED Visits   ■ 1 ED Visit   ■ 2+ ED Visits
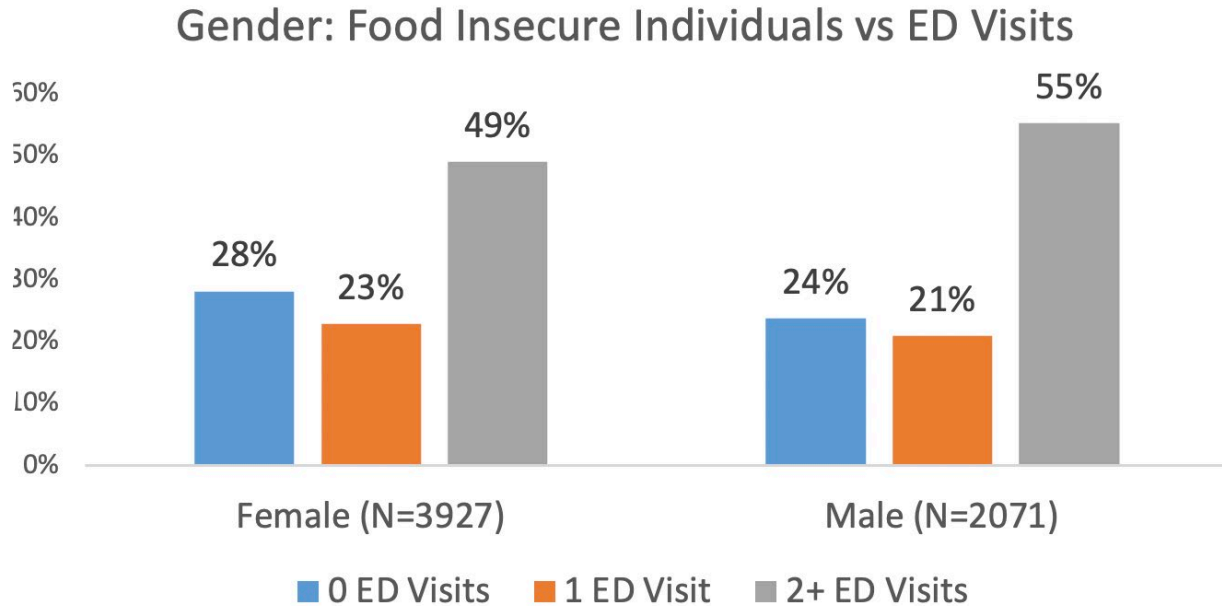
This graph includes only food insecure individuals with the same definitions of female and male as in the previous graph. Most interesting is that in the food insecure individuals, males have a higher incidence of going to the emergency room 2 or more times in the previous year than females. Overall, in food insecure populations there are higher proportions of visiting the ED 2 or more times in a year, regardless of reported gender.

Schooling and Food Insecurity

For schooling I chose to use a different method to observe the data trends. The graphs below look at the proportion of those with food insecurity who have finished high school, gone to some college, or finished college. This is because finishing high school would be representative of going through the K-12 Oregon public school system (a low-ranking system across the US). Additionally, this excludes all children who were surveyed by their parents within this dataset who would be under 18 and unlikely to have finished high school by this time. I chose to add some college and a college degree to have a comparison point for those who received education outside of the Oregon public school system.

Figure 7A – Schooling and Food Insecurity
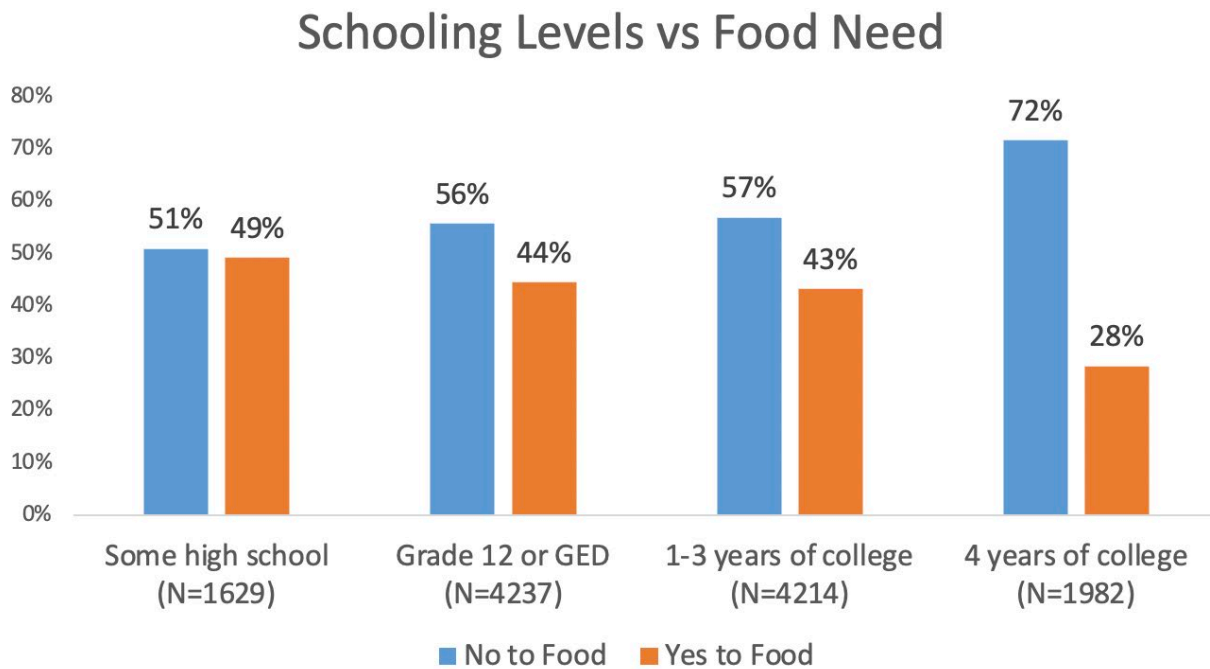
The figure above includes schooling on the x axis, increasing in schooling level from left to right. This includes the entire Medicaid population. As schooling increases, the prevalence of food insecurity in the population decreases shown by the decreased percentages for the orange bars. Those who haven't finished high school had 49% food insecurity in comparison to those

who have been to high school or have earned their GED had 44% food insecurity. Further those who have been some college had 43% food insecurity in comparison with college graduates who have a much lower food insecurity rate at. 28%. This suggests that increased levels of schooling are correlated to lower rates of food insecurity. There are a few explanations for this with the most plausible being that the college graduates are more likely to have more money, whether as a product of their college degree or because they come from a family with the ability to send them to higher education.

Figure 7B – Schooling and Food Insecurity by ED Visits

Years of School: Food Insecure Individuals vs ED Visits

	Some high school (N=801)	Grade 12 or GED (N=1881)	1-3 years of college (N=1820)	4 years of college (N=563)
0 ED Visits	24%	25%	28%	32%
1 ED Visit	18%	20%	23%	23%
2+ ED Visits	58%	55%	49%	45%

■ 0 ED Visits ■ 1 ED Visit ■ 2+ ED Visits
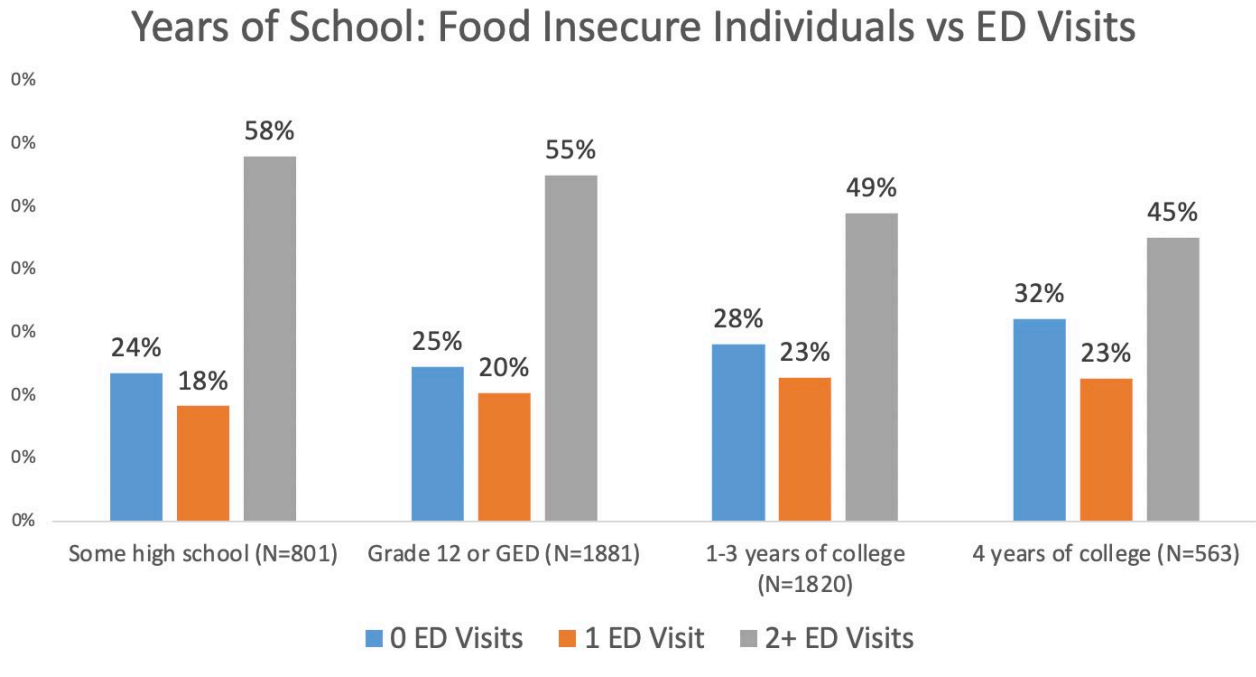
This figure observes food insecure individuals in comparison to their visits to the emergency department in the previous year. Across all schooling populations, there is a higher proportion of going to the emergency department 2 or more times in the previous year. Further, those who have had less schooling have higher instances of going to the emergency department 2 or more times and this percentage decreases as schooling level increases. Overall, all food insecure populations face higher rates of increase ED visits while the most exacerbated populations are those with the least amount of schooling.

Regression Analysis

```
================================================================================
                                       Dependent variable:
                         -------------------------------------------------------
                         Number of ED Visits in Year  Probability of Increased ED visits per Year
                                   (1)                              (2)
--------------------------------------------------------------------------------
Food Insecure                    0.347***                         0.157***
                                (0.016)                          (0.009)

Latinx                          -0.103***                        -0.045***
                                (0.023)                          (0.013)

Male                             0.041**                          0.026***
                                (0.016)                          (0.009)

Went to College                 -0.082***                        -0.038***
                                (0.016)                          (0.009)

Non-White                        0.200***                         0.096***
                                (0.019)                          (0.011)

Constant                         0.847***                         0.548***
                                (0.015)                          (0.009)

--------------------------------------------------------------------------------
Observations                     11,563                           11,563
R2                               0.055                            0.037
Adjusted R2                      0.054                            0.037
Residual Std. Error (df = 11557) 0.846                            0.476
F Statistic (df = 5; 11557)      134.151***                       89.812***
================================================================================
Note:                                              *p<0.1; **p<0.05; ***p<0.01
```

Above is a regression analysis for the variables viewed in figure 3-7. Before completing this regression, I made each variable into a binary variable to facilitate this linear regression. This means that the constant represents a White, female, non-Latinx food secure person who has not gone to college. From here on out I will refer to this as the constant individual. Each line above the constant represents adding in one of those variables to the regression model. This means that I only looked at the White population versus the non-White population and those who have not gone to college versus those who have. Overall, I looked at the variables in terms of food insecurity and number of ED visits to understand if there is a significant non-zero difference in number and probability of increased ED visits in a year.

First, I looked at the base relationship of food insecurity and ED visits. According to the regression if you are a constant individual, you will visit the emergency department 0.847 times in a year. The three stars next to the number indicate high confidence that they don't go zero times. This number increases by 41% in food insecure populations with those people going to the ED 1.194 times within a year. In column 2, the probability of increased visits to the emergency room in a year for the constant individual is 54.8% but increases to 70.5% if an individual is food insecure. This represents a 29% percentage increase in probability of increased visits to the emergency department in a year for those who are food insecure. These numbers also have the highest level of confidence that they are non-zero, so it can be said that these numbers are significant at the 1% level.

The next variable added was race in terms of White versus non-White. Being non-White represents a 23.6% increased number of visits to the emergency room in a year (0.847 to 1.05 visits in a year), food insecure or not. When you add in food insecurity, this represents a 64.6% increase (0.847 visits to 1.394 visits). These numbers all have the highest level of significance. In terms of probability of increased visits to the ED, being non-White adds a 9.6% probability of increased ED visits within a year which represents a percent increase of 17.5%. For those who are food insecure and non-White, the probability increases by 25.5% from 54.8% to 80.3%. This represents a 46% percentage increase in probability of increased visits to the emergency department in a year as a non-White, food insecure individual. These numbers are significant to the 1% level.

The third variable I added is schooling. I compared those who have gone to college and those who have not as the two binary variables. There is a small significant change in increased probability and number of ED visits in a year. Number of ED visits decrease from 0.847 to 0.765

if you have gone to college. Probability of increased ED visits decreases from 54.8% to 51%. These numbers are significant to the 1% but are small, indicating that schooling does not play the largest role in this data set in terms of worsening health outcomes regardless of if the individual is food insecure or not.

Next, I added in the male and female variable into this regression table. Males, both food secure and insecure, showed an increase in the number of visits to the emergency department in a year by 0.041 times. This number was calculated with high confidence, but it is so close to zero that it would suggest there is no real difference between females and males, food insecure or not, in terms of number of times going to the emergency department in a year. This was similar in terms of the probability of increased visits to the emergency department where males are 2.6% more likely to have increased emergency department visits, food insecure or not, in comparison to females. This percentage value is calculated at the highest significance level however, again because it is a small value it does not represent a large difference from the female population.

Lastly, I added in the variable of identifying as Latinx. In terms of number of ED visits and probability of increased visits to the emergency department there is a very small significant difference in the Latinx vs non-Latinx community. A 0.103 drop in number of emergency department visits per year is viewed in the Latinx community as well as a 4.5% drop of probability. These numbers are significant to the 1% level, meaning there is high confidence they aren't 0, but because they are so close to 0 this suggests that identifying as Latinx does not have a large effect on ED visits.

The R^2 value for column one is 5.5% and for column 2 is 3.7%. This means that the variables included explain 5.5% and 3.7%, for columns 1 and 2 respectively, of the variation in number of ED visits. This number grows as more variables are added into the regression and

does not add a lot of value for this analysis. The residual error also does not provide any significant information for this case because I am comparing number of ED visits with probability of increased visits to the ED. Residual error is helpful when comparing two similar models which is not the case in this regression. Lastly, the F statistics are both significant to the 1% level, representing the highest level of significance this regression model can have. These values represent the overall significance of the model and allows us to reject the null hypothesis. The null hypothesis for this model would be that a model with no independent variables would fit the data. Instead, we can accept the alternative hypothesis that this model with independent variables fits the data.

Discussion

Figures 3-7 all serve to illustrate the relationship between food insecurity and low-income individuals in Oregon. The base relationship (figure 3) establishes the positive correlation between increased prevalence of food insecurity and increased incidence of going to the emergency department.

One issue brought up throughout this data is the pattern of having a higher prevalence of never going to the emergency department over going once in the previous year in food insecure populations across a multitude of different demographics (figures 4B, 5B, 6B, and 7B). There are a few possible explanations for this phenomenon, but they are not limited to the ones listed in this research. The two most common reasons for visiting the emergency department are injuries and abnormal symptoms or findings.[23] Additionally, there are 439 visits per 1000 people in the United States to the emergency room as of 2018.[23] The main premise of the Accountable Health Communities project is that unmet health-related social health needs (e.g., food) may increase the risk of chronic conditions which leads to increased health care costs and avoidable health care utilization, specifically in the emergency department. The incidence of going to the emergency room 2 or more times in the previous year aligns more closely with that research while a single visit aligns more closely with having an acute injury or abnormal finding unrelated to a chronic condition. The individuals who go to the emergency room once may be experiencing an emergent injury that cannot be handled by their regular primary care physician. This is different from going to the emergency department for issues like chronic pains and injuries that could often be monitored by primary care physicians that low-income communities often lack. This leads to the paradox whereby those who go to the emergency room once may not be experiencing worsening health outcomes over those visiting zero times in a year. Overall, those

who were experiencing food insecurity were the least likely to go to the emergency room once in a year, a phenomenon that may tend to be more like those not visiting the emergency department in a year.

The data from the food insecure populations across all demographics consistently shows that those who are food insecure are more likely to go to the emergency department two or more times in the previous year. This points to a strong correlation between food insecurity and increased emergency department visits which serves as an indicator of worsening health outcomes.

The different populations provide even more insight into which communities are most effected by food insecurity. Figures 4A and 4B observe the relationship between race and the correlation of food insecurity and ED visits. The data suggests that within Oregon, Asian and White populations experience the lowest levels of food insecurity while the other racial groups observed experienced markedly higher levels of food insecurity (figure 4A). Adding the layer of ED visits illustrates that across all racial groups, food insecure people are more likely to visit the emergency department 2 or more times within a year (figure 4B). This data suggests that policy geared toward non-White and non-Asian populations would produce the greatest benefit in terms of helping those who are most affected. Further, all food insecure racial groups are more likely to visit the emergency department 2 or more times in a year meaning that food insecurity tends to stay correlated with worsening health outcomes across racial identities.

Figures 5A and 5B graph the same relationship but looking across ethnicity. I viewed the Latinx community versus the non-Latinx community because in Oregon this is the largest non-White ethnic group. Because of this, it is important to look at how these communities can be further supported by state as their population continues to grow. As shown in figure 5A, the

Latinx community is facing slightly higher rates of food insecurity across the entire Medicaid population. In figure 5B, we find that the correlation between increased ED visits in food insecure populations holds across both non-Latinx and Latinx communities. These findings suggest that policies geared toward the Latinx community would certainly serve to support their community. In addition, food insecure populations, no matter their ethnicity, are experiencing worsening health outcomes.

In figures 6A and 6B the relationship between self-reported gender and the correlation between food insecurity and worsening health outcomes was graphed. Due to survey limitations, the only options for gender were female, male or blank. I chose to not include the blanks because it does not differentiate between those who do not identify as male or female and those who do not want to answer the gender question in general. Figure 6A illustrates that females have higher rates of reported food insecurity. This finding is not surprising and aligns with previous research. 60% of the food insecure people across the globe are women.[24] Women tend to face systematic challenges, like gender-based violence and the gender wage gap, which exacerbate the problems low-income communities of all genders face. For example, in 2019 it was reported that single mothers have a food insecurity rate of 28.7% while single fathers have a 15.4% rate.[24] Policy supporting the nutritional needs of women would be beneficial in reducing the prevalence of food insecurity. Additionally, figure 6B illustrates the same relationship we have seen in previous figures where those who are food insecure, regardless of gender, are more likely to visit the emergency department 2 or more times within a year. This further illustrates that food insecurity is positively correlated with worsening health outcomes for both male and females.

Lastly, figures 7A and 7B observe the relationship of level of schooling and the correlation between food insecurity and worsening health outcomes. I chose to view those who

haven't completed high school, who have a high school diploma/GED, who have completed some college and those who had their bachelor's degree or higher. I chose these groups to exclude children who may still be living with their parents and to ensure that these people had gone through the Oregon public school system. The K-12 Oregon public school system is rated 44th in the nation, making it one of the lowest. Figure 7A illustrates that as level of schooling increases, the prevalence of food insecurity decreases. There are many potential explanations for this phenomenon. For example, those who have a college degree are eligible for higher paying jobs so they can better support themselves financially. Additionally, those who have more education may be exposed to more learning surrounding nutrition and budgeting which could reduce their likelihood of food insecurity. And most plausibly, those who have had the opportunity to go to college come from more financially stable backgrounds. Figure 7B illustrates that across all schooling levels, those who are food insecure are most likely to visit the emergency department 2 or more times within a year. Further, those with the least schooling had the highest proportion visiting 2 or more times. Overall, food insecure populations are more likely to visit the emergency room 2 or more times a year which is further exacerbated by lower levels of schooling. Other studies looking at the relationship between schooling and food insecurity have found that food insecurity decreases the chances of a student graduating from high school.[25] This adds another layer where food insecurity affects the level of schooling that is possible for an individual adding to the vicious cycle of food insecurity.

Adding in a regression analysis to my data proved to be a relevant way to determine if what these graphs represent is significant. Overall, the biggest indicator of increasing number of visits or probability of increased visits turned out to be whether the individual was food insecure.

The second most significant variable in determining both number of ED visits in a year and probability of increased visits in a year was race. For individuals in this data set, if they identified as any race or combination of races other than solely White, they had a 0.204 increase in number of ED visits and a 9.8% probability of increased visits to the emergency department in a year. This indicates that race is correlated with increasing visits to the emergency department, for those who are food insecure or not. Going to college, gender and identifying as Latinx produced significant differences in the number and probability of increased ED visits in a year, but these numbers were nearly 0 suggesting there is a large significant difference. Interestingly, the Latinx population had a slightly lower amount of both probability of increased visits and number of visits, directly opposing my hypothesis. One explanation for this could be due to the lower sample size within the Latinx population compared to the non-Latinx population which could mean this does not provide a strong enough comparison point. The slight decrease in both number of ED visits and probability of increased ED visits in a year when having received a college education supports my hypothesis but is not the strongest variable affecting my base relationship of food insecurity versus ED visits.

Even within the context of social inequity, food insecurity stands out as an influence across all groups. Within those food insecure groups, the most likely health outcome continued to be 2+ ED visits within a year. Overall, this data suggests that food insecurity and race are most correlated to increased emergency department visits and therefore healthcare utilization and spending across all populations. Because of this, food insecurity and race considerations should be considered larger variables when determining policy to reduce health expenditures due to emergency department visits. Because food security rests on the three pillars of availability, access and use, policies should reflect these pillars focusing on ensuring availability and access

as well as education on how to use nutritious food to support healthy lifestyles with the food that

is available. Additionally, cultural considerations are important when creating policy changes to

support decreased medical spending due to the correlation of increased ED visits within non-

White populations.

Bibliography

1. A Global Food Crisis. World Food Programme. http://www.wfp.org/global-hunger-crisis. Published 2023. Accessed February 13, 2023.
2. Edwards M. Oregon's food insecurity in the time of Covid. Oregon State University. https://liberalarts.oregonstate.edu/sites/liberalarts.oregonstate.edu/files/oregonhungerreportdecember_2020.pdf. Published December 8, 2020. Accessed February 13, 2023.
3. Hake M, Dewey A, Engelhard E, et al. The Impact of the Coronavirus on Food Insecurity in 2020 and 2021. Feeding America. https://www.feedingamerica.org/sites/default/files/2021-03/National%20Projections%20Brief_3.9.2021_0.pdf. Published March 2021. Accessed February 13, 2023.
4. Food Security in the U.S. USDA ERS. https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-u-s/. Published January 10, 2023. Accessed February 13, 2023.
5. Barrett CB. Measuring food insecurity. *Science*. 2010;327(5967):825-828. doi:10.1126/science.1182768
6. Pérez-Escamilla R, Segall-Corrêa AM. Food insecurity measurement and indicators. *Revista de Nutrição*. 2008;21. doi:10.1590/s1415-52732008000700003
7. Brownson RC, Fielding JE, Maylahn CM. Evidence-based Public Health: A fundamental concept for public health practice. *Annual Review of Public Health*. 2009;30(1):175-201. doi:10.1146/annurev.publhealth.031308.100134
8. Rose D. Economic determinants and dietary consequences of food insecurity in the United States. *The Journal of Nutrition*. 1999;129(2). doi:10.1093/jn/129.2.517s
9. Bernell S, Weber B, Edwards M. Restricted Opportunities, Personal Choices, Ineffective Policies: What Explains Food Insecurity in Oregon? *Journal of Agricultural and Resource Economics*. 2006;31(2):193-211. doi:http://www.jstor.org/stable/40987315
10. Bartfeld J, Dunifon R. State-level predictors of food insecurity among households with children. *Journal of Policy Analysis and Management*. 2006;25(4):921-942. doi:10.1002/pam.20214
11. Heimann J. Social Determinants of health - Oregon. Oregon Health Authority. https://www.oregon.gov/oha/PH/ABOUT/Documents/indicators/povertylevel.pdf. Published 2019. Accessed February 13, 2023.
12. De Marco M, Thorburn S, Kue J. "in a country as affluent as America, people should be eating": Experiences with and perceptions of food insecurity among rural and Urban Oregonians. *Qualitative Health Research*. 2009;19(7):1010-1024. doi:10.1177/1049732309338868
13. Eicher-Miller HA, Mason AC, Weaver CM, McCabe GP, Boushey CJ. Food insecurity is associated with iron deficiency anemia in US adolescents. *The American Journal of Clinical Nutrition*. 2009;90(5):1358-1371. doi:10.3945/ajcn.2009.27886
14. Kirkpatrick SI, McIntyre L, Potestio ML. Child hunger and long-term adverse consequences for health. *Archives of Pediatrics & Adolescent Medicine*. 2010;164(8). doi:10.1001/archpediatrics.2010.117
15. Whitaker RC, Phillips SM, Orzol SM. Food insecurity and the risks of depression and anxiety in mothers and behavior problems in their preschool-aged children. *Pediatrics*. 2006;118(3). doi:10.1542/peds.2006-0239

16. Lee JS, Frongillo EA. Nutritional and health consequences are associated with food insecurity among U.S. elderly persons. *The Journal of Nutrition*. 2001;131(5):1503-1509. doi:10.1093/jn/131.5.1503
17. Berkowitz S, Seligman H, Meigs J, Basu S. Food Insecurity, Healthcare Utilization, and High Cost: A Longitudinal Cohort Study. *The American Journal of Managed Care*. 2018;24(9):399-404.
18. Miner J, Westgard B, Olives T, Patel R, Biros M. Hunger and food insecurity among patients in an urban emergency department. *Western Journal of Emergency Medicine*. 2013;14(3):253-262. doi:10.5811/westjem.2012.5.6890
19. Supplemental Nutrition Assistance Program (SNAP). Benefits.gov. https://www.benefits.gov/benefit/361#:~:text=SNAP%20provides%20benefits%20to%20eligible,largest%20federal%20nutrition%20assistance%20program. Accessed February 13, 2023.
20. Accountable health communities model: CMS innovation center. Innovation Center. https://innovation.cms.gov/innovation-models/ahcm. Published January 26, 2023. Accessed February 16, 2023.
21. Seligman HK, Schillinger D. Hunger and socioeconomic disparities in chronic disease. *New England Journal of Medicine*. 2010;363(1):6-9. doi:10.1056/nejmp1000072
22. María del Río-González A. To Latinx or not to latinx: A question of gender inclusivity versus gender neutrality. *American Journal of Public Health*. 2021;111(6):1018-1021. doi:10.2105/ajph.2021.306238
23. Weiss A, Jiang H. Most Frequent Reasons for Emergency Department Visits, 2018. Healthcare Cost and Utilization Project. https://www.hcup-us.ahrq.gov/reports/statbriefs/sb286-ED-Frequent-Conditions-2018.jsp. Published December 2021. Accessed February 13, 2023.
24. Hunger and the gender gap: Move for hunger. Hunger and the Gender Gap | Move For Hunger. https://moveforhunger.org/the-links-between-hunger-and-the-gender-gap#:~:text=There%20are%20around%20690%20million,feed%20themselves%20and%20their%20families. Accessed February 13, 2023.
25. Hicksen M, Ettinger de Cuba S, Weiss I, Donofrio G, Cook J. Feeding our human capital: Food insecurity and tomorrow's workforce. Children's HealthWatch. https://childrenshealthwatch.org/feeding-our-human-capital-food-insecurity-and-tomorrows-workforce/. Published December 23, 2016. Accessed February 13, 2023.