The Intersection of Immigration and Climate Change in Farm Worker Communities

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ABSTRACT

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In this paper, we describe the way in which socioeconomic factors (i.e. language, socioeconomic status, and education), climate change, and the migration patterns of US farm worker populations affect healthcare utilization across the nation, specifically in Washington State. The majority of farm industry workers are immigrants, with a large number coming from Mexico and other Latin countries. Immigration is a social determinant of health that contributes to other socioeconomic disparities. The farm worker population experiences a range of factors relating to immigration and immigration status, education, and poverty that impact health. Common reasons for decreased healthcare access and utilization in immigrant communities include geographic and linguistic isolation, lack of employer-provided care, unmet Medicaid qualifications, and documentation status. In addition to socioeconomic forces impacting health, farm worker health is also affected by the environment. The intimate connection between agriculture and climate can lead to climate driven impacts on employment. The length of the

growing season represents the time between the last spring frost and the first fall frost. Due to regional temperature increases in Washington State and across the nation resulting from climate change, the length of the growing season in the US has been increasing. Quantitative analysis of the correlation between the nationwide change in the length of growing season versus the nationwide percentage of migrant farm workers suggests that climate change effects are reflected in the settling behavior of migrant communities. The study design for this paper is a quantitative descriptive analysis of publicly available data and geographic information system data paired with the Social Ecological Model as a conceptual framework. Highlighting King, Skagit, Whatcom, and Yakima Counties paints a broad picture of the ways climate driven changes in migration patterns would impact urban and rural health care systems differently. Examining the differences in health care facility locations and utilizing the Social Ecological Model to examine the social determinants that are barriers to health care utilization illustrates the need for more culturally relevant interventions, health clinics, and policies in rural areas to accommodate immigrant communities from Latin America. The hypothesis explored in this paper is that as the length of the growing season increases, the percentage of migrant farm workers decreases. As the share of settled farm workers increases, the amount of farm workers relying on one local healthcare system increases. The decrease in the migrant share of farm workers has the potential to impact the healthcare infrastructure of Washington State counties with large Latinx/Hispanic farm worker communities, particularly in rural areas, by overburdening the healthcare system as migrant workers transition to settled workers. Understanding the association between climate change, migration, and access to health care will inform future policy decisions and interventions concerning healthcare access in Latin American communities in the US.

INTRODUCTION

In the US, the immigrant population is rapidly growing. According to the Census Bureau, net international migration will be the main driver behind U.S. population growth between 2027 and 2038 due to US fertility rates reaching an historic low. The aging of the native-born population in the United States renders immigration as a demographic necessity [28]. With the rapid increase in immigration, both documented and undocumented, immigrant health becomes an increasingly important issue within the context of the overall US health system.

'Latinx' and 'Hispanic'

Latinx is the gender inclusive term used to describe people from Latin American countries. Throughout this paper the term Latinx is used instead of the gendered Latino or Latina (unless specifically discussing a particular data set) to acknowledge the gender diversity of immigrants from Latin America. When collecting publically available data, some sources use Hispanic rather than Latino as an indicator. Although there is quite a bit of overlap between the Hispanic and Latino population, the terms are not synonymous with each other. Gaps in population estimates arise when Hispanic and Latino are used and/or interpreted incorrectly by surveyors and respondents. According to the U.S. Census Bureau, the ethnonym Hispanic or Latino to refers to "a person of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin regardless of race" and states that Hispanics or Latinos can be of any race, any ancestry, any ethnicity. Hispanic is the term traditionally reserved for people who descend from Spanish speaking countries. Latino is the term reserved for people who descend from Latin American countries. Since data on immigration from Latin American countries is collected by a range of different research entities, both Hispanic and Latino population data is used in this

study. We acknowledge that discrepancies in how individuals identify and interpret their Hispanic and/or Latino identity likely skews the true population data.

'Migrant' vs 'Immigrant'

The terms 'migrant' and 'immigrant' are used throughout this paper to indicate two overlapping but distinct populations. 'Migrant' refers to someone who moves from place to place (either across borders or within the same country) for economic reasons such as seasonal work [26]. In this paper, 'migrant' is used to describe the population of workers that continuously travels more than 75 miles to work [10]. 'Immigrant' refers to someone that makes a conscious decision to leave their home and move to a foreign country with the intent of settling there [26]. In this paper, 'immigrant' is used to describe individuals with the lived experience of leaving their former country and settling in the United States. Since 'immigrants' account for a portion of the 'migrant' worker population and the farm worker population as a whole, this paper examines the impact immigration and documentation/immigration status have on our population of interest.

Washington State Economic and Demographic Data

One of the biggest industries on the West Coast and in Washington State specifically is agriculture. Washington State currently has approximately 35,900 farms and over 15 million acres of farmland [1]. Producing over 300 different crops each year, Washington State's agricultural impact has both national and global reach [1]. Canada, Japan, South Korea, China, and Mexico are Washington's top trading partners, importing a variety of goods ranging from

seafood to apples [34]. The Washington agricultural sector accounts for over 160,000 jobs and brings in an estimated 20.1 billion in revenue [34]. Apples are Washington's top crop, with much of the industry located in Yakima County [1]. Apples account for over 20% of the total agriculture value in the state [34]. The booming agricultural sector in Washington State provides a good study location for our research. Focusing on the agricultural industry allows us to describe the relationship between the length of the growing season on vulnerable populations who would be most directly affected from these seasonal changes.

Nationally, individuals who identify as Hispanic account for 83% of the farm worker labor force [27]. Of the US-born farm worker population, only 35% identified as Hispanic, indicating that the remaining Hispanic share are foreign-born [27]. This research focuses on the Hispanic/Latinx population due to the high national percentage of Hispanic/Latinx farm workers and the unique experiences of race, class, and immigration status that impact their lives. In Washington State, there are approximately 858,000 Hispanic identified individuals residing, accounting for approximately 12% of the population [8]. About 32% of individuals who identify as Hispanic are foreign-born, indicating that about a third of the population is made up of immigrants. Of the foreign-born Hispanic population, 80% are from Mexico. The median income for individuals who identify as Hispanic in Washington State is $22,000 annually. Approximately 45% of the foreign-born Hispanic population in Washington is uninsured. According to the CDC, farm work is one of the most hazardous industries to work in [2]. Everyday about 100 farm workers experience a lost-work-time injury [2]. The high rate of uninsured foreign-born individuals and the high rate of farm worker injuries guided this paper's focus on access to healthcare in farm worker communities.

In an attempt to paint a broad picture of farm worker healthcare access, this paper will focus on four counties in Washington State: King County, Skagit County, Whatcom County, and Yakima County.

'Rural' vs 'Urban'

Focusing on the social determinants that are barriers for healthcare access and utilization in Skagit, Whatcom, King, and Yakima Counties illustrates the differences in the potential burden to healthcare systems in rural and urban areas. According to the US Census, urban areas are defined in two ways: Urbanized area and urban clusters. Urbanized areas are areas with a population of 50,000 or more. Urban clusters are areas with a population of at least 2500 and less than 50,000. On the other hand, "rural" is defined as "all population, housing, and territory not included within an urban area". Skagit and Whatcom Counties represent urban clusters (due to the mix of urbanized areas and large rural swaths), Yakima County represents rural areas, and King County represents urbanized areas.

Barriers to healthcare access in rural areas include lack of transportation, absence of services, and financial burdens [12]. Increased travel time and perceived difficulty in traveling to see a doctor are prohibitive to accessing healthcare [12]. When available, rural residents will substitute a trip to the doctors' or the pharmacy with phone appointments and mail in prescriptions [12]. A chronic scarcity of practitioners, clinics, and hospitals plagues rural areas across America [12]. Disparities in insurance coverage and poverty in rural areas prevents some residents from utilizing healthcare options [12]. These disparities are compounded by the unique

experiences of farm workers such as immigration status and linguistic isolation. The compounding factors will be discussed in depth in later sections.

Farm Workers and Migrant Workers

Focusing on farmworker health and safety is crucial to understanding how climate change affects population dynamics and how those effects may exacerbate difficulties in accessing healthcare for communities. According to a report by the Pew Research Center, the farming, fishing, and forestry industry is the number one occupational category in terms of the largest share of immigrant workers [11]. Of the farm workers interviewed for the National Agricultural Workers' Survey, 79% of US farm workers were born in Mexico [27].

The number of migrant farm workers has decreased from 42% in 2001-2002 to 16% in 2013-2014 [24]. This is due primarily to migrant farm workers opting to settle semi-permanently within a particular area [10]. The seasonality of farm worker jobs is shifting as temperatures rise and growing seasons increase in length. The migrant farm worker population consists of two groups: migrant shuttle and migrant follow-the-crop. Migrant follow-the-crop workers represent the portion of farm workers whose location changes with crop seasonality. This group of workers moves from state to state. Migrant shuttle workers represent the portion of farm workers who travel to one location more than 75 miles from home to work, potentially crossing international borders in the process. Approximately 32% of the migrant shuttle population consists of workers who cross international borders to work in the US [27].

Latinx/Hispanic Immigrants and Declining Health

Latinx/Hispanic immigrants are the focus of this study due to the high rate of immigration from Mexico and other Latin American countries and the significant share of Latinx/Hispanic immigrants in the farm worker population. The top five countries of origin for immigrants in the US are Mexico, China, India, the Philippines, and El Salvador. Asian and Latinx immigrants make up a large part of the immigrant population, making up 36% and 31% of the immigrant population, respectively [36]. Although Asian immigrants make up a comparable share of the immigrant population, the circumstances in which Asian immigrants migrate to the US differ drastically from the circumstances of Latin American immigrants. The H-1B visa, also known as the high-skilled visa, is issued by the US to immigrants working in highly skilled labor sectors such as science and engineering. To qualify for a H-1B visa, the employer must require a bachelor's degree or higher for the job to be eligible [17]. The H-1B visa is sponsored by employers meaning that those who immigrate to the US on the H-1B visa are employed by high skilled companies, indicating income disparities between H-1B visa recipients and immigrants without.

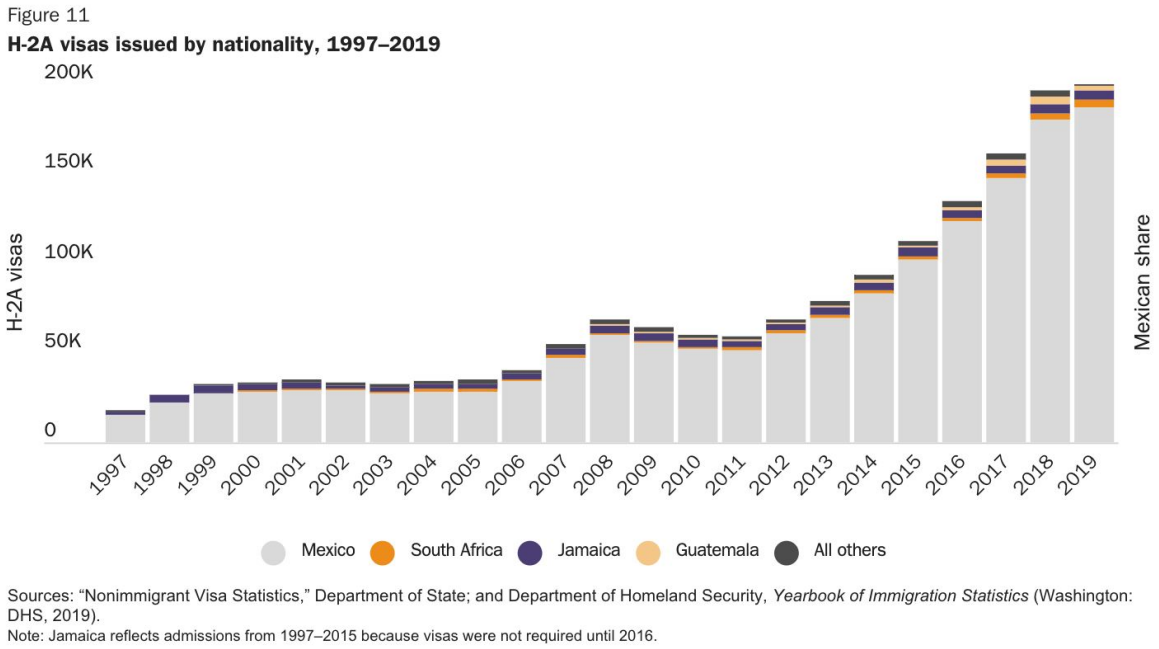
FY2015: H-1B Beneficiaries		
	Number	Share
Total	275,317	
India	195,247	70.9%
China (PRC)	26,669	9.7%
Canada	3,607	1.3%
South Korea	3,470	1.3%
Philippines	3,146	1.1%
United Kingdom	2,241	0.8%
Taiwan	2,060	0.7%
Mexico	2,017	0.7%
France	1,794	0.7%
Pakistan	1,602	0.6%

Source: US Department of Homeland Security

According to a report by the US Department of Homeland Security in 2016, 70% of H-1B visas were given to immigrants from India, 9.7% were given to immigrants from China, and 0.7% were given to immigrants from Mexico [3]. Mexico along with other Latin American countries listed on the H-1B visa breakdown each made up less than 1% of the H-1B visas [3].

The H-2A visa allows foreign nationals to work in the US in low-skilled temporary or seasonal agricultural jobs. Unlike the H-1B visa, there is no education requirement for the job to qualify as eligible. Mexico accounts for 91% of the H-2A visa recipients in 2019 [18]. Washington, Florida, California, North Carolina, and Georgia account for 55.8% of all H-2A-certified workers [19]. Of the top ten Department of Justice jobs for H-2A certified workers, all of the H-2A-certified workers' average hourly wages are below the national hourly wage for non H-2A workers in

those same jobs [19]. The education and wage disparities between H-1B and H-2A-certified workers highlights some of the factors that contribute to different immigration experiences for Asian and Latinx/Hispanic immigrants.



Source: Cato Institute

The process of immigration and the integration of immigrants into American society overlap with many of the social and economic factors that determine health. Economic stability, access to health care, educational attainment, and social and community context are just a few of the areas immigration overlaps with, creating diverse outcomes for people caught at the intersection of many compounding identities [28]. Although immigrants are reportedly healthier than their native-born counterparts when they arrive in the US, the marginalization and discrimination that immigrants face results in the immigrant health disparities we see today. A clear example of

immigrant health decline can be seen in the Latinx community, referred to as the “Latino Paradox”. The “Latino Paradox” occurs when immigrants from Latin American countries move to the US with initially better health than their native born Latinx counterparts. Occupational hazards of farm labor affect the health of farm workers. As previously mentioned, farm work is one of the most hazardous industries, reporting 100 lost-work-time injuries a day [2]. Analyzing the decline in immigrant health that we see after spending a significant amount of time in the US can provide us with answers on why we see these trends and how we can manage them so that the health of US immigrants is improved. To understand the challenges immigrants face, a better understanding of the people who migrate to the US is necessary.

Undocumented Immigrants and Access to Healthcare

Access to healthcare varies widely among immigrant groups, with undocumented immigrants typically experiencing the worst access to healthcare. A study by the Pew Research Center stated that 10.7 million (about 23.7%) of immigrants are undocumented [36]. Seattle ranks among the top 20 major metropolitan areas with a large undocumented population [29]. The status of being undocumented comes with its own addition of hardships both separate and unique to the immigrant experience. Although healthcare is only one factor in determining one’s health along with structural and institutional discrimination, limited access to healthcare has a significant impact on well-being. Fear of immigration enforcement often leads to immigrants being less proactive about seeking healthcare and utilizing other social services [28]. Undocumented immigrants have lower levels of health care utilization due to various barriers to accessing care. Fears of deportation and lack of employer health insurance are a few

contributing factors to low health care utilization. In a study by Leighton Ku and Sheetal Matani about immigrant access to healthcare, Ku and Matani reported that noncitizen immigrants and their children experience large gaps in their health insurance coverage and access to health care, even when the children are citizens [20]. Their study found that noncitizen immigrants status "was associated with a 2.5 percent reduction in Medicaid coverage, an 8.9 percent decrease in job-based insurance coverage, and an 8.5 percent increase in the probability of being uninsured, compared with native citizens" [20]. Similarly, noncitizen children suffered higher rates of being uninsured [20]. Ku reported that "noncitizen children had 14 percent less Medicaid, 15 percent less job-based insurance, and 16 percent greater risk of being uninsured, compared with children whose parents were citizens" [20]. The study by Ku and Matani not only highlights the impact of immigration status on health insurance for adults but also for children. This emphasizes the familial impacts on immigration status on farm worker families, particularly families with mixed immigration status. Including data about children of uninsured parents illustrates the multi-generational community impacts of the lack of insurance for farm worker families. The high rate of uninsured Latinx results from the large number of noncitizen members of families; no significant difference in insurance coverage was found when the researchers controlled for immigration status [20].

According to the USDA, from 2014-2016 approximately 48% of the farm worker labor force was unauthorized workers [10]. "Unauthorized" indicates foreign-born laborers who do not possess documentation unlike green card holders or lawful permanent residents [10]. The high number of undocumented laborers highlights the structural vulnerabilities affecting farm worker communities. Lack of employer-provided care, documentation status, and Medicaid qualification all contribute to the low number of insured farm workers.

Socioeconomic Factors Impacting Immigrant Health

In addition to the health care infrastructure concerns, many other factors play a role in determining health outcomes in immigrant communities. Research suggests that the primary social pathways that affect health are low socioeconomic status (SES), adverse health behaviors, and lack of health insurance [33]. Research suggests that SES affects healthcare utilization, with greater health disparities in countries where healthcare is more privatized [16]. In the United States, universal healthcare coverage does not exist, indicating that insurance status represents an additional factor for health outcomes [33]. Although the Affordable Care Act has expanded Medicaid coverage to a degree, individuals who are not US citizens, have been previously incarcerated, and who do not live in the US are ineligible to use the Marketplace [23]. With nearly half of farm workers surveyed reporting being undocumented and one-third of the migrant shuttle population traveling internationally to work in the US, many farm workers do not qualify to recieve Medicaid coverage through the Affordable Care Act [15, 27]. Based on a 2018 report by the National Center for Health Statistics, non-white Hispanics represent the highest group of uninsured adults between the ages of 18-64, with 26.6% uninsured [6]. According to the Farmer Justice Report, only 35% of farm workers have health insurance. Of the total uninsured adult population, 52.2% were identified as poor or near poor [4]. Despite working 44 hour work weeks on average, farm workers' wages remain low [15]. Farmer Justice reports that 30% of farm workers are living below the federal poverty level [31]. The average wage of farm workers overall is $10.91/hr [31]. The personal mean and median annual income for farm workers from 2015-2016 was $17,500 and $19,999, respectively [27]. Approximately 14% of workers reported that their personal annual income was below $10,000 [27]. The mean and

median annual income of workers' families in 2015-2016 was $20,000 and $24,999, respectively [27]. Approximately 27% of workers reported that their total family income was less than $20,000 [27].

Related to socioeconomic status, educational attainment is a compounding factor for other social determinants of health as well as a social determinant of health itself. The average education level of formal education completed by farm workers is eighth grade [27]. Approximately 4% of farm workers reported receiving no formal education and 37% reported completing sixth grade or lower. [27]. Only 10% of farm workers reported completing education beyond high school [27]. Educational attainment levels are associated with infant mortality, life expectancy, and self-rated health. According to a report by the Robert Wood Johnson Foundation, adults with low educational attainment are more likely to report worse health outcomes, across all races and ethnicities [14]. Mothers who did not graduate high school are twice as likely to have babies that die before their first birthday [14]. College graduates are expected to live at least five years longer than their counterparts who did not graduate high school [14]. Low educational attainment is also associated with low economic opportunities, less access to healthy foods, and reduced access to safe neighborhoods [32].

Linguistic isolation also plays a major role in health care access and utilization. Linguistic isolation is defined by the US Census as living in a household in which all members above the age of 14 speak a non-English language and speak English less than very well. Approximately 77% of farm workers surveyed nationally stated that Spanish was the language they were most comfortable conversing in and 1% said indigenous languages [13]. In a study by Jane Chung, Jin Young Seo, and Jongwon Lee language barriers were identified as a barrier to healthcare

utilization among older Korean immigrants [4]. Linguistic isolation also has a significant impact on public health survey response rates. In a study published by the NIH, a 7% decrease in survey responses was associated with Spanish-only households [22].

Traditionally, analyses on immigrant health focused on immigration as an individual issue and not one steeped in inequality stemming from structures of poverty and immigration policy. Immigration status, like gender or race, represents another layer of inequality that has very real impacts on health [16].

Climate Change and Health

Changes to the climate can affect various aspects of human life including agriculture, public health, land development, and land use [5]. The impacts of climate on human health are complex, resulting in indirect impacts that are dependent on societal factors as well [5]. Numerous studies have examined the direct impacts of climate on health. Although environmental hazards impact the health of farm workers, this paper will not focus on environmentally driven health disparities. This paper aims to examine an indirect effect of climate on health by examining the effects of climate on employment driven migration patterns. Washington State's booming agricultural sector provides an ideal environment to study the intimate connection between the length of the growing season and agricultural employment patterns. Examining the ways in which climate intimately affects health through the avenue of employment and migration patterns led us to focus our study on farm workers.

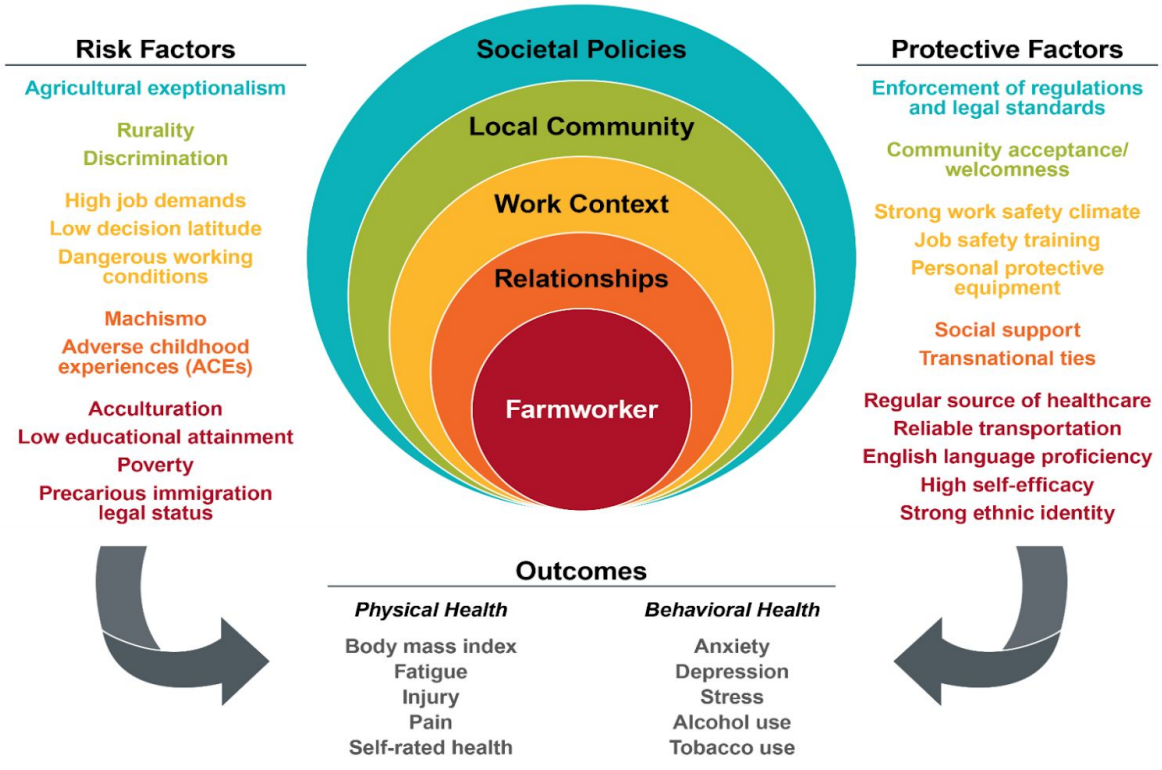
Conceptual Framework

The socioecological model (SEM) is a conceptual framework that is typically depicted as concentric circles representing the hierarchy of social interactions, ranging from the interpersonal dynamics to the policy and institutions. There are several iterations of this model using a variety of “layers”. The variety and flexibility of the layers in this model allows it to be personalized in distinct ways that cater to the specificities of various subjects. The SEM looks at the environment from a social perspective, attributing influence of a particular phenomenon to the interaction between the multiple layers of the model: individual, community, institutional, and political [10]. This approach paired with insights from political economy, critical race theory, structural violence, structural vulnerability, and intersectionality can be a powerful tool in leveling the playing field by recognizing disparities and areas of intervention for eliminating them [28].

A study published by Jane Chung, Jin Young Seo, and Jongwon Lee explored immigrant health among older Korean communities in Seattle by utilizing the conceptual framework provided by the Social Ecological Model [4]. The study notes the multiplicity of factors contributing to lack of access and under-utilization of healthcare and health related services in a foreign country. Factors such as “limited language proficiency, lack of health insurance, social marginalisation [*sic*], low socio-economic status (SES), lack of societal resources and unstable immigration status” all contribute to healthcare access disparities seen in immigrant communities [4]. Researchers decided to employ the Social Ecological Model (SEM) because of its ability as a tool to recognize “that individual behaviours [*sic*] both influence and are influenced by multilevel factors and are shaped by the social environment surrounding them” [4]. Using the SEM, the researchers were able to identify a multitude of factors ranging from the interpersonal, to the

community level, to policy level that affected older Korean immigrant access to healthcare [4]. Some key contributing factors discussed in their article include cultural values and norms, living circumstances, language barriers, and affordability. Although their study focused on older Korean immigrants, their findings reveal similar themes seen across various immigrant communities.

SEMs that focus on farm worker health have adapted the SEM in a variety of ways, often placing the individual farm worker as the primary level, with concentric circles relating to community relationships and policy. The SEM adapted by Ramos provides an example of a farm worker-centered model [30].



Source: Clemson University, Athena K. Ramos

Ramos' study focuses on the social, cultural, and political factors that impact migrant farm worker health in the Midwest [30]. Including the complex dynamic between social, political, and cultural factors is central to the analysis in Ramos' paper [30] . Our paper focuses less on the cultural and societal interpersonal relationship dynamics impacting farm worker health, and more on the structural and over-arching environmental impacts on farm worker health. Interpersonal and intrapersonal relationships' impact on farm worker health are not the focus of our study.

For the purposes of this study, we will be using an adapted version of the Social Ecological Model which incorporates the natural environment into the framework, as seen in Figure 1. The impact of the natural environment is central to our analysis, leading us to choose a Social Ecological Model that allows us to incorporate climate change indicators into our conceptual framework.

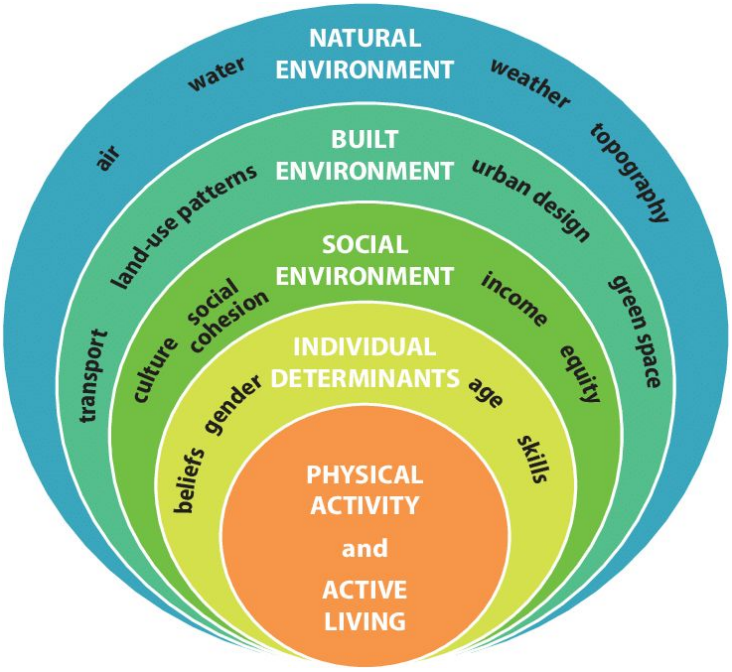


Figure 1. Social Ecological Model. Image Source: Research Gate, adapted by Daniel B. Bornstein

METHODOLOGY

Figure 2 places key areas of focus for this study in context with the adapted version of the SEM. For our purposes, we focused on the top three concentric circles of the adapted SEM: natural environment, built environment, and social environment. Additional factors such as healthcare worker shortages, insured vs uninsured, and immigration status are not placed into this version of the SEM because they are not easily incorporated into this model. Healthcare worker shortages, insured vs uninsured, and immigration status are analyzed as factors that contribute to low health care utilization. These factors remain part of our analysis in that they contribute to the social-political context surrounding the questions we are analyzing. Figure 3. Is included to add clarity to the SEM levels of focus.

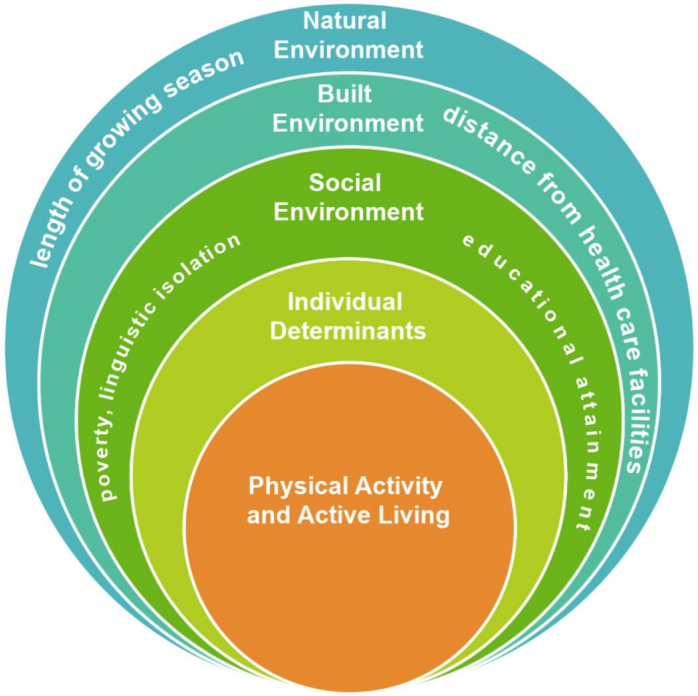


Figure 2. Adapted SEM with Factors for Analysis

Figure 3. Factors for Analysis

Quantitative Analysis

Due to the variety of data sources ranging in levels of granularity, this paper will focus on general demographic data from a county level analysis, climate data from a national and state level, and migrant worker data on a national and state level. Data for each county was collected from the Washington Tracking Network, a publicly available dataset containing county level demographic data. The correlation between climate change indicators and migration indicators is analyzed using publicly available nationwide data. Change in the length of growing season is the climate indicator used in this study. The length of the growing season is intimately connected with agriculture. The EPA recognizes the deviation from the average growing season as an indication of climate change. The deviation from the nationwide average growing season as collected by the EPA is used in this study. The USDA nationwide data set tracks the

percentage of migrant laborers within the total farm worker population, beginning in 1991 and ending in 2016. Using a linear regression model with change in the length of growing season as the independent variable and percent of migrant workers as the dependent variable, the correlation coefficient for each migrant sub-category was calculated.

To determine the relationship between climate change and migration, publicly available data was collected for each variable over the period of time between 1991 and 2016. Nationwide data was used for this analysis due to lack of state-by-state granularity in the USDA immigration data set. However, the nationwide and Washington state change in growing season followed a similar upward trend, and it is assumed that migration patterns in Washington state are similar to those measured nationally. Therefore, inferences about Washington State can be made based on the nationwide data.

RESULTS

Social Environment: Latin American Immigration and Hispanic Population in Washington

Figure 4 illustrates the Hispanic population in Washington state counties in the year 2000.

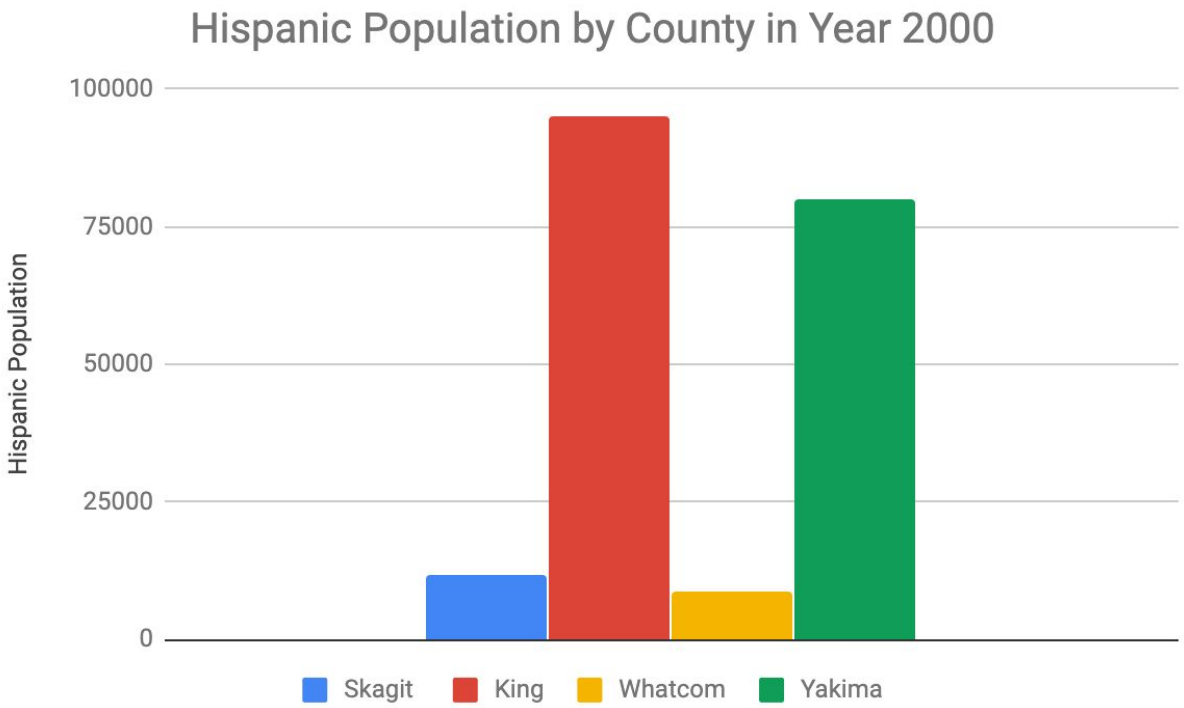


Figure 4. Hispanic population by County in Year 2000

King and Yakima counties have the highest Hispanic population. However, King county has a very high overall population. It is more illuminating to consider Figure 5, which shows the percentage of people within each county who identify as Hispanic.

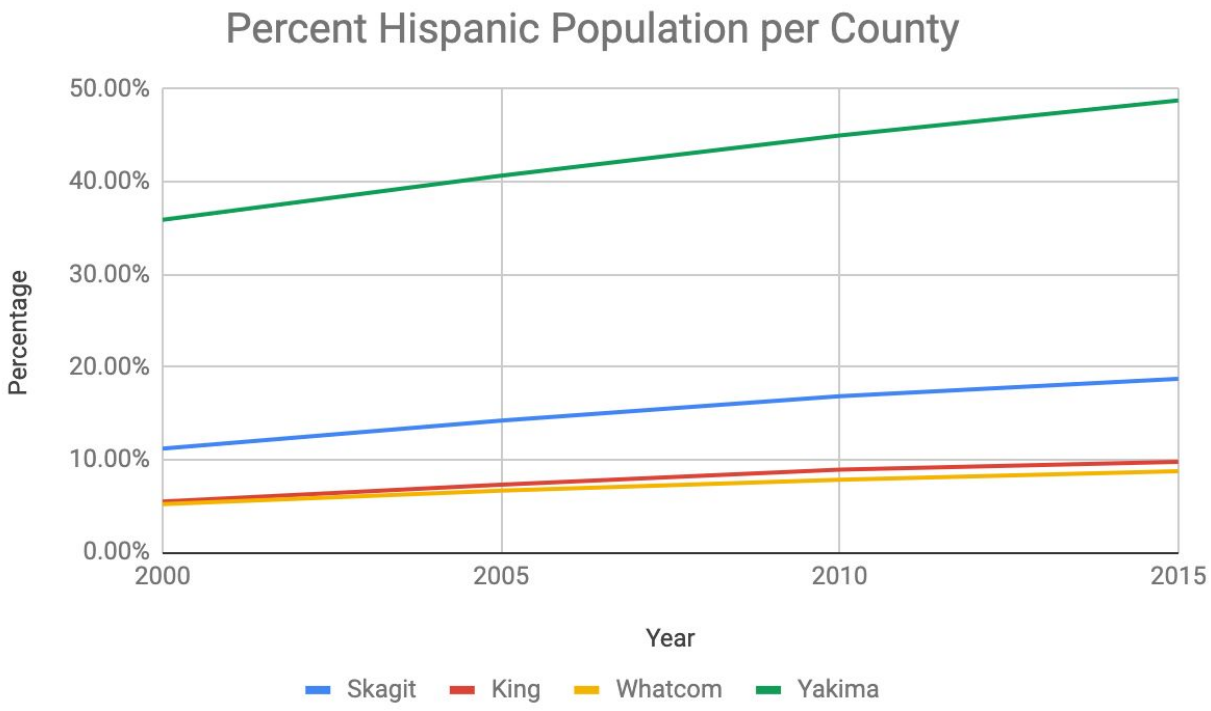


Figure 5. Percent Hispanic Population by County from 2000 - 2015

Based on Figure 5, it is clear that Yakima not only has a large Hispanic population, but also has a high percentage of Hispanic people, and that share of the population is growing at a faster rate than in King county.

Social Environment: Poverty, Linguistic Isolation, and Educational Attainment

Figure 6 uses data from the Washington Tracking Network to map the population living below the federal poverty limit in each county.

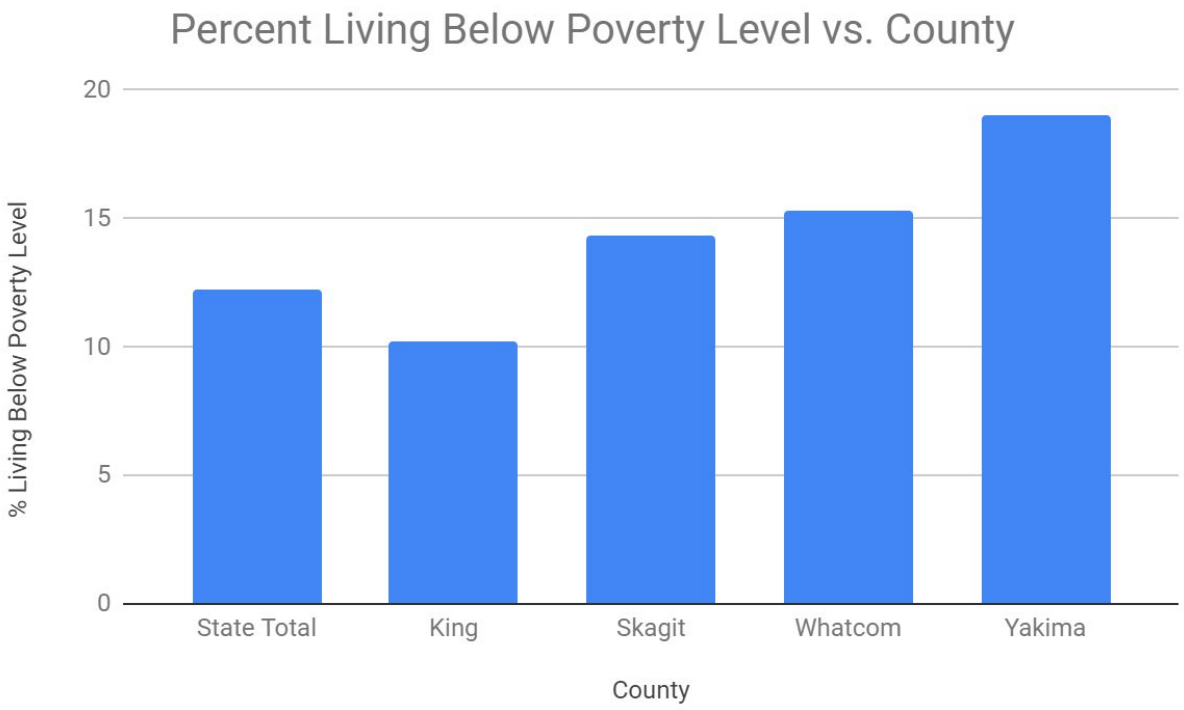


Figure 6. Percent Living Below the Poverty Level by County

Yakima County had the highest number of residents living below the poverty level at almost 20%, approximately double the percentage of residents in King County.

Using Limited English Proficiency (LEP) as an indicator for linguistic isolation illustrates the percentage of people who have difficulty speaking and understanding English. LEP refers to individuals who are not fluent in English because it is not their native language. This indicator gets at the core of the defined parameters for linguistic isolation. Figure 7 illustrates this high percentage of LEP individuals in Yakima County.

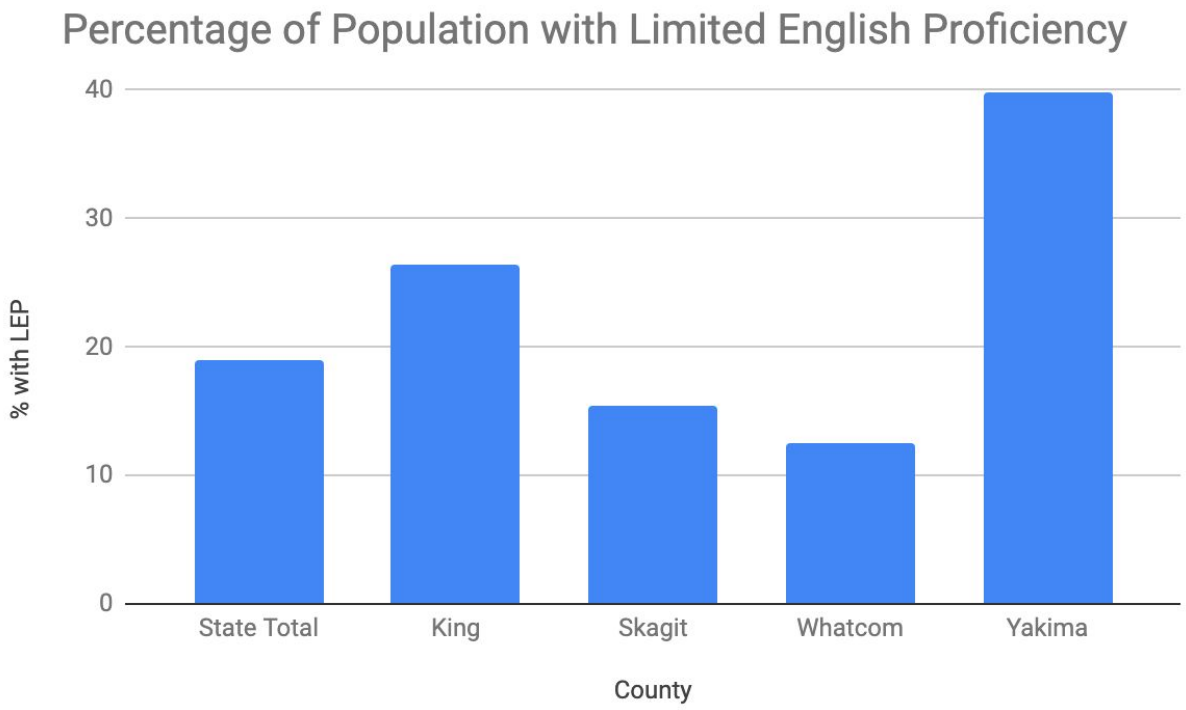


Figure 7. Percent of the Population with Low English Proficiency

Figure 8 shows the percentage of people in Washington counties without high school diplomas.

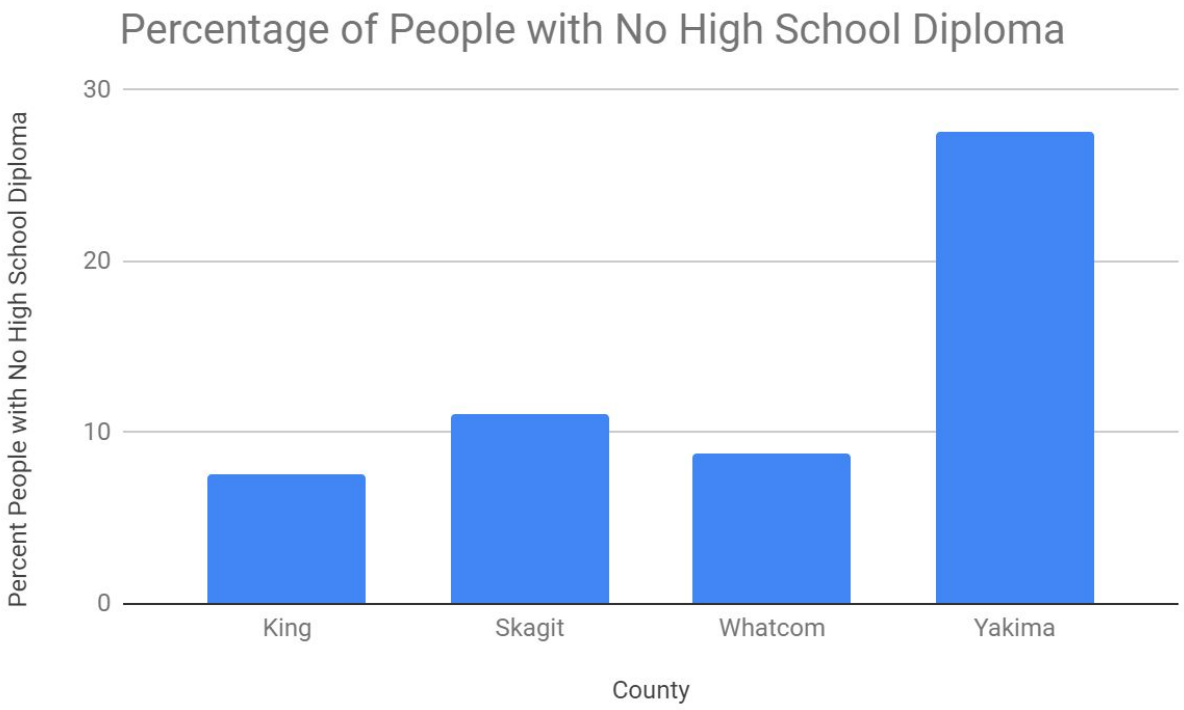


Figure 8. Percent of People with No High School Diploma

King County has the lowest percentage at less than 10% while Yakima County has the highest percentage at over 25%.

Built Environment: Health Care System and Infrastructure Vulnerabilities

The graph below illustrates the percentage of the population ages 18 to 64 without health insurance by county. Yakima County has the largest percentage of uninsured individuals.

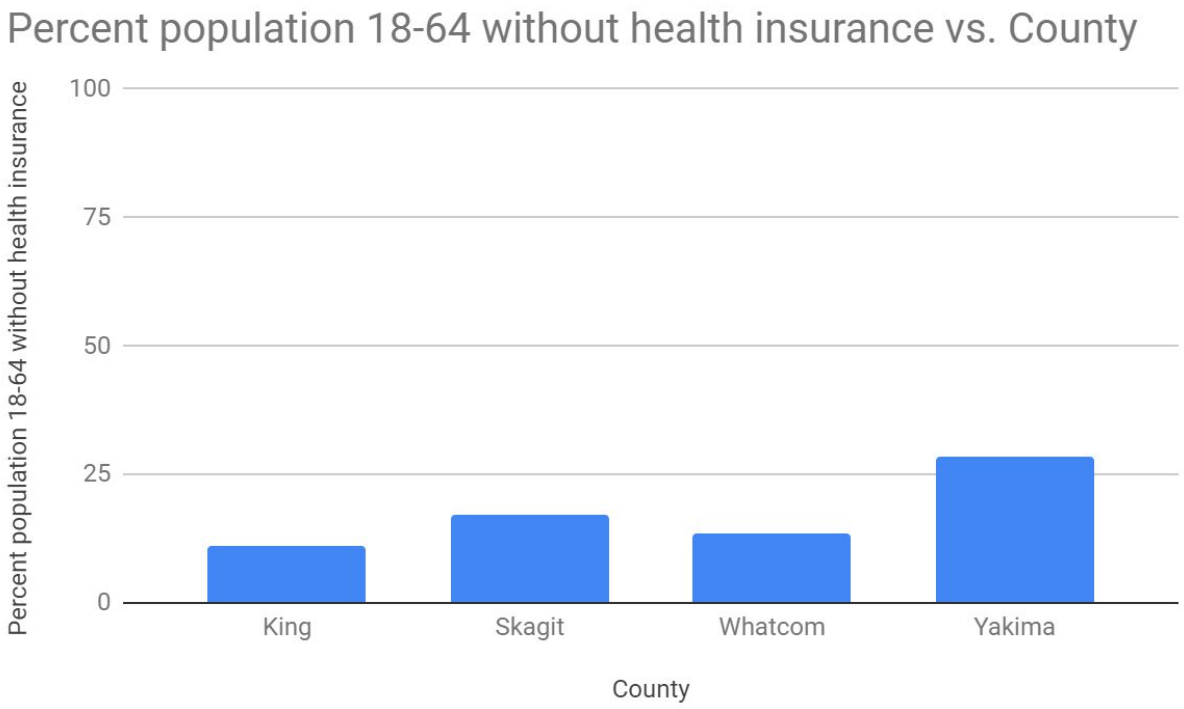


Figure 9. Uninsured Adult Population in Washington Counties

Another barrier to healthcare access is the location of clinics and the number of providers available. Farm worker housing is often located in rural, isolated areas, geographically isolating them from clinics and hospitals. Figure 9 uses data from the Washington Geospatial Open Data Portal to illustrate the presence of farm worker housing compared to hospital and clinic locations in Washington State.

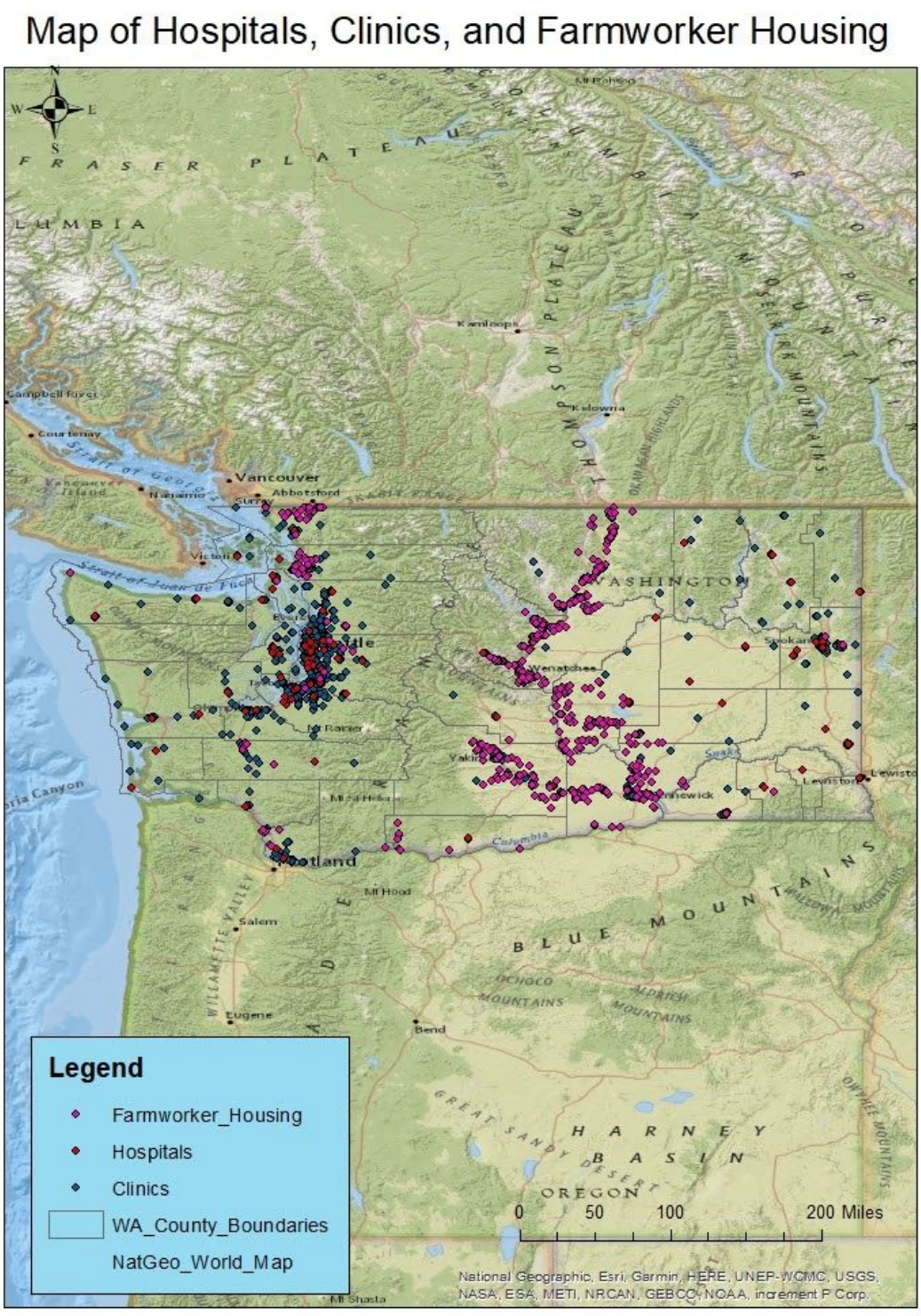


Figure 9. Location of Health Care Facilities and Farm Working Housing in Washington State

Yakima County has a large number of farm worker housing but relatively sparse hospitals and clinics. On the other hand, King County has relatively few farm worker housing locations but a high number of hospitals and clinics, making King County the most concentrated area in Washington State in terms of health care facilities.

Another indicator of health care infrastructure is the average Health Professional Shortage Areas (HPSA) score. The shortages in healthcare providers may be in primary, dental, or mental health care. Healthcare provider shortages are caused by geographic, population, or facility-based factors. Geographic shortages indicate a lack of providers within a geographically defined area. Population shortages indicate a lack of providers for a specific population, such as migrant workers or low-income communities. Facility shortages indicate a lack of health care facilities (both public and private). Higher HPSA scores are associated with an increase in shortages in mental, dental, and primary care providers. Using data from the Washington Tracking Network, Figure 10 identifies the average HSPA scores by county.

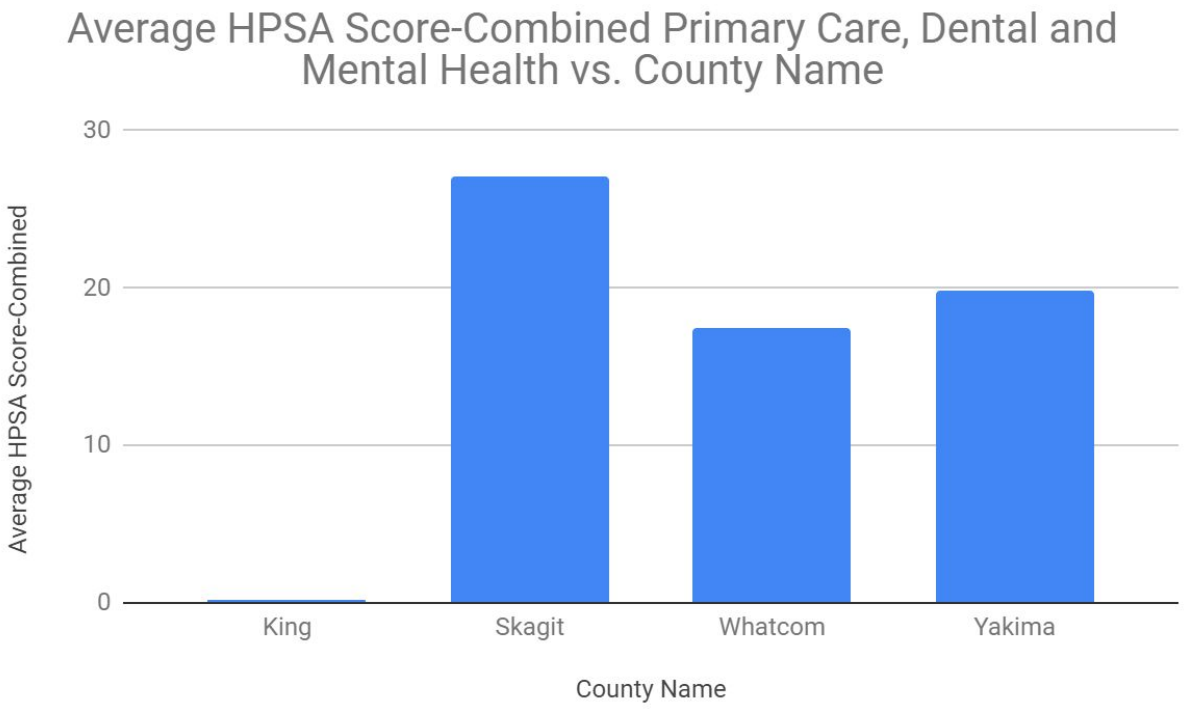


Figure 10. Average HPSA Score for Washington State Counties

King County has the lowest HPSA score, indicating that for that geographically defined population, the number of health care facilities and providers is positioned to adequately meet the needs of the community. Although Skagit has the highest HPSA score, Yakima County's score is potentially more concerning due to the combined health system vulnerabilities previously identified in this area.

Natural Environment: Changing Migration Patterns and Climate Change Indicators

Figure 11 illustrates the change in the length of the growing season in Washington State from 1895 to 2015.

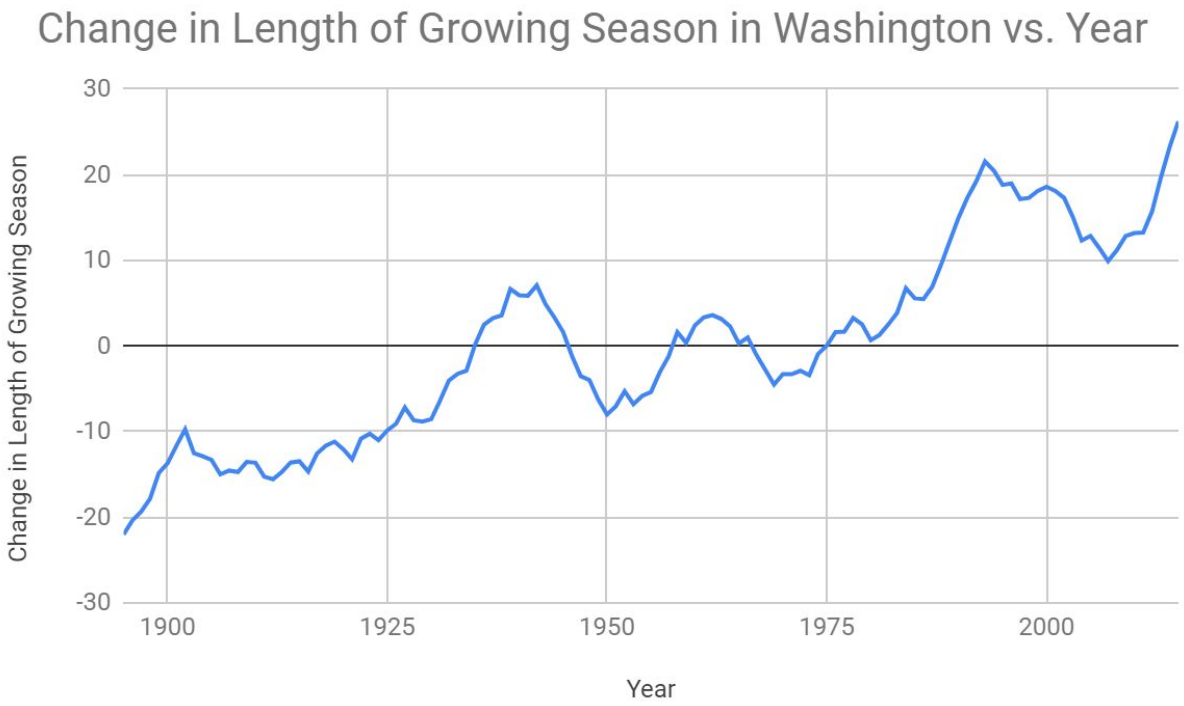


Figure 11. Change in the length of Growing Season in Washington

The average length of the growing season is set at 0 and all other deviations from the average are tracked in the figure below. The change in the length of the growing season is a good indicator of climate change according to the EPA [5]. The length of the growing season was determined by the time between the last spring frost and the first fall frost. This period is known as the frost-free period. Between 1895 and 2015, the average number of days for the growing season in Washington State has increased by 25 days, just shy of a month.

Natural Environment: Correlation between Climate Change and Migration

The change in length of growing season (as a deviation from the average) versus the percent of migrant workers for both shuttle and follow-the-crop migrants was plotted, treating time as a

hidden parameter. Migrant fraction refers to the share of the total farm worker population that is identified as one of two types of migrant workers. A linear regression was performed to obtain the slope and correlation coefficient, and the results are shown in Figure 12 below.

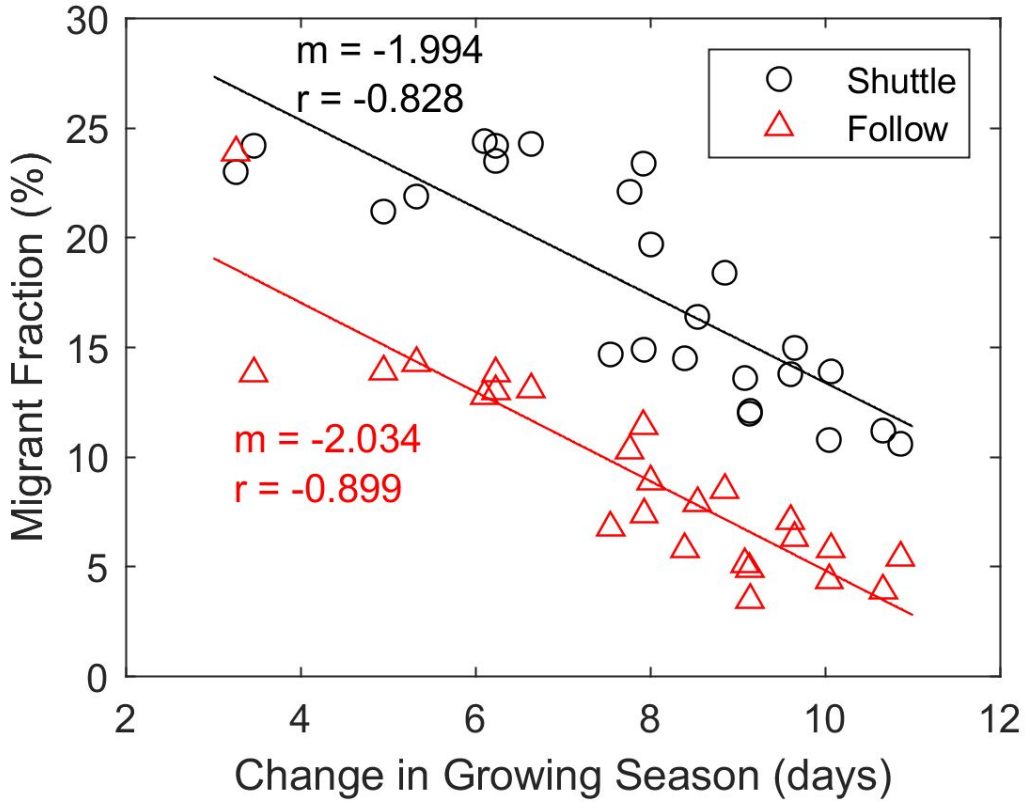


Figure 12. Migrant Fraction vs Change in Growing Season

A correlation coefficient of -1 would indicate perfect negative correlation between two variables. Correlation coefficients of -0.828 and -0.899 for Shuttle and Follow migrants, respectively, indicate a fairly high degree of negative correlation between these two factors. Additionally, the slope of the line tells us approximately how much we can expect these migrant fractions to change as the length of the growing season increases. Figure 12 indicates that the percentage of migrant farm workers decreases by 2% for each day the growing season increases.

Information and employment availability take time to adjust. In an effort to capture these effects in the available dataset, a lag was introduced to measure correlation as a function of lag. This linear regression then took the form of y(ti)=m*x(ti-t)+b, where y is the migrant fraction, x is the change in length of growing season, ti is the time series from 1991 to 2016, t is the lag between changes in growing season and the resulting change in migrant fraction, and m and b are linear regression parameters.

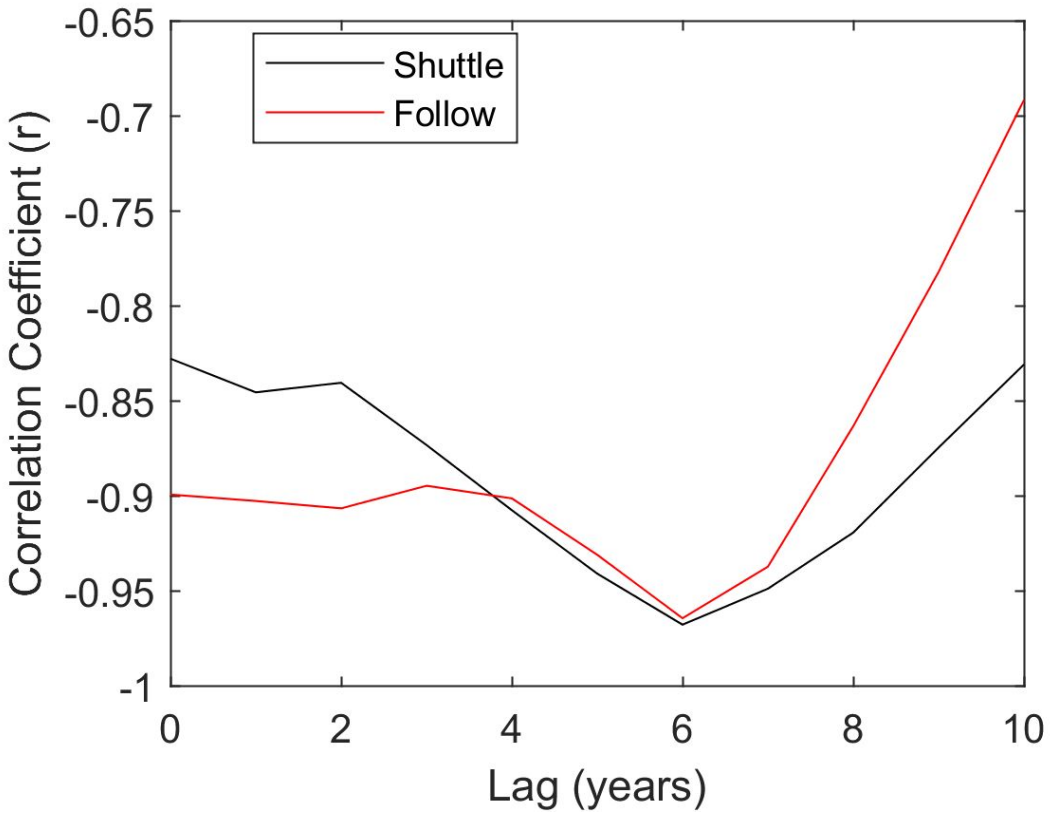


Figure 13. Correlation Coefficient vs Lag

As shown in Figure 13, the correlation coefficient varies significantly as a function of the lag time t in years. A minimum can be clearly seen at a lag time of 6 years, with a value of r=-0.96,

interpreted as a very good quality negative correlation. This could be interpreted as the effects of climate change taking 6 years to influence the migratory behavior of immigrant communities.

Taking lag time as 6 years, the migrant fraction is once again plotted as a function of the change in growing season, as shown in Figure 14.

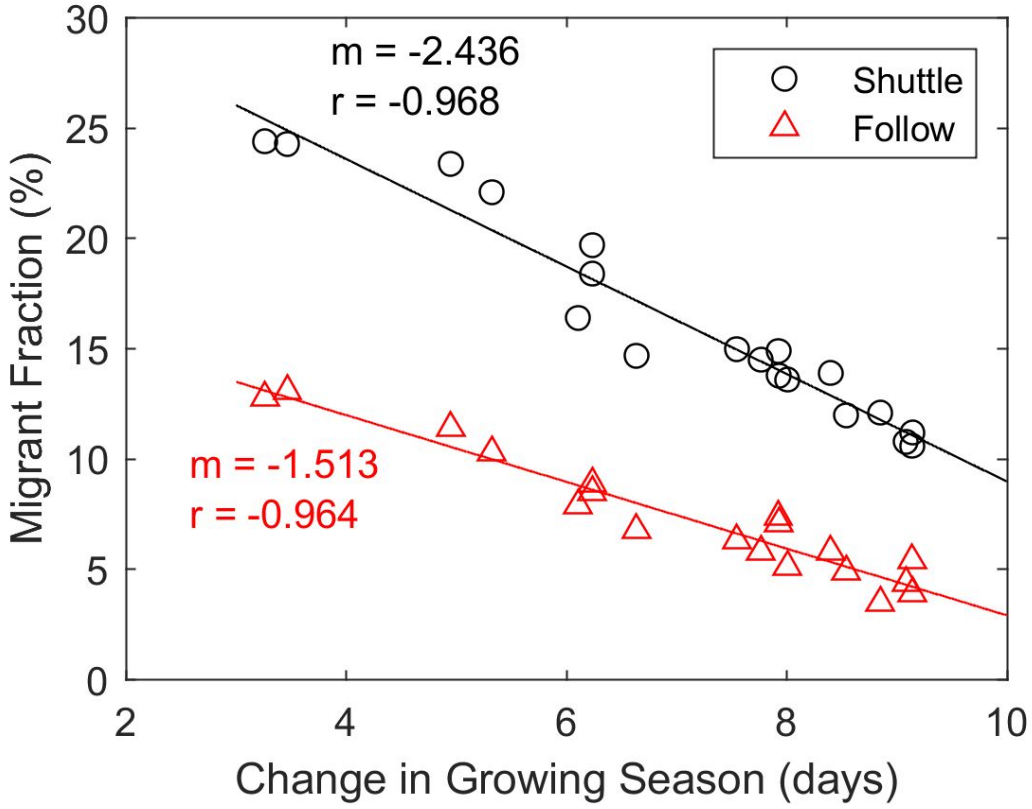


Figure 14. Lag Adjusted Migrant Fraction vs Change in Growing Season

The negative correlation with a lag of 6 years is stronger than the original plot, with migrant shuttle and migrant follow the crop correlation coefficients of r=-0.968 and r=-0.964, respectively.

DISCUSSION

Examination of the social environment data suggests that Yakima County is the most vulnerable to healthcare infrastructure pitfalls as the Latinx/Hispanic population increases and King County is the most equipped. Yakima County had the largest share of Hispanics at 49%. King County had one of the lowest percentages of Hispanics at 10%. In addition to the demographic data, Yakima scored the highest percentage for population with no high school diploma, population living below the federal poverty limit, population with limited English proficiency, and population of adults 18-64 with no health insurance.

The built environment data shed more light on Yakima's vulnerabilities, with Yakima County having the highest concentration of farm worker housing and the lowest concentration of hospitals and clinics. Although Skagit has the highest HSPA score, Yakima's high score paired with other social and built environment data indicates that Yakima County is the most ill-equipped to handle an influx of long term Hispanic/Latinx residents compared to the other three counties in our study. The data suggests that Yakima County has poor healthcare infrastructure relative to King County. Serving as theoretical foils to each other, the differences in rural Yakima and urban King counties illustrates the need for increased healthcare infrastructure to meet the needs of vulnerable populations in rural communities.

The natural environment data indicates an increase in the length of growing season both nationally and in Washington State. The length of the growing season is an important factor to consider when examining migrant farm labor dynamics. Changes in the growing season could

impact the number of migrant workers that move to Washington to work and how long they are able to stay. Analysis of changing percentages of migrant shuttle and migrant follow the crop labor plotted against the length of the growing season revealed a negative correlation, with correlation coefficients for migrant shuttle and migrant follow the crop of -0.828 and -0.899, respectively. Taking a lag time of 6 years into account, the migrant shuttle and migrant follow the crop correlation coefficients are $r=-0.968$ and $r=-0.964$, respectively.

The high degree of correlation is apparent in the two data sets, further illustrating the connection between climate change and overall behavioral trends in immigrant communities. The climate-driven decrease in migrant workers is an indicator of more settled farm workers. As the settled population of farm workers increases, the areas of the country with high Hispanic and Latino migrant workers need to prepare their health care infrastructure to support a population with many vulnerability indicators. Paired with the poor existing health care infrastructure, the needs of the farm worker community in Yakima are likely not being adequately met. Counties like Yakima are likely to be hit the hardest by this predicted increase in long-term farm worker residents.

The data suggests that health care infrastructure, linguistic isolation, poverty, educational attainment, and documentation status are contributing factors to health care access and utilization in farm worker communities. The decrease in the share of migrant farm labor due to the lengthening of the growing season has the potential to exacerbate gaps in health care in communities that are already vulnerable. This study focused on four counties in Washington State. King County was identified as being the best equipped in its current state to handle an increase in settled Latinx and/or Hispanic farm workers. On the other hand, Yakima is the least

equipped to handle an increase in settled Latinx and/or Hispanic farm workers. Yakima is also the most likely to experience this influx if the increase in the Hispanic population continues along its current trajectory.

Recommendations

Using the Social Ecological Model, it is clear that intervention areas for the majority of these factors lie at the natural, built, and social environment levels. Built environment interventions include improving healthcare infrastructure in terms of creating more health care facilities and hiring more health professionals to meet the demand. Social environment interventions include improving culturally and linguistically relevant outreach and information to the Latinx and Hispanic communities. This includes Spanish language accommodations and hiring health care staff of Latinx and/or Hispanic descent. Oral and written interpreters should be used when necessary to account for language barriers [25]. Information regarding health care options for undocumented workers is also crucial for reaching this vulnerable population. Further research on the number of indigenous-identifying farm workers is necessary to determine the need for additional language accommodations aside from Spanish.

Limitations

A limitation of this study is the lack of analysis on additional potentially contributing factors to the decrease in migrant workers. Global economics, policy, and domestic and international politics are just a few potentially contributing factors to a decrease in migrant workers. As mentioned

before, the reasons for immigrating are complex, often caused by a multitude of factors. As US immigration policy impacts detainment and deportation at the US-Mexico border and the number of refugees accepted into the country, we can expect to see shifts in who is immigrating to the US, for what purpose, and by what method or route. Global pandemics and political instability will also impact the reasons behind who is immigrating and what resources are available to help them. Since the scope of this work did not include an analysis of the broad political and economic factors contributing to changes in migrant worker percentages, it is difficult to disentangle the climate related effects from the larger global economic and political forces at play. Our data suggests that climate does have an effect on farm workers, particularly when examining the length of the growing season as a climate change indicator. The trouble is discerning the magnitude of the climate effect on the farm worker community. The data suggests that there is a delayed effect in terms of the ways climate change impacts the farm worker population. Our data suggests a lag time of about 6 years. This analysis is limited due to the lack of granularity in our datasets and our limited number of data points. A more robust dataset is needed to more effectively predict the impact climate has on the farm worker population.

Additionally, the undocumented and indigenous populations of immigrants from Latin America are not accurately represented by the data in this study. Undocumented individuals are hard to capture in population-based surveys due to fears of deportation and general mistrust for the government and research institutions by undocumented immigrants. Indigenous Latin Americans, particularly from Mexico, are also hard to capture, mainly due to linguistic barriers and personal identity discrepancies. According to the National Agricultural Workers' Survey, 6% of farm workers identify as indigenous [27]. Many indigenous peoples, from Mexico specifically,

speak Mixteco or Trique as their first language. Spanish language outreach is therefore ineffective in accurately capturing this population of immigrants. Not all indigenous peoples identify as indigenous, so accurately capturing the indigenous population can be difficult.

Further research should focus on the undocumented and indigenous population of farm workers in order to best assess their needs and potential areas of intervention. A full-scale analysis of the various potentially compounding factors that influence immigration and migrant farm workers is necessary to assess which factors have the largest effect on the farm worker community. Rural communities with health care infrastructure vulnerabilities, population vulnerabilities, and a growing Hispanic and/or Latinx population should take steps to identify institutional and community level interventions to prepare for a vulnerable population increase.

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