UNIVERSITY OF CALIFNORIA, MERCED

Structural Determinants of Asthma in a Predominantly Hispanic/Latinx Population

A dissertation submitted in partial satisfaction of the requirements for the degree Doctor of Philosophy

in

Public Health

By

Emanuel Alcala

Committee members:

Prof. Ricardo Cisneros, Chair

Prof. Mariaelena Gonzalez

Prof. Paul Brown

2022

The Dissertation of Emanuel Alcala is approved, and it is acceptable in quality and form for publication on microfilm and electronically:

Ricardo Cisneros

Signature

Mariaelena Gonzalez

Signature

Paul Brown

Signature

University of California, Merced

2022

Table of Contents

List of Tables 6

Acknowledgements 9

Curriculum Vitae 10

General Abstract 16

Chapter 1: General Introduction 18

Chapter 2. A Review of the Literature 22

Chapter 3. Study 1: Ecological Analysis of Housing Quality and Asthma-Related Emergency Department Visits Among Hispanics/Latinxs 34

Chapter 4. Study 2: An Ecological Analysis of Air Pollution and Environmental Degradation on Asthma-Related Emergency Department Visits Among Hispanics/Latinxs 61

Chapter 5. Study 3: Major Life Experiences of Discrimination and Asthma 77

Chapter 6. Conclusion 92

References 95

List of Tables

Table 1. Research Attributes of Study 1: Neighborhood-Level Analysis of Housing Quality and Asthma-Related Emergency Department Visits Among Hispanics/Latinxs 31

Table 2. Research Attributes of Study 2: Neighborhood-Level Effects of Air Pollution and Environmental Degradation on Asthma-Related ED Visits Among a Hispanic/Latinx Population 32

Table 3. Research Attributes of Study 1: Perceived Discrimination and Asthma 33

Table 4. Descriptive Statistics of Hispanic/Latino Asthma-Related ED Visits at the Census Tract-Level by County, 2016-2017..... 42

Table 5. Mean Rate of Asthma-Related ED Visits per 1,000 by Poverty and Year Housing Structure Built, Census Tract-Level (n=1,002)..... 43

Table 6. Results of Negative Binomial Regression of Latino Asthma ED Visits (n=1,002)..... 45

Table 7. Mean Housing Costs by Poverty and Year Housing Structure Built, Census Tract-Level 51

Table 8. Results of a Poisson Regression of Latino Asthma ED Visits by Median Year of Built Structures (n=1,002)..... 55

Table 9. Predicted Mean Rates from Final Model (n=1,002) 56

Table 10. Model Parameters OLS, Poisson, and Negative Binomial Regression of Latino Asthma ED Visits (n=1,002) 58

Table 11. Pairwise Comparison of Asthma ED Visits using Tukey's Methods post-ANOVA (n=1,002) 59

Table 12. Predicted Margins of Mean Asthma ED Visits from Moderation Model 60

Table 13. Descriptive Statistics of Hispanic/Latino Asthma-Related ED Visits at the Census Tract-Level by County, 2016-2017 67

Table 14. Items, Cronbach's alpha, and Descriptive Statistics by Factor (n=1,002) 69
Table 15. Summary Statistics of Variables at the Census Tract-Level (n=1,002) 71

Table 16. Rate Ratios and 95% Confidence Intervals of Asthma Emergency Department Visits on Predictor Variables from Four Negative Binomial Models (n=1,002) 71

Table 17. Frequency and Percent of Sample Characteristics (n=1,238) 84

Table 18. Items, Cronbach's alpha, and Descriptive Statistics by Factor (n=1,238) 85

Table 19. Mean and Standard Deviation of Ever Being Diagnosed with Asthma by Dichotomously Coded Composite Factor (n=1,238) 86

Table 20. Results of Four Multivariate Logistic Models for Ever Diagnosed with Asthma (n=1,238) 87

Table 21. Internal Consistency of Scales and Items (n=1,238) 89

Table 22. Pearson's r Correlations (n=1,238) 90

Table 23. Results of Four Multivariate Logistic Regressions for Ever Diagnosed with Asthma (n=1,238) 91

List of Figures

Figure 1 Ecosocial Model Adopted from Kreiger (2000)..... 28

Figure 2. Direct Acyclic Graph of the Study Hypothesis: The Effect of Poverty on Hispanic/Latino Asthma Emergency Department Visits is Moderated by the Median Year of Housing Structure Built at the Census Tract-Level..... 40

Figure 3. Predicted Mean Rate of Asthma-Related ED Visits (Moderation Model) by Poverty and Neighborhood Housing Age, Census Tract-Level, 2016-2017. 46

Figure 4. Rate of Asthma ED Visits Among Hispanics/Latinxs by Poverty and Median Year House Built 57

Acknowledgements

This dissertation is a win for me and my family. I would like to acknowledge the loving home that I was fortunate to have been raised in. My mother injected love into our home regardless of circumstances and sacrificed a lot to ensure a quality education for me. Also, I would like to acknowledge my two older brothers who would let me win in basketball games and helped to instill and grow in me the confidence it takes to complete a dissertation. I would like to thank my sister who, lately, has served as a soundboard to my actions and motivates me to remain disciplined in my goals and values. I would like to thank many others who helped me along the way, but none more than Dr. John A. Capitman who consistently demonstrates an unrelenting belief that I will reach self-actualization at the highest level. Thank you. Thank you. Thank you.

Curriculum Vitae

Emanuel Alcala

Email: ealcala4@ucmerced.edu

EDUCATION

University of California, Merced **ABD** Completion Date - Fall 2022
Public Health

California State University, Fresno **MA** 2011-2013
Emphasis: General-Experimental Psychology
Thesis: Effects of Weapon Exposure on Confidence in Weapon Identification

California State University, Fresno **BA** 2005-2010
Major: Psychology

ACADEMIC AWARDS

Robert Wood Johnson Foundation Health Policy Research Scholar	2017-21
Graduate Student Opportunity Fellowship	2017-18
Post-Graduate Fellowship (CVHPI)	2015-16
Dean's List	Fall 2008, Spring 2009
President's List	Fall 2007

PROFESSIONAL AFFILIATIONS

American Public Health Association (APHA)
Section: Applied Public Health Statistics
Section: Environmental Health

AREAS OF INTEREST

Health Equity, Culture of Health, Biostatistics, Multilevel Statistical Modeling, Epidemiology, Healthcare Services, Ambulatory Care-Sensitive Conditions, Non-Communicable Chronic Conditions, Social and Environmental Justice

PEER-REVIEWED PUBLICATIONS

Torres, J.M., **Alcala, E.,** Shaver, A., Collin, D.F., Franck, L.S., Gomez, A.M., Karasek, D., Nidey, N., Hotard, M., Hamad, R., & Pacheco-Werner, T. (2022). The deferred action for childhood arrivals program and birth outcomes in California: A quasi-experimental study. *BMC Public Health*.

Jadhav, R., **Alcala, E.,** Sirota, S., & Capitman, J. A. (2021). Risk factors for acute urticaria in central California. *International Journal of Environmental Research and Public Health,* 18(7), 3728.

Zografos, K., **Alcala, E.,** Capitman, J.A., & Khang, L. (2020). Integrating undergraduate research experience into public health curricula: Effects on undergraduate students' knowledge of neighborhood inequalities, perception of research, and motivation to talk about health issues. *Pedagogy in Health Promotion*.

Garcia, T. D., **Alcala, E.,** & Capitman, J. A. (2020). Has the Affordable Care Act Influenced Cardiology Disease Rates in the San Joaquin Valley? *Research in health science,* 5(3). doi: http://www.scholink.org/ojs/index.php/rhs/article/view/3174

Alcala, E., Brown, P., Capitman, J. A., Gonzalez, M., & Cisneros, R. (2019). Cumulative Impact of Environmental Pollution and Population Vulnerability on Pediatric Asthma Hospitalizations: A Multilevel Analysis of CalEnviroScreen. *International journal of environmental research and public health*, *16*(15), 2683.

Lama, G., **Alcala E.,** & Capitman, J.A. (2018). Poor people are hospitalized three times more for mental health services than the non-poor in Central Valley California. *Healthcare Multidisciplinary Digital Publishing Institute*, Vol. 6, No. 1, p. 5.

Alcala, E., Cisneros, R., & Capitman, J.A. (2017). Health care Access, concentrated poverty, and pediatric asthma hospital care use in California's San Joaquin Valley: A multilevel approach**. *Journal of Asthma,* 1-9.**

Lessard, L., **Alcala, E.,** & Capitman, J.A. (2015). Pollution, poverty, and potentially preventable childhood morbidity in central California. *Journal of Pediatrics.* Original Articles www.jpeds.com doi: http://dx.doi.org/10.1016/j.jpeds.2015.08.007

Zografos, K., Krenz, V., Yarmo, K., & **Alcala, E.** (2015). College students' utilization of protective alcohol-use behaviors: Effects of age, gender, and year in school. *California Journal of Health Promotion* 12(3), 49-58

Sharps, M.J., Herrera, M., Dunn, L., & **Alcala, E.** (2012). Repetition and reconfiguration: Demand-based confabulation in initial eyewitness memory. *Journal of Investigative Psychology and Offender Profiling*. 9,149-160. doi: 10.1002/jip.1361

Alcala, E., & Capitman, J.A. (in preparation). Social determinants of premature mortality for Mexican-American elders.

CONFERENCE ORAL PRESENTATIONS

Alcala, E., Chan, S., Cruz, A., Lopez, A., Oberholtzer, D., & Garcia, M. (2021). Positive effects in controlling hypertension in a hispanic population through medication therapy management and electronic health record use.

Alcala, E., Silva, Y., Megally, H., Doherty, R., & Capitman, J. A. (2020). Innovative Design for Identifying Priority needs in the San Joaquin Valley: Fresno County Community Health Needs Assessment. American Public Health Association (APHA) annual conference, Virtual Convening. October 28.

Jadhav, R., **Alcala E.,** Sirota, S., & Capitman, J. A. (2020). Risk factors for acute urticaria in central California American Public Health Association (APHA) annual conference, Virtual Convening. October 28.

Larsen, M., **Alcala, E.,** Tawfik, A., Capitman, J., & Sadeeghvaziri, E. (2020). Exploring the effects of traffic-related air pollution on public health in census tract level. *International Conference on Transportation and Development,* 75-85.

Alcala, E., Wiemann, A., & Capitman, J.A. (2019). Race/ethnicity, nativity, interpregnancy interval and preterm delivery in the San Joaquin Valley. American Public Health Association (APHA) annual meeting and exposition. (Nov. 2 – Nov. 6).

Capitman, J. A., Pacheco-Werner, T., Chambers, B., Mendoza, S., Chan, S., **Alcala, E.** (2019). Using science and community to create a preterm birth policy agenda. American Public Health Association (APHA) annual meeting and exposition. (Nov. 2 – Nov. 6).

Alcala, E., & Capitman, J.A. (2017). Neighborhood Context and the Latino Paradox among Mexican American Elders in Central California. American Public Health Association (APHA) annual conference, Atlanta, GA. November 7.

Alcala, E., & Capitman, J.A. (2016). Pollution, Insurance Coverage, and Childhood Asthma Morbidity in Central California. Presentation at Valley Children's Hospital for the Central California Asthma Coalition, Madera, CA. November 11.

Alcala, E. (2016). Racial & ethnic disparities in birth outcomes in central California. Presentation at the California WIC Association 2016 Annual Conference and Trade Show in San Diego California, April 18-19.

Alcala, E., & Capitman, J.A. (2015). Social Determinants of Health: CalEnviroScreen and Potentially Preventable Childhood Morbidity in California's Central Valley. Presentation at the National Institute of Environmental Health Sciences/Environmental Protection Agency (NIEHS/EPA) Children's Centers Annual Meeting, Washington, D.C.

Capitman, J.A., & **Alcala, E.** (2015). Social determinants of health: The San Joaquin Valley. Webinar/presentation on individual and neighborhood determinants of health inequities in California's Central Valley. http://www.csufresno.edu/chhs/cvhpi/presentations/index.html

CONFERENCE POSTERS

Alcala. E., Wiemann, A., & Captimant, J.A. (2019). Race/ethnicity, nativity, interpregnancy interval and preterm delivery in the San Joaquin Valley. American Public Health Association (APHA) Annual Conference, Philadelphia, PA. November 3.

Alcala. E., Conley, A., Garcia, T., Silva, Y., & Capitman, J.A. (2019). Estimated Regional Impact of the Public Charge Proposal. American Public Health Association (APHA) Annual Conference, Philadelphia, PA. November 5.

Alcala, E., & Capitman, J.A. (2017). Emergency department and hospital utilization in an asthmatic pediatric population in central California. American Public Health Association (APHA) annual conference, Atlanta, GA. November 6.

Alcala, E., & Capitman, J.A. (2016). **Pollution, poverty, and childhood asthma morbidity in central California**. American Public Health Association (APHA), Denver, CO. October 31.

Alcala, E., & Capitman, J.A. (2015). Social Determinants of Health: CalEnviroScreen and Potentially Preventable Childhood Morbidity in California's Central Valley. Poster board session at NIEHS/EPA Children's Centers Annual Meeting, Washington, D.C.

Alcala, E., Lessard, L., & Capitman, J.A. (2014). Place and health: Preventable hospitalizations for adults in the Central Valley of California. Poster presented at the American Public Health Association (APHA), New Orleans, LA.

RELATED EXPERIENCE

Central Valley Health Policy Institute 2019-Present

Assistant Director

Conduct process and outcome program evaluation, develop logic models, strategic plans, and indicators for the improvement of program implementation

University of California, Merced Fall 2018-Spring 2019

Graduate Peer-Mentor

Mentor incoming graduate students to acclimate to the academic environment, increase knowledge of resources, and interact with various faculty, staff, and students

Post Graduate Fellow 2014
Conduct process and outcome program evaluation, develop logic models, strategic plans, and indicators for the improvement of program implementation

Central Valley Health Policy Institute 2017-2019
Research Associate
Develop research questions, designs, and analyses in collaboration with researchers from the Children's Health and Air Pollution Study (CHAPS) funded by EPA/NIEHS

University of California, Merced spring 2016
Graduate Student Researcher (GSR)
Consult graduate students on data management and analysis

Central Valley Health Policy Institute
Research Analyst 2013 – 2016
Develop research ideas and design, run statistical analyses (logistic, Poisson-based, and multilevel regressions), manage large datasets (SPSS, Excel, SAS), write and review health reports, submit data requests, and supervise and provide support for interns
Central Valley Health Policy Institute (Off-Site)
Statistical Consultant 2013 – 2016
Consult professors, graduate, and undergraduate students on statistical analyses for unpublished manuscripts and theses
Cognitive Psychology Lab
Research Assistant 2009 – 2013
Assisted in administration of research studies, coding, building scoring rubrics, conducted inter-rater judging, used SPSS to manage data and apply statistics to answer research questions including reliability tests, t-tests, ANOVAs, and Chi-Squared tests

TEACHING EXPERIENCE

University of California, Merced 2021-2022

Environmental Health
Graduate Teaching Assistant (TA) and Guest Lecturer – "Introduction to Public Health"

University of California, Merced 2016
Environmental Health
Graduate Teaching Assistant (TA) and Guest Lecturer – "Introduction to Toxicology"

California State University, Fresno 2014
Graduate Public Health Seminar
Guest Lecturer – "Childhood Morbidity in the Central Valley"

California State University, Fresno 2014
Introduction to Statistics
Guest Lecturer – "Distribution Theory"

California State University, Fresno 2014
Introduction to Statistics
Guest Lecturer – "F Distribution"

California State University, Fresno 2012
Introduction to Psychology
Guest Lecturer – "Careers in Psychology"

General Abstract

Asthma is the most disparate common disease by race/ethnicity (Oh et al., 2016). To lessen the racial/ethnic gap in asthma, one must understand the mediating pathways in which a social construct such as race/ethnicity is linked to asthma. The aim of this dissertation is to investigate variations in asthma in association with individual- and neighborhood-level discrimination that this closely linked with racial/ethnic composition across three studies.

Study 1 is an ecological design and investigates housing quality in association with asthma emergency department (ED) visits among a Hispanic/Latinx population. This study illustrates that housing quality moderates the effect of poverty on asthma ED visits where communities of affluence tend to attenuate the effects of poverty on asthma. More specifically, the effect of poverty on asthma tends to increase as expected in older housing communities where affluent communities have very low rates and poor communities have very high rates. However, the effect of poverty on asthma tends to be different in newer housing developments where affluent communities tend to have higher rates than expected and poor communities have even higher rates of asthma.

Study 2 is an ecological analysis and builds on Study 1 by adding air pollution (i.e., ozone and particulate matter 2.5) and environmental degradation sites (e.g., hazardous waste sites) to the model. This study shows that air pollution is positively associated with asthma ED visits (RR = 1.2, 95% CI 1.16 – 1.25). Environmental degradation sites are positively associated with asthma ED visits (RR = 1.09, 95% CI 1.04 – 1.13).

Study 3 investigates major life experiences of discrimination and ever being diagnosed with asthma. The study shows that having two or more major life experiences

of discrimination, such as being denied a housing loan due to race/ethnicity, is associated with 1.2 times odds increase in ever being diagnosed with asthma in comparison to those who reported one or fewer major life experiences of discrimination.

In Conclusion, structural determinants of asthma manifest in different ways at differing levels. This dissertation shows that historical policies of housing and mortgage loan discrimination are linked to present-day asthma ED visits through housing quality. Moreover, concentrations of air pollution and environmental degradation sites increase the risk for asthma ED visits across census tracts. Finally, through self-reported data, the systematic denial of mortgage loans, job promotions, and living in specific neighborhoods is associated with increased risk for ever being diagnosed with asthma. Together, these three studies suggest that racial/ethnic disparities in asthma are at least in part due to the places where people live. Future research should focus on developing a deeper understanding of how community shapes racial/ethnic disparities in asthma to understand the commodities that promote health. Policy implications range from improvement of housing conditions, air pollution, and environmental degradation sites to opportunities of implicit bias training.

Chapter 1: General Introduction

Asthma is the most disparate common disease by race/ethnicity (Oh et al., 2016). Some studies show that this trend is worsening (Akinbami et al., 2014) while other studies show no improvement (Hossain et al., 2022). Annually, it is estimated that adult asthmatics average approximately $4,000 in lost earnings (Belova et al., 2020) and the U.S. spends an estimated $1.59 billion in pediatric hospitalizations alone (Perry et al., 2018). Multiple pathways contribute to asthma exacerbations ranging from behavioral, social, and environmental including cigarette smoke, genetic predisposition, diet, poor housing conditions, and indoor and outdoor air pollution, among other factors (Beck et al., 2014; Delfino et al., 2014; Strina et al., 2014; Uphoff et al., 2015; Wang et al., 2015). Despite major advances in medicine, treatment, and program implementation to combat the aforementioned pathways, asthma health care utilization and costs have been shown to rise suggesting unexplored pathways (Akinbami et al., 2014; Akinbami & Schoendorf, 2002). This study aims to assess structural determinants of asthma to identify specific mechanisms in which population-level asthma arises.

Chapter 2 presents a review of the literature on structural determinants of asthma and structural determinants manifest at multiple levels (e.g., person, neighborhood, county, and state) to produce poor asthma-related outcomes. First, a brief description of the economic burden of asthma where individuals living with asthma are estimated to lose $4,000 in annual earnings (Belova et al., 2020). This is followed by a discussion of disparities seen at the individual-level by age, gender, race/ethnicity, and socioeconomic position. Then an exploration of geographic disparities that tend to vary with neighborhood-level poverty, housing quality, and environmental pollutants. Finally, an

introduction to a theoretical framework developed by Krieger (Krieger, 2001) to provide context and a perspective on how structural determinants are linked to asthma.

Chapter 3 describes an ecological study of housing quality in relation to asthma-related emergency department (ED) visits among a Hispanic/Latinx population. This study is rooted in the discriminatory mortgage lending practices of the 1930's by the Home Owners Loan Corporation (HOLC) that graded neighborhoods based on income, education, and racial/ethnic composition where Hispanic/Latinx, Black American, and Asian communities were almost exclusively given the lowest grade. In turn, people living in these communities were denied mortgage loans even though they qualified for the loan. Present-day communities closely resemble the graded communities of the 1930's where Hispanic/Latinx populations tend to live in old and poor-quality housing. This study uses the measure of medial year of housing structures built in a census tract to investigate any association with asthma-related ED visits. The findings illustrate that the age of housing structures moderates the effect of poverty on asthma-related ED visits. In older housing communities the relationship between poverty and asthma tends to increase as expected. In new housing communities the relationship between poverty and asthma is different in that affluent communities are not as protective in comparison to affluent communities in older housing communities.

Chapter 4 builds on the ecological investigation conducted in Chapter 3 by adding measures of air pollution and environmental degradation to the model. The aim of this study is to understand the extent to which air pollution and environmental degradation sites independently contribute to asthma-related ED visits among a Hispanic/Latinx population. Hispanic/Latinx communities are in close proximity to poor air quality and

environmental degradation sties. In fact, Hispanic/Latinx populations are exposed to the highest level of air pollutions and environmental degradation sites in California. Air pollution is computed as a composite score of ozone and particulate matter 2.5. Environmental degradation is computed as a composite score of weighted cleanup sites, solid waste sites and facilities, and groundwater threats. For each unit increase in air pollution (one standard deviation), holding covariates constant, a rate increase of 1.2 times is expected for asthma ED visits. For each unit increase in environmental degradation (one standard deviation), holding covariates constant, a rate increase of 1.09 times is expected for asthma ED visits.

Chapter 5 describes a study on perceived and major life experiences of discrimination in relation to ever being diagnosed with asthma. The major guiding research question: Are major life experiences of discrimination associated with the likelihood of ever being diagnosed with asthma? Major life experiences of discrimination are things like being denied a promotion, a housing loan, or the opportunity to live in a desired neighborhood due to race/ethnicity. These major life experiences of discrimination are structural because of the support of private and public sectors to systematically deny marginalized populations socioeconomic opportunity (Rothstein, 2017). A survey is distributed to residents of Fresno and Madera County. The key finding is that there is a strong association with having at least two major life experiences of discrimination and the risk of ever being diagnosed with asthma. If people are at greater risk for asthma after having experienced the denial of economic opportunity, either through employment or building wealth in purchasing a home, the follow-up question is, why? In the chapter, there is a discussion of physiological biomarkers and psychosocial

responses to discrimination such as allostatic load that may help to explain the person-level manifestation of asthma.

Chapter 6 provides a conclusion and summation of the three studies as well as key policy recommendations. Future studies should continue to examine the relationship between race/ethnicity, place, and health. Mortgage lending has played a key role in increasing wealth and health disparities. This dissertation attempts to understand how discriminatory acts such as denial of a mortgage loan due to race/ethnicity impacts asthma outcomes in Fresno and Madera Counties.

Chapter 2. A Review of the Literature

Around the globe more than 300 million people have asthma and annually there is a 50% increase in the rate of diagnosis (Braman, 2006). Industrialized countries are no exception. Trends in asthma prevalence, health care use, and mortality in the United States are a serious public health concern (Akinbami et al., 2012, 2016; Akinbami & Schoendorf, 2002). In the United States, asthma is the leading chronic condition for children causing severe life disruption that may be prevented with appropriate care and service (Akinbami & Schoendorf, 2002). Population rates of asthma are on the rise and the burden of asthma is disparate across populations including age, gender, race/ethnicity, socioeconomic position (SEP), and neighborhoods (Akinbami et al., 2014; Bhan et al., 2015).

Age is one of the strongest risk factors of asthma. A general U-shaped relationship is commonly cited when referring to the relationship between age and asthma where young children are at high risk, adults are at low risk, and older adults are at high risk. Most of the studies on asthma incidence and prevalence focus on early onset asthma for youth. Leading researchers have shown that genetic predisposition is linked to children developing the disease at a young age. However, it has been documented that teenagers and young adults tend to not show symptoms or be at low risk for the development of asthma. Thus, researchers have postulated that young children and older adults tend to be most vulnerable to their surrounding environment including smokers, mold, dust mites, cockroaches, allergens, and air pollution.

There are gender disparities in asthma and it is dependent upon the age group that is in question. Young boys tend to be at greater risk for asthma-related diagnosis, emergency

department visit, and hospitalization in comparison to young girls. At approximately the age of sixteen there is a cross-over effect where young women tend to be at greater risk for asthma-related outcomes in comparison to young men. When considering populations that are thirty years of age and older the disparity is clearly overburdened for women in comparison to men. There is evidence suggesting a higher congenital predisposition to asthma for young boys in comparison to young girls. Young boys also tend to be more vulnerable to the environment in comparison to young girls. In terms of the cross-over effect that occurs in later stages of life, researchers have suggested that women tend to be more highly involved in their health and engaged with the healthcare system. This would explain a higher rate of asthma-related diagnoses and hospitalizations for women.

The association between race/ethnicity and asthma has been documented in the scientific literature. Gupta, Carrion-Carire, and Weiss (2006) describe the widening black/white gap in asthma hospitalizations and mortality through a trend analysis. These authors show that among children ages 5-18 years there was a 50% increase in the black/white rate ratio and the rate difference increased from 22.8 to 28.3 hospitalizations per 10,000 in the population. Similarly, Akinbami (2014) found a disparities in asthma prevalence between black and white children increased from 2001 to 2010; despite that during the same period overall trends were decreasing. Although there is evidence suggesting that genetic predisposition does contribute to risk of asthma development (Galanter et al., 2017; Lin et al., 2015), research largely suggests that racial/ethnic asthma disparities observed are largely due to social construction of identities.

A popular theory among health disparities researchers, the so-called Latino Paradox, suggests that the relationship between race/ethnicity and health is at the very

least complicated. The Latino Paradox (formerly known as the Hispanic Paradox) was first described in a manuscript by Markides and Coreil in 1986 which showed that despite living in poverty, Hispanics demonstrated equal or in some cases better health outcomes than their white counterparts (Markides & Coreil, 1986). Camacho-rivera et al (and other studies in Chicago) demonstrate that the Hispanic Paradox may be most prominent among Mexican and Central American decent because asthma prevalence tends to be higher among Puerto Ricans, Dominicans, and Cubans, in comparison to their US-born white counterparts (Camacho-Rivera et al., 2014, 2015).

Albeit complex, it is clear the socioeconomic position has a strong relationship with health and is one of the most heavily referenced risk factors among public health research across a plethora of poor health outcomes (Chen & Miller, 2013; Lago et al., 2018; Reiss, 2013; Uphoff et al., 2015). Most research can be traced back to the Whitehall studies. In this seminal work researchers followed a cohort of British civil servants in a longitudinal design and found that the risk for coronary heart disease was inversely related with employment status (Marmot et al., 1978). Although participants of the lower working class were heavier for their weight, smoked more, had higher blood pressure, and reported less physical activity than the men in the highest employment grade, the authors concluded that the higher risk profile alone could only partially explain the increased risk for coronary heart disease mortality among the men in the lowest employment grade. In current research the most used measures of SEP include education, income, and occupation, all of which have been associated with asthma.

Recent compelling studies have demonstrated that children with asthma from a low socioeconomic background show overexpression of genes regulating inflammatory

processes, including those involved in chemokine activity, stress responses and wound responses, compared with children with asthma from high socioeconomic background (Chen et al., 2009). These researchers suggested that decreased activity of cyclic AMP response element binding protein and nuclear factor Y and increased nuclear factor kB transcriptional signaling mediated these effects. These are pathways that are known to regulate catecholamine and inflammatory signaling commonly observed in asthmatics. These findings are significant because asthma medications tend to target catecholamine and inflammatory signaling pathways.

Researchers have documented the geographic disparity of the burden of asthma and how characteristics of neighborhoods such as poverty, racial/ethnic segregation, psychosocial stress, and collective efficacy contribute to asthma (E. Alcala et al., 2017; Cagney et al., 2007; Cagney & Browning, 2004b). The geographic distribution of concentrated poverty has implications for California residents and hospital care use. According to a report by the Brookings Institute (Kneebone & Holmes, 2016), concentrated poverty is on the rise. Across a few cities and regions of California, cross sectional data on hospital care use is beginning to build toward a connection between neighborhood-level concentrated poverty and asthma emergency department visits (E. Alcala et al., 2017; Nardone et al., 2020). There are longitudinal data sets that suggest similar findings, albeit self-reported data (Cantu et al., 2019).

Studies in Texas have found similar findings in asthma prevalence and wheezing among a largely Hispanic/Latino community (Collins et al., 2014). Collins measured economic deprivation at both the individual- and neighborhood-level and found that poverty was protective for asthma morbidity and doctor diagnosis. Poverty at the

neighborhood-level did attenuate effects at the individual level; however, findings were significant. Keet et al., (2015) who proposes a new approach to urbanness, race/ethnicity, and SEP found a similar effect for Hispanic vs non-Hispanic groups where Hispanic groups were at lower risk for asthma (in comparison to their non-Hispanic counterparts), despite living in low SEP communities. Note that the literature around effects of acculturation proposes that Mexican Hispanics are at increased risk for asthma development with greater amount of years and generations in the US (Gold & Acevedo-Garcia, 2005; Koinis-Mitchell et al., 2011; Neophytou et al., 2016).

In a study conducted in California by Alcala, Brown, Capitman, Gonzalez, and Cisneros (Emanuel Alcala et al., 2019), the authors found that increased levels of poverty and racial/ethnic segregation were associated with increased mean rates of asthma hospitalizations. There is evidence suggesting that racial/ethnic minorities are segregated into communities with greater social and environmental burden. The sociopolitical historical events that shaped communities of color and placed multiple sources of pollution differ across the regions of California; however, the framework of allostatic load, the adverse physiological response to chronic tress exposure, may provide insight into how asthma exacerbation may be induced by chronic exposure to stress.

Among researchers interested in discriminatory acts, there has been an increased interest in understanding the effects of redlining practices developed in the 1930's by the Home Owner's Loan Corporation (HOLC) and health outcomes. Redlining refers to lending or insurance discriminatory practices that were literally drawn around census tracts that would be denied such services. The HOLC traveled across the nation grading neighborhoods and developing maps by census tract for each major metropolitan city.

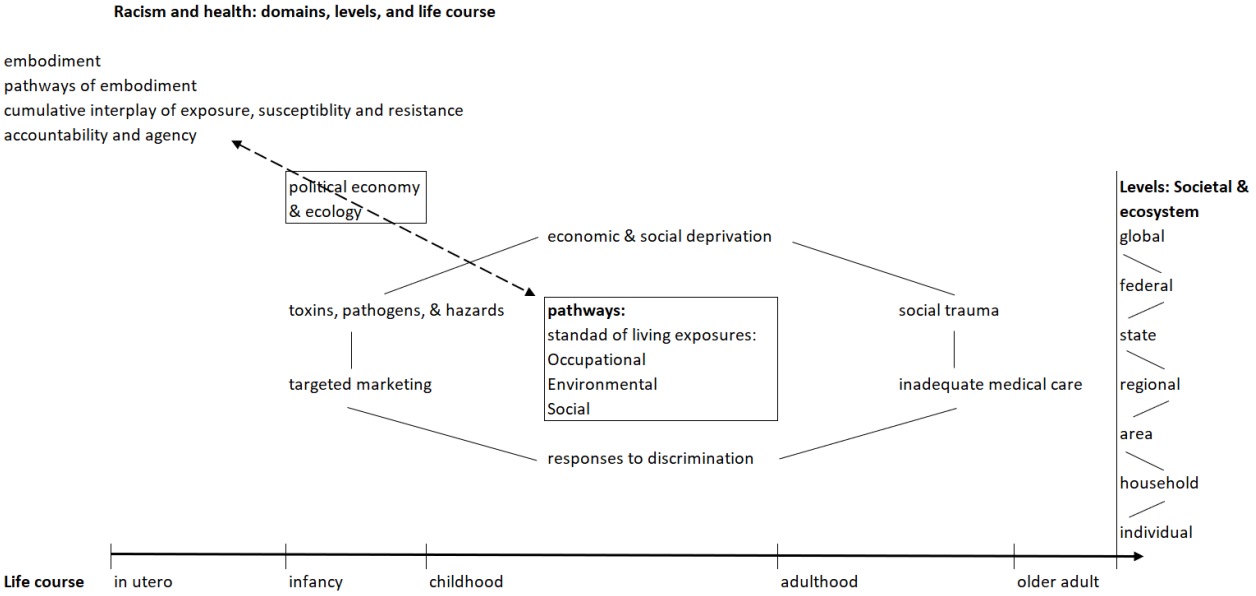
There were four grades ranging from A to D where A represented a highly desirable neighborhood and D represented low-income, black populations, foreigners, and other people of color. Many studies have shown that redlining maps from the 1930's correlate with present-day poor health . At least one scoping review concluded that HOLC grades are associated with numerous present-day health outcomes (e.g, preterm birth, cardiovascular disease among black populations) and poorer neighborhood conditions (e.g., food deserts, air pollution). In California, historic redlining maps have been associated with present-day asthma emergency department visits (Nardone et al., 2020), green space (Nardone et al., 2021), and air pollution (Lane et al., 2022). In a commentary piece by Bose, Madrigano, and Hansel (Bose et al., 2022), the authors eloquently weave poor asthma outcomes to the multifaceted impacts of redlining including poor housing quality, lack of green space, urban-heat exposure, nitrogen dioxide, fine particulate matter, sulfur dioxide, and volatile organic compounds. The authors strongly suggest that future research focus on racism, over race, as a risk factor for health inequities.

The Ecosocial Theoretical Framework

Social epidemiological theories can be categorized into one of three categories, 1) psychosocial, 2) social production of disease and/or political economy of health, and 3) ecosocial theory and related multi-level frameworks (Krieger, 2001). The ecosocial approach incorporates many positive facets of other leading theories toward explaining health including disease mechanism, health behavior, social determinants (as factors), psychosocial, life course, levels, history and historical contingency, and ecosystem, to name a few. Most importantly to this work, an ecosocial approach leverages ideas from the previously mentioned theoretical perspectives and allows the researcher to explore

questions about levels, place, and a spatiotemporal scale. To the best of my knowledge, an ecosocial approach is the only theory that helps to explain explicit relationships across levels, place, social determinants, and a spatiotemporal scale.

Figure 1 Ecosocial Model Adopted from Kreiger (2000)



The relationship between racism and health is complex as noted in the background section of this proposal. Kreiger (2001) describes the relationship between racism and health across domains, level, and life course in Figure 1. The research design and interpretation of measures of association will be with respect to the theoretical framework outlined in Figure 1. Although not all concepts across the domains, levels, and life course will be covered, the following is a description of the concepts that will be assessed. In terms of domains, economic and social deprivation as well as responses to discrimination are domains that will be tested in association with asthma. The societal and ecosystem levels that will be tested include individual and area. Finally, the life course components include historical context and generation as well as childhood. All

scientific endeavors relevant to this dissertation will be with respect to the previously mentioned domains, levels, and stages of life course.

Hypotheses

This dissertation investigates structural determinants including housing, toxic environmental exposures, and interpersonal discriminatory practices and how they are associated with asthma among a predominately Hispanic/Latinx population. The purpose of this dissertation is to apply the ecosocial theoretical framework on a San Joaquin Valley population that has been characterized as a high poverty and pollution region. I will be using data that focuses on California and California's San Joaquin Valley on a predominately Hispanc/Latinx population. The first study will illuminate the ecological relationship between housing quality, concentrated poverty, and asthma-related ED visits (see Table 1). The second study will add measures of air pollution and environmental degradation to the model developed in study two (see Table 2). The third study will examine the person-level relationship between racial/ethnic discrimination, income, and asthma (see Table 3). Tables 1 through 3 outline the specific research questions, study designs, and hypotheses that each study will test.

Objective of Dissertation

The objective of this dissertation is to gain a deeper understanding of how discrimination influences poor respiratory health at the individual- and neighborhood-level through a variety of factors across the life course. Using Krieger's ecosocial theoretical framework for understanding racism and health, across three studies this dissertation will explore the domains of responses to discrimination, economic and social

deprivation through housing policy, as well as toxins, pathogens, and hazards through environmental justice measures. Specifically, the objective of this dissertation can be separated into three distinct Research questions:

Research Question 1: At the census tract-level, is poor housing quality associated with rates of asthma emergency department visits among a Hispanic/Latinx population? (See Table 1)

Research Question 2: At the census tract-level, is air pollution and environmental degradation associated with rates of asthma emergency department visits among a Hispanic/Latinx population? (See Table 2)

Research Question 3: At the individual-level, is perceived racial/ethnic discrimination associated with the likelihood of ever being diagnosed with asthma? (See Table 3)

The following three tables outline the methods for each study. A chapter is dedicated to each study. Each table consists of the research questions, hypotheses, research design, data sets to be used, independent variables, and outcome variables.

Table 1. Research Attributes of Study 1: Neighborhood-Level Analysis of Housing Quality and Asthma-Related Emergency Department Visits Among Hispanics/Latinxs

Research Questions	**Hypothesis**	**Research Design**	**Data Sets**	**Independent Variables**	**Outcome Variable**
a. Is housing quality associated with rates of asthma emergency department (ED) visits among a Hispanic/Latinx population? b. Is concentrated poverty associated with rates of asthma ED visits? c. Does housing quality moderate the effect of concentrated poverty on asthma-related ED visits?	a. Poor housing quality is associated with increased rates of asthma ED visits. b. Concentrated poverty has a positive and significant association with asthma ED visits. c. Housing quality and concentrated poverty have a significant interaction to produce differential effects on asthma-related ED visits.	Cross-sectional ecological study of the state of California Census tract-level analysis. Negative binomial regression of asthma ED rates.	CalEnviroScreen v4 Census 2020 (American Community Survey) Office of Statewide Planning and Development (OSHPD)	<u>Predictors:</u> a. Median Year of housing structure built. b. Percent of population living below two times the federal poverty level. c. Interaction term between median Year of housing structure built and concentrated poverty. <u>Covariates:</u> -Percent limited English speaking households -Percent of the population over the age of 16 that is unemployed and eligible for the labor force -Percent foreign-born	Count of asthma-related emergency department visits among Hispanic/Latinxs

Table 2. Research Attributes of Study 2: Neighborhood-Level Effects of Air Pollution and Environmental Degradation on Asthma-Related ED Visits Among a Hispanic/Latinx Population

Research Question	**Hypothesis**	**Research Design**	**Data Sets**	**Variables**	**Outcome**
a. Is air pollution associated with asthma ED visits among a Hispanic/Latinx population? b. Is environmental degradation associated with asthma ED visits among a Hispanic/Latinx population?	a. Air pollution has a positive and significant association with asthma ED visits among a Hispanic/Latinx population. b. Environmental degradation has a positive and significant association with asthma ED visits among a Hispanic/Latinx population.	Cross-sectional study. Census tract-level analysis. Factor analysis and Cronbach's alpha to generate composite scores of air pollution and environmental degradation sites. Multivariate Negative binomial regression.	CalEnviroScreen v4 Census 2020 (American Community Survey) Office of Statewide Planning and Development (OSHPD)	<u>Predictors:</u> a. Composite air pollution score b. Composite environmental degradation score <u>Covariates:</u> -Median year housing built -Percent limited English speaking households -Percent of the population over the age of 16 that is unemployed and eligible for the labor force -Percent foreign-born	Count of asthma-related emergency department visits among Hispanic/Latinxs

Table 3. Research Attributes of Study 1: Perceived Discrimination and Asthma

Research Questions	**Hypothesis**	**Research Design**	**Data Sets**	**Variables**	**Outcome**
a. Is perceived interpersonal discrimination associated with the likelihood of ever being diagnosed with asthma? b. Is a major life experience of discrimination associated with the likelihood of ever being diagnosed with asthma? c. Is socioeconomic hardship associated with ever being diagnosed with asthma?	a. Perceived racial/ethnic discrimination has a positive and significant association with ever being diagnosed with asthma. b. Major life experiences of discrimination has a positive and significant association with ever being diagnosed with asthma. c. Economic hardship has a positive and significant association with ever being diagnosed with asthma.	Cross-sectional analysis of convenience sample in Fresno County. Person-level analysis. Factor analysis and Cronbach's alpha to generate composite scores. Multivariate logistic regression analysis.	Fresno County Community Health Needs Assessment Survey	<u>Predictors:</u> a. Composite everyday discrimination score. b. Composite major life experiences of discrimination score. c. Composite socioeconomic hardship score. <u>Covariates:</u> -Age -Gender -Race/Ethnicity -income -self-rated health	Ever diagnosed with asthma (0=no; 1=yes).

Chapter 3. Study 1: Ecological Analysis of Housing Quality and Asthma-Related Emergency Department Visits Among Hispanics/Latinxs

Abstract

Background. Rates of asthma-related emergency department visits have been shown to vary significantly by place (i.e., neighborhood) and race/ethnicity. The moderating factors of asthmatic events among Hispanic/Latino-specific populations are known to a much lesser degree. **Objective.** To assess the extent to which housing moderates the effect of poverty on Hispanic/Latino-specific asthma-related emergency department (ED) visits at an ecological level. **Methods.** Using data from the Office of Statewide Health Planning and Development (OSHPD) and the U.S. Census from 2016-2017 a cross-sectional ecological analysis at the census tract-level was conducted. Crosswalk files from the U.S. Department of Housing and Urban Development to associate zip codes to census tracts. Negative binomial regression was used to estimate rate ratios. **Results.** The effect of poverty on asthma-related ED visits was significantly moderated by the median year of housing structures built. The effect of mid-level poverty (RR= 1.57, 95% CI 1.27, 1.95) and high-level poverty (RR= 1.47, 95% CI 1.22, 1.78) in comparison to low-level poverty, was significantly greater among census tracts with housing built prior to 1965 in comparison to census tract with housing built between 1965-2020. **Conclusion.** Communities with older housing structures tend to be associated with increased Hispanic/Latino ED visits with the exception of affluent communities.

Background

In California, the rate of Hispanic/Latino asthma-related emergency department (ED) visits is estimated to be 42.3 per 10,000 in the population compared to 30.3 per 10,000 among their white counterparts (Health, 2019). In 2021, Hispanics/Latinos were the largest (and growing) racial/ethnic group in the state composed 15.7 million individuals (*American Community Survey 1-Year Estimates Selected Population Profiles*, 2021). Due to social and economic barriers, Hispanics/Latinos tend to initiate engagement with the healthcare system at the emergency department. Among children with asthma, one study found that 92% reported using a nonurgent care service in the past year and that Hispanics/Latinos were 57% less likely to have used such care in the same time frame (Chang et al., 2011). Moreover, Hispanics/Latinos with existing asthma were 49% more likely to have at least one ED visit compared to their counterparts (Chang et al., 2011). Given that Hispanics/Latinos have a higher rate of ED utilization than their white counterparts, are the largest racial/ethnic group, it follows that the health and well-being of this population has significant economic and healthcare policy implications.

The asthma disparities literature has seen a recent surge in studies highlighting social and environmental conditions as root causes of asthma (Grant et al., 2022) including chronic exposure to poor quality housing (Bryant-Stephens et al., 2021), racial/ethnic segregation (Emanuel Alcala, Brown, et al., 2017), poverty (Emanuel Alcala, Cisneros, et al., 2017), and air pollution (Gharibi et al., 2019). The emphasis being that historical policies coupled with discriminatory implementation practices have shaped economic, social, and health inequities at the community-level (Ayón, 2015;

Bryant-Stephens et al., 2021; Nardone et al., 2020). Asthma-related ED visits have been shown to vary geographically among Hispanic/Latinos (Emanuel Alcala, Cisneros, et al., 2017; Cagney & Browning, 2004a) and has been considered a health indicator of vulnerable populations due to poor neighborhood conditions (Emanuel Alcala et al., 2019; Cushing et al., 2015). What is less known is how neighborhood-level housing age relates to poverty and asthma among this population.

This study aims to gain a deeper understanding on how neighborhood-level housing age, poverty, and related community-level factors associate to asthma-related ED visits in a Hispanic/Latino-specific population. To the best of my knowledge, there has not been a Hispanic/Latino-specific ecological analysis investigating these factors in California. The objective of the study is twofold: 1) conduct an ecological analysis examining the extent to which the age of housing structures is associated with asthma-related ED visits among Hispanics/Latinos, and 2) to assess if the age of housing structures moderates the effect of poverty on asthma-related ED visits among Hispanics/Latinos.

Hypothesis 1: Census tracts with housing structures built prior to 1965 will be associated with increased Hispanic/Latino rates of asthma-related emergency department visits in comparison to census tracts with housing structures built between 1965-2020.

Hypothesis 2: The effect of poverty on Hispanic/Latino asthma-related emergency department visits will be greater among census tracts with housing structures built prior to 1965 in comparison to census tracts with housing structures built between 1965 and 2020.

Methods

A cross-sectional ecological study design was implemented where the unit of analysis was the census tract. Secondary data was collected from various sources. The outcome of interest was the rate asthma-related emergency department visits among Hispanics/Latinos/as in 2016-2017. Health data were collected from the Office of Statewide Planning and Development (OSHPD). Hospitals licensed in the state of California are required to report all emergency department visits to the OSHPD. To access these data a research protocol was approved by the Committee for the Protection of Human Subjects Internal Review Board with the California Health and Human Services Agency. Analysis was completed on census tracts within the following fourteen Californian counties: Fresno, Kern, Kings, Madera, Merced, San Francisco, San Joaquin, San Luis Obispo, Santa Barbara, Santa Cruz, Sonoma, Stanislaus, Tulare, and Ventura.

Data from the U.S. Census' American Community Survey (2016-2020) 5-year estimates were used to estimate the number of Hispanic/Latino individuals, the percent of individuals living two times below the federal poverty level, linguistic isolation among Spanish-speaking populations, foreign-born from a Hispanic/Latino country, and the median year of housing structures built per census tract.

Outcome Variable

The outcome of interest was the census tract-level rate of Hispanic/Latino asthma-related emergency department (ED) visits. Asthma diagnoses were identified using the single-level Clinical Classifications Software (CCS) diagnosis category of 128. The numerator was the count of asthma-related ED visits. The denominator was the estimated number of Hispanics/Latinos in a census tract. In Poisson and negative binomial analyses,

the natural log of the estimated number of Hispanics/Latinos in each census tract was entered into models which allows exponentiated coefficients to be interpreted as rate ratios (Osgood, 2000).

Health records from the OSHPD provide the patients' zip code of residence so counts of ED visits can only be aggregated to the zip code-level—not the census tract. Therefore, an area apportionment method (Din & Wilson, 2020) was used to relate aggregated zip code-level data to census tract-level data using a crosswalk file from the U.S. Department of Housing and Urban Development (Wilson & Din, 2018). The complete description of this method can be found in Appendix A.

Independent Variables

Neighborhood housing age was measured as the median year of housing structures built in a census tract. The American Community Survey (2016-2020) 5-year estimates provides a definitive median year of the building structures across census tracts. Neighborhood housing age was treated dichotomously in analyses. A cut point for census tracts was made at the median year of 1964. Census tracts with a median year of 1964 and prior (27%) was recoded to one and census tracts with a median year between 1965 to 2020 was recoded to zero (reference group).

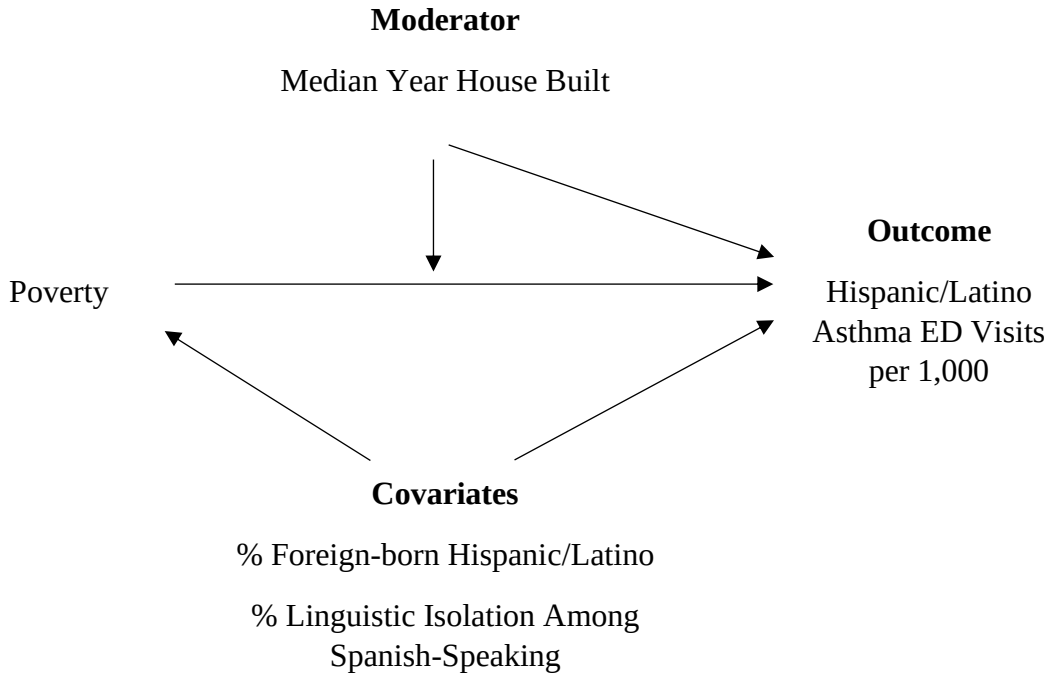
Poverty was measured as the percentage of individuals living two times below the federal poverty level from 2015-2019 in a census tract. Poverty was transformed by creating two cut points that split the variable into approximately three quantiles. The two cut points were 19.1% and 37.9% where low poverty ranged from 0% - 19%, mid poverty ranged from 19.1% - 37.8%, and high poverty ranged from 37.9% - 92%. The percent of foreign-born Hispanics/Latinos was the number of individuals born in Hispanic/Latin

countries divided by the total populations residing in a census tract. The percent of Spanish-speaking linguistic isolation was the number of individuals with limited English-speaking from Spanish-speaking households divided by the total population residing in a census tract. Foreign-born Hispanics/Latinos and Spanish-speaking linguistic isolation were treating continuously in subsequent analyses.

Analytic Techniques

A negative binomial regression was the primary multivariate statistical test used to estimate relationships at the census tract-level. Sensitivity analyses were conducted by comparing ordinary least squares (transformed outcome to a rate), Poisson, and negative binomial as well as to compare model fit and can be found in Table 10 of Study 1 Appendix. It was most appropriate to present results of the negative binomial due to the discrete nature of the outcome variable, overdispersion of the outcome, and residual plots did not suggest major biases. Negative binomial closely resembles model assumptions of a Poisson regression with the added benefit of accounting for excess zeros in the outcome variable as well as to model rate ratios by using the natural log of the population at risk (natural log of Hispanic/Latino population in each census tract). The robust VCE option was used to estimate conservative standard errors and protect against type II errors. Measures of socioeconomic status such as education and median household income were omitted in preliminary analyses due to high collinearity.

Figure 2. Direct Acyclic Graph of the Study Hypothesis: The Effect of Poverty on Hispanic/Latino Asthma Emergency Department Visits is Moderated by the Median Year of Housing Structure Built at the Census Tract-Level.



Results

Using the area apportionment crosswalk method there were 1,069 census tracts that successfully merged the asthma data to U.S. Census. Among those, 66 (6%) outliers were dropped after examining residuals and observations with high leverage. There were 1,002 census tracts included in the ecological analysis. Within these census tracts, there were 29,231 asthma-related ED visits among Hispanics/Latino/as from 2016-2017. The mean age was 21.5 years (SD = 19.2) where 48% (n=13,970) were female and 52% (n=52,261) were male.

Table 4 shows the descriptive statistics by county. The mean rate of asthma-related ED visits across census tracts was 4.9 (SD=2.9) with a minimum of zero and a maximum of 1.3 per 1,000 in the population. Fresno County had the highest average rate of asthma-related ED visits with 7.6 per 1,000 in the population and had the highest percent of census tracts at 16% (n=156). Kings County had the second highest mean rate of 7.3 per 1,000 in the population and 2% (n=18) of the sample census tracts. In contrast, Santa Cruz and San Luis Obispo Counties had lowest mean rates at 2.4 and 2.8 per 1,000 in the population, respectively.

Table 4. Descriptive Statistics of Hispanic/Latino Asthma-Related ED Visits at the Census Tract-Level by County, 2016-2017

County	Mean Rate/ 1,000	SD	n	%
Fresno	7.6	2.7	156	16%
Kings	7.3	2.6	18	2%
Merced	6.8	2.5	34	3%
Stanislaus	5.5	2.5	79	8%
Madera	5.4	2.4	10	1%
Kern	5.1	3.0	76	8%
San Joaquin	4.9	2.3	108	11%
Sonoma	4.4	2.6	74	7%
San Francisco	4.1	2.6	139	14%
Santa Barbara	3.9	2.1	64	6%
Ventura	3.7	2.0	128	13%
Tulare	3.3	2.4	52	5%
San Luis Obispo	2.8	1.3	30	3%
Santa Cruz	2.4	1.7	34	3%
Total Sample	4.9	2.9	1,002	100%

Table 5 shows mean rates, standard deviations, and frequencies by neighborhood housing age and poverty. A two-way analysis of variance (ANOVA) on a sample of 1,002 census tracts showed an effect of neighborhood housing age and poverty on asthma-related ED visits. There was a significant interaction effect (moderation) of neighborhood housing age and poverty on asthma-related ED visits, $F(2, 996) = 10.6$, $p < .001$. Tukey's test was used for postestimation pairwise comparison and showed that census tracts with a housing age prior to 1965 and were of high poverty (MEAN= 6.4, SD= 3.0) were at significant greater risk for asthma-related ED visits than every other pairwise comparison, except when comparing census tracts to mid poverty with a median year of pre-1965. This analysis suggested that neighborhood housing age potentially modified the effect of poverty on asthma.

Table 5. Mean Rate of Asthma-Related ED Visits per 1,000 by Poverty and Year Housing Structure Built, Census Tract-Level (n=1,002)

Year Housing Structure Built	Poverty			
1965 and later	Low	Mid	High	Total
Mean	4.5	4.2	5.3	4.8
SD	2.6	2.6	2.9	2.7
n	180	252	296	728
Pre-1965				
Mean	3.7	5.5	6.4	5.3
SD	2.2	3.3	3.0	3.1
n	86	77	111	274
Total				
Mean	4.2	4.5	5.6	4.9
SD	2.5	2.8	2.9	2.9
n	266	329	407	1002

Note. The mean asthma rate of census tracts with housing structures built pre-1965 and of high poverty was significantly higher than all other pairwise comparisons by Tukey's post ANOVA statistical test (<.001 in all comparisons).

Table 6 shows the results of testing hypothesis 1 and hypothesis 2 with a Main Effects Model and a Moderation Model, respectively. An in-depth statistical model comparison between ordinary least squares (outcome was transformed to a continuous rate), Poisson, and negative binomial regression is shown in Table 10 of the Appendix. The three competing statistical models did not change the results. Due to the discrete nature of the outcome variable, violation of the Poisson assumption that explanatory variables account for all variance in the outcome, and the added convenience of producing interpretable rate ratios, results from a negative binomial are shown in Table 6.

Hypothesis 1: In Table 6, the Main Effects Model shows that census tracts with a neighborhood housing age prior to 1965 had a greater risk of asthma-related ED visits

compared to census tracts with a median housing age between 1965 and 2020 (RR=1.10, 95% CI 1.02, 1.19). The Main Effects Model shows that mid and high poverty were associated with higher rates of asthma in comparison to census tracts of low poverty (RR=1.13, 95% CI 1.03, 1.25; RR=1.56, 95% CI 1.40, 1.73, respectively).

Hypothesis 2: In Table 6, the results of the Moderation Model show that the effect of mid poverty (in comparison to low poverty) on the mean rate of asthma-related ED visits is 1.57 times greater in census tracts with a neighborhood housing age prior to 1965 compared to those with a neighborhood housing age between 1965 and 2020 (RR= 1.57, 95% CI 1.27, 1.95). In other words, mid poverty has a differentially higher effect in older census tracts than in newer census tracts. Similarly, the effect of high poverty on the mean rate of asthma-related ED visits is 1.47 times greater in census tracts with housing age prior to 1965 in comparison to those with a housing age between 1965 and 2020 (RR= 1.47, 95% CI 1.22, 1.78).

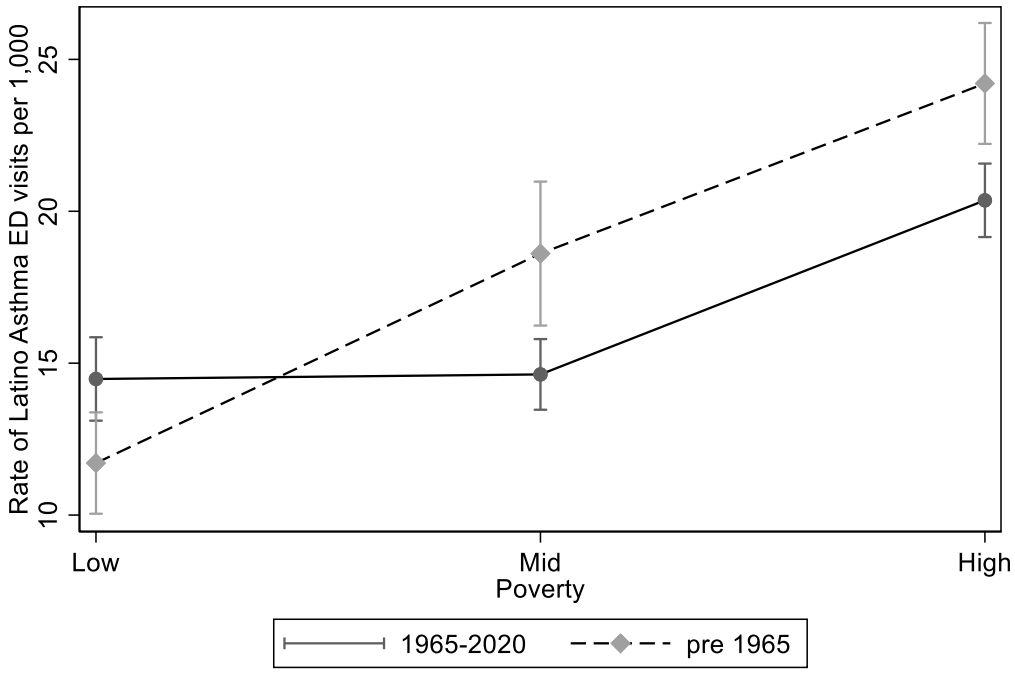
Table 6. Results of Negative Binomial Regression of Latino Asthma ED Visits (n=1,002)

Variable	Main Effects Model			Moderation Model		
	RR	Lower	Upper	RR	Lower	Upper
Moderation Effects						
Housing Structure Built X Poverty						
Pre-1965 X Mid Poverty	-	-	-	1.57***	1.27	1.95
Pre-1965 X High Poverty	-	-	-	1.47***	1.22	1.78
Main Effects						
Housing Structure Built						
1965-2020	REF			REF		
Pre-1965	1.10***	1.02	1.19	0.81**	0.69	0.95
Poverty						
Low	REF			REF		
Mid	1.13**	1.03	1.25	1.01	0.90	1.12
High	1.56***	1.40	1.73	1.41***	1.25	1.59
Covariates						
% Latino Foreign-born	0.98***	0.97	0.98	0.98***	0.97	0.98
% Linguistic Isolation	1.05***	1.02	1.08	1.05***	1.02	1.08
_cons	0.01	0.01	0.01	0.01	0.01	0.01
ln(Hispanic Count)	1			1		

Note. ***<.001. **<.01. *<.05.

Census tracts of low poverty (affluent) and a housing age prior to 1965 tend to have the lowest rates of asthma-related ED visits (MEAN = 11.71, 95% CI 10.04, 13.38). Census tracts of low poverty and a housing age between 1965 and 2020 have a predicted rate that is slightly higher (MEAN = 14.48, 95% CI 13.11, 15.85). Among census tracts with a housing age prior to 1965, the effects of mid poverty (RR= 1.57, 95% CI 1.27, 1.95) and high poverty (RR= 1.47, 95% CI 1.22, 1.78), in comparison to low poverty, tend to increase asthma-related ED visits linearly. Among census tracts with a housing age between 1965 and 2020, levels of poverty are not associated with similar increases in asthma-related ED visits (see Appendix D for exact estimates).

Figure 3. Predicted Mean Rate of Asthma-Related ED Visits (Moderation Model) by Poverty and Neighborhood Housing Age, Census Tract-Level, 2016-2017.



Discussion.

The aim of this study was to examine the extent to which neighborhood housing age and poverty interact in association with Hispanic/Latino asthma-related emergency department (ED) visits, at the census tract-level. The primary finding of this study is that the effect of poverty on asthma-related ED visits is differentially higher in communities with older housing structures in comparison to communities with newer housing structures based on the median year of housing structures built in a census tract.

This study suggests that communities with older housing structures and increased levels of poverty have some of the highest rates of Hispanic/Latino asthma-related ED visits. This finding aligns with several Hispanic/Latino-based prospective cohort studies

that share a similar region and population including the Center for the Health Assessment of Mothers and Children of Salinas (CHAMACOS), Genes-Environments and Admixture in Latino Americans (GALA) II, and Children's Health and Air Pollution Study (CHAPS). Hispanic/Latina mothers and children living in poor housing quality conditions tend to be exposed to asthma triggers including cockroaches and rodents (Bradman et al., 2005), mold and house dust (K C Dannemiller et al., 2016; Karen C Dannemiller et al., 2014), and poor indoor air quality. Furthermore, Hispanic/Latinos tend to live in poor urban communities or work in agriculture where asthma-inducing air pollution (Gale et al., 2012; Mann et al., 2010; Neophytou et al., 2016) and pesticides are present (Raanan et al., 2015), respectively. In response to the evidence outlined above there have been numerous interventions aimed at reducing in-home triggers with some success.

Place-based research has illustrated the connection between policies, environmental conditions, and health. Nardone, Casey, Morello-Frosch, Mujahid, Balmes, and Thakur (Nardone et al., 2020) conducted an in-depth ecological study investigating age-adjusted asthma ED visits in association to the redlining practices of the Home Owner's Loan Corporation (HOLC) and found a significant association. The authors suggest that historical redlining practices contribute to present-day asthma disparities. Another study found that HOLC redlining maps of the 1930's were strongly associated with modern day green space across the U.S. (Nardone et al., 2021). Intraurban communities across the nation, present-day variation in air pollution and disparities in exposure to nitrogen dioxide (NO2) and particulate matter (PM2.5) is strongly associated to redlining maps developed by HOLC to delineate favorable versus unfavorable neighborhoods and to a

lesser degree to race and ethnicity (Lane et al., 2022). This suggests that housing policies are only one of many contributors to disparate environmental exposures across racial/ethnic groups. It should be noted that within California, there has been a substantial amount of work showing that black and brown communities are exposed to the highest degrees of cumulative environmental hazards (Cushing et al., 2015) and that concentration of Hispanics/Latinos, in particular, demonstrate the highest exposure to cumulative pollution (Lievanos, 2019; Liévanos, 2018). In turn, cumulative exposure to environmental hazards has been shown to be associated with asthma-related health outcomes (Emanuel Alcala et al., 2019) including the joint effect of ambient air pollution and agricultural pesticide exposure (Benka-Coker et al., 2020; Winquist et al., 2014). Bose, Madrigano, and Hansel (Bose et al., 2022) concisely summarize the recent literature on redlining practices, air pollution, and asthma and reorient the field to focus on structural *racism*—over race as a risk factor for health inequities and a target for intervention.

This study adjusted for Hispanic/Latino foreign-born and linguistic isolation among Spanish-speaking concentrations within census tracts. Contrary to the growing literature on linguistic isolation, in fully adjusted models the effect of linguistic isolation was positively associated with asthma-related ED visits (RR = 1.05, 95% CI 1.02, 1.08). However, studies tend to find that linguistic isolation is associated with reduced rates of healthcare services due to language barriers. In a multilevel analysis of California, Alcala, Brown, Capitman, Gonzalez, and Cisneros (Emanuel Alcala et al., 2019) illustrate that zip code-level concentration of linguistic isolation is associated with reduced pediatric asthma-related hospitalizations. In a longitudinal study using electronic health

records (EHR) across the U.S., researchers (Heintzman et al., 2022) show that among Hispanic/Latino children with at least one possible presenting symptom of asthma, Spanish-speaking Hispanic/Latino children were less likely to be diagnosed with asthma in comparison to English-speaking Latino children. The authors of that study suggest that disparities among Hispanic/Latino children depend on language access. The relationship between health services and Hispanic/Latino asthma-related conditions is complex; however, clinicians and policy makers should focus on the absolute number of diagnoses because the volume of cases is vital to children's health in the U.S. (Heintzman et al., 2022).

There is a large body of evidence suggesting that the so-called Hispanic/Latino Paradox is most prominent among Hispanics/Latinos of Mexican decent. In other words, Hispanics/Latinos of Mexican decent tend to have better health outcomes than other Hispanic/Latino subgroups and tend to demonstrate similar outcomes to their white counterparts. For example, Rosenbaum (Rosenbaum, 2008) illustrates that housing conditions only partially mediate the racial/ethnic disparities in asthma prevalence among households in New York City and that Black Americans and Puerto Ricans are at greater risk than other racial/ethnic groups after adjustment. In Chicago, Cagney et al. (Cagney et al., 2007) found that asthma prevalence is highly dependent upon the concentration of foreign-born Hispanics/Latinos in a community.

This study does not stratify by Hispanic/Latino subgroups working under the assumption that most of the study population represent Mexican-origin Hispanic/Latinos. At the least, Puerto Ricans who have been consistently shown to have a higher risk for

asthma compared to individuals of Mexican decent do not compose a significant proportion of the studied population. Further research needs to be done on how healthcare access compares between these populations by language, uninsured rates, and rural living. Potentially, Hispanics/Latinos of Mexican decent have unique language barriers, higher uninsured rates, and more often live in rural settings with poor healthcare access in comparison to other Hispanics/Latinos. In this study, we focus on emergency department visits—as opposed to various other outcomes such as mortality or prevalence on the premise that Hispanics/Latinos do demonstrate a higher rate of emergency department utilization than their white counterparts at the state-level (Health, 2019) and that by analyzing a Hispanic/Latino-specific population a better understanding of the pathways toward asthma-related ED visits may be gained.

Differences in community socioeconomic and investment status of older affluent housing in comparison to older poor housing. We could not identify a census tract-level proxy for housing investments, so we compared housing costs that are associated with monthly owner costs for mortgages, deeds of trust, real estate taxes, insurance, utilities, and fuels. Table 7 shows mean values of census tract-level median housing costs by housing age and poverty. We found a significant interaction after conducting an ordinary least squares regression where old housing and mid-level poverty and old housing and high-poverty had significantly lower slopes than the effect of old housing in low-poverty communities (b = -148.2, 95% CI [-291.4, -5.0]; b = -319.7, 95% CI [-453.1, -186.4]), respectively. This may suggest that costs associated with older, affluent housing may protect against faulty roofing, floors, walls, and foundational structures that may contribute to asthma-related triggers such as dust mites, mold, and cockroaches.

Table 7. Mean Housing Costs by Poverty and Year Housing Structure Built, Census Tract-Level

Housing Structure Built	Poverty			
	Low	Mid	High	Total
1965-2020	$2,149	$1,626	$1,091	$1,538
Pre-1965	$2,460	$1,788	$1,082	$1,713
Total	$2,249	$1,664	$1,089	$1,586

Limitations

Although this study is cross-sectional, the use of neighborhood housing age in the analysis adds to the literature by attempting to capture historical housing policies and current health outcomes for Hispanics/Latinos. Furthermore, this study applies a novel area apportionment method developed by Din and Wilson (Din & Wilson, 2020) using geographic crosswalk files developed by the U.S. Department of Housing and Urban Development (Wilson & Din, 2018) so a baseline assessment needed to be completed. Data collected from the American Community Survey for the present study has been shown to produce inconsistent estimates per year. However, this study used 5-year estimates which tend to normalize outliers and reduce differences between the American Community Survey and US Census (Gage, 2006).

Appendix: Study 1

Description of area apportionment method and results.

Objective

1. To apportion area data from a zip code-level to census tract level.

Method

The Office of Policy Development and Research (PD&R) with the US Department of Housing and Urban Development developed crosswalk files between ZIP codes and various census geographies including county, census tract, and census block. Recognizing limitations of merging data from larger areal units to smaller areal units, the crosswalk files updated quarterly from USPS Vacancy Data to respond to rapidly changing geographies. ZIP code areas may contain varying densities of residential and business addresses, so the crosswalk files come with computed proportions of residential, business, and other address-types.

Emergency department visitation data was collected from the Office of Statewide Planning and Development (OSHPD) for the years 2016 and 2017. These health data are de-identified and can only be aggregated to the ZIP code level. So, to estimate emergency department visitation rates at the census tract-level the following method by Din and Wilson (2020).

Crosswalk ZIP codes to Census Tracts

Step 1: create variables “zip code parts” and “tract parts”. Zip code parts represents the number of times a unique census tract crosscuts through a given ZIP code. Tract parts

represent the number of times a ZIP code crosscuts the given census tract. ZIP codes tend to encompass a larger area than census tracts. Therefore, it may be common that many census tracts are fully engulfed by ZIP codes.

Step 2: aggregate number of Latino ED visits to ZIP Code.

Step 3. Multiply the total asthma ED visits reported in the ZIP code by the residential ratio of addresses of each census tract (res_ratio). The result is a set of estimated ED visits per census tract that intersects with a give ZIP code.

Step 3: Census tracts will intersect with multiple ZIP codes; therefore, the resulting table will have multiple estimates of asthma ED visits for the same census tract. Use a census tract identifier to sum the values across records for the same census tract.

Step 4 Merge the data set with aggregated asthma counts to the data set with US census data. Compute rate per census tract and run analysis. A total of 2,645 census tracts were successfully merged.

Results

Table 8 shows the results in rate ratios of a Poisson regression at the census tract level. The outcome of interest was counts of Latino ED visits per census tract. However, by including the natural log the number of Latinos in a census tract, the exponentiated coefficients may be interpreted as rate ratios among the Latino population. The main effects model shows that communities that tend to have older built structures is significant and positively associated with Latino asthma ED visits. For example, census tracts where the building structures have a median year built between 2001-2000 have a

higher rate of asthma ED visits compared to census tracts where the building structures have a median year built between 2001-2020 (reference group), RR = 1.32, 95% CI [1.20, 1.45]. Older communities had a similar effect, where those in the 1941-1964 and those that were built prior 1940 were at a greater risk for asthma ED visits compared to census tracts with newer buildings, (RR = 1.43, 95% CI [1.32, 1.56] and RR = 1.41, 95% CI [1.26, 1.57], respectively.

The highest level of poverty was associated with increased risk for asthma ED visits RR = 1.32, 95% CI [1.20, 1.45].

NOTE. In the full model, once the interaction and covariates are taken into account, high poverty is protective of asthma ED visits in comparison to low poverty. The estimate that is driving this finding is clearly seen in Table 9 by looking at the predicted asthma rates of High poverty and newly built communities. The estimate is 5.43 per 1,000 in the population. This is the lowest rate that is modeled. Figure 1 clearly illustrates the same thing. Gentrification? Low number of observations in the interaction of high poverty and new development? (most likely)

Table 8. Results of a Poisson Regression of Latino Asthma ED Visits by Median Year of Built Structures (n=1,002)

Variable	Main Effects Model			Interaction Model			Full model		
	RR	lower	upper	RR	lower	upper	RR	lower	upper
Median Year Built									
2001-2020	REF			REF			REF		
1991-2000	1.32	1.20	1.45	1.37	1.20	1.57	1.34	1.17	1.54
1965-1990	1.03	0.95	1.11	1.00	0.89	1.12	1.00	0.89	1.13
1941-1964	1.43	1.32	1.56	1.07	0.91	1.25	1.07	0.91	1.26
pre 1940	1.41	1.26	1.57	0.99	0.84	1.17	0.99	0.84	1.17
Poverty									
Low	REF			REF			REF		
Mid	0.98	0.93	1.03	0.99	0.84	1.17	0.95	0.81	1.13
High	1.09	1.04	1.14	0.48	0.35	0.67	0.62	0.44	0.88
Year Built X Poverty									
1991-2000#Mid				0.87	0.71	1.06	0.92	0.74	1.13
1991-2000#High				1.86	1.32	2.62	1.55	1.08	2.22
1965-1990#Mid				0.94	0.79	1.12	1.05	0.88	1.26
1965-1990#High				2.13	1.54	2.95	2.06	1.46	2.91
1941-1964#Mid				1.22	0.98	1.51	1.35	1.08	1.68
1941-1964#High				2.87	2.03	4.04	2.56	1.78	3.68
pre1940#Mid				1.24	0.97	1.59	1.44	1.12	1.85
pre1940#High				4.36	3.03	6.29	3.58	2.41	5.32
% No HS Education							1.00	0.99	1.00
% Linguistic Isolation							0.99	0.99	0.99
% Black American							1.02	1.02	1.02
_cons	0.00	0.00	0.01	0.01	0.00	0.01	0.01	0.00	0.01

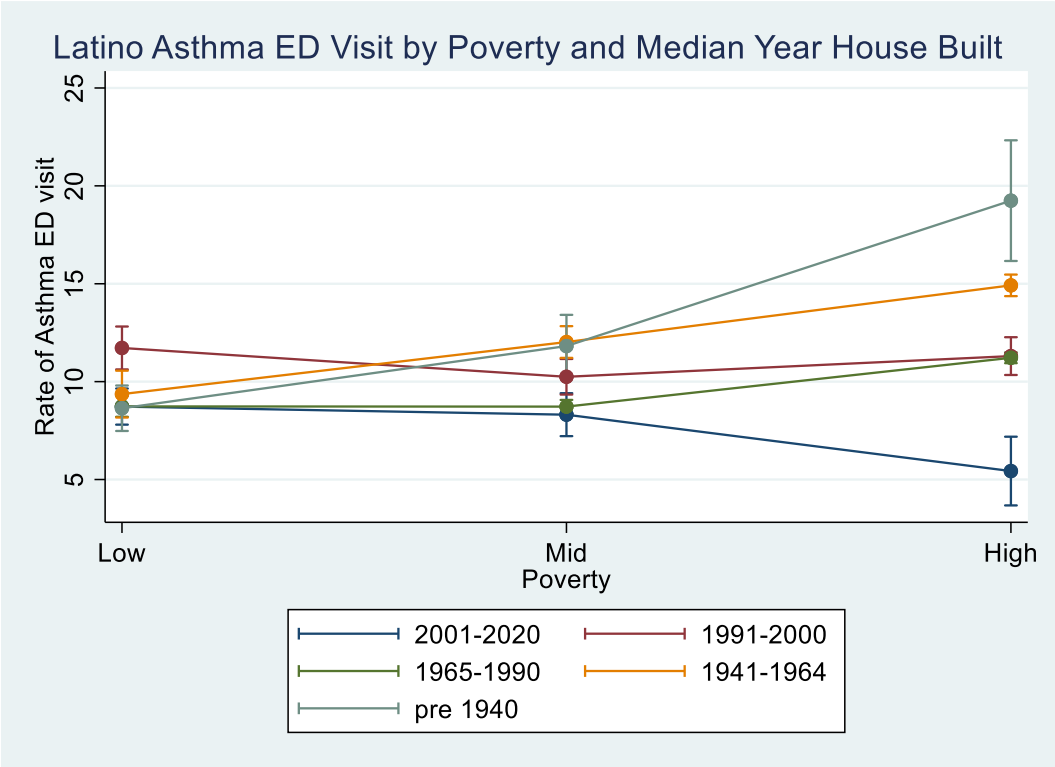
Table 9 shows predicted rates of Asthma ED visits among Latinos stratified by Poverty and the median year structures were built in the census tract.

Table 9. Predicted Mean Rates from Final Model (n=1,002)

Poverty	Year Built	Predicted Asthma Rate per 1k	SE	z	P>|z|	Lower	Upper
Low	2001-2020 (newest)	8.72	0.47	18.54	0.00	7.80	9.65
	1991-2000	11.72	0.56	20.98	0.00	10.62	12.81
	1965-1990	8.74	0.27	32.18	0.00	8.20	9.27
	1941-1964	9.36	0.61	15.34	0.00	8.17	10.56
	pre 1940 (oldest)	8.64	0.59	14.59	0.00	7.48	9.80
Mid	2001-2020 (newest)	8.31	0.56	14.84	0.00	7.21	9.41
	1991-2000	10.25	0.46	22.12	0.00	9.34	11.16
	1965-1990	8.72	0.17	50.16	0.00	8.38	9.06
	1941-1964	12.02	0.41	29.09	0.00	11.21	12.83
	pre 1940 (oldest)	11.82	0.81	14.54	0.00	10.22	13.41
High	2001-2020 (newest)	5.43	0.90	6.07	0.00	3.68	7.19
	1991-2000	11.30	0.49	22.95	0.00	10.34	12.27
	1965-1990	11.22	0.14	79.87	0.00	10.94	11.49
	1941-1964	14.92	0.28	53.11	0.00	14.37	15.47
	pre 1940 (oldest)	19.24	1.57	12.24	0.00	16.16	22.33

Figure 4 illustrates the predicted rates of Asthma ED visits among Latinos described in Table 9 by Poverty and media year of built structures. Latino Asthma rates are on the y-axis. Levels of poverty are on the x-axis including low, mid, and high poverty. Each line represents a different range of how old the structures are in a community by median years. For example, “pre 1940” represents census tracts where the structures tend to have been built before 1940. “Pre 1940” represents the oldest census tracts and “2001-2020” represents census tracts that tend to have newly built structures.

Figure 4. Rate of Asthma ED Visits Among Hispanics/Latinxs by Poverty and Median Year House Built



Study 1 Appendix

Table 10. Model Parameters OLS, Poisson, and Negative Binomial Regression of Latino Asthma ED Visits (n=1,002)

Variable	OLS			Poisson			Negative Binomial		
	beta	Lo	Up	RR	Lo	Up	RR	Lo	Up
Neighborhood Housing Age 1965 – 2020and Later	Ref			Ref			Ref		
Pre-1965	-.97 ^	-1.66	-.28	.85	.71	1.02	.81 ^	.69	.95
Poverty									
Low	Ref			Ref			Ref		
Mid	.08	-.45	.60	.99	.87	1.13	1.01	.90	1.13
High	1.66+	1.07	2.25	1.37+	1.20	1.57	1.41+	1.25	1.59
Neighborhood Housing Age X Poverty									
pre-1965 X Mid Poverty	2.14+	1.17	3.11	1.45 ^	1.14	1.86	1.57+	1.27	1.95
pre-1965 X High Poverty	1.93+	1.02	2.83	1.47+	1.20	1.82	1.47+	1.22	1.77
% Hispanic/Latino Foreign-born	-.11+	-.14	-.08	.98+	.97	.99	.98+	.97	.98
% Linguistic Isolation	.23 ^	.10	.36	1.03*	1.01	1.06	1.05+	1.02	1.08
_cons	4.93	4.52	5.34	.01	.01	.01	.01	.01	.01
ln(Hispanic Count)	-			1			1		

Note. +<.001. ^ <.01. *<.05.

Study 1 Appendix C

Table 11. Pairwise Comparison of Asthma ED Visits using Tukey's Methods post-ANOVA (n=1,002)

			Tukey			
Comparison	Mean Contrast	SE	t	P>|t|	Lower	Upper
Neighborhood Housing Age						
Pre 1965 vs 1965-2020*	0.46	0.20	2.31	0.02	0.07	0.85
Poverty						
Mid vs Low**	0.76	0.25	3.00	0.01	0.17	1.36
High vs Low***	1.77	0.24	7.46	0.00	1.21	2.32
High vs Mid***	1.00	0.24	4.25	0.00	0.45	1.56
Poverty and Neighborhood Housing Age						
(post 1965#Mid) vs (post 1965#Low)	-0.28	0.27	-1.05	0.90	-1.05	0.49
(post 1965#High) vs (post 1965#Low)*	0.83	0.26	3.19	0.02	0.09	1.57
(pre 1964#Low) vs (post 1965#Low)	-0.86	0.36	-2.39	0.16	-1.90	0.17
(pre 1964#Mid) vs (post 1965#Low)	0.94	0.38	2.52	0.12	-0.13	2.02
(pre 1964#High) vs (post 1965#Low)***	1.84	0.33	5.53	0.00	0.89	2.79
(post 1965#High) vs (post 1965#Mid)***	1.11	0.24	4.71	0.00	0.44	1.79
(pre 1964#Low) vs (post 1965#Mid)	-0.58	0.34	-1.69	0.54	-1.57	0.40
(pre 1964#Mid) vs (post 1965#Mid)*	1.23	0.36	3.42	0.01	0.20	2.25
(pre 1964#High) vs (post 1965#Mid)***	2.12	0.31	6.76	0.00	1.22	3.02
(pre 1964#Low) vs (post 1965#High)***	-1.69	0.34	-5.02	0.00	-2.66	-0.73
(pre 1964#Mid) vs (post 1965#High)	0.11	0.35	0.33	1.00	-0.89	1.12
(pre 1964#High) vs (post 1965#High)*	1.01	0.31	3.29	0.01	0.13	1.89
(pre 1964#Mid) vs (pre 1964#Low)***	1.81	0.43	4.18	0.00	0.57	3.04
(pre 1964#High) vs (pre 1964#Low)***	2.70	0.40	6.83	0.00	1.57	3.83
(pre 1964#High) vs (pre 1964#Mid)	0.89	0.41	2.19	0.24	-0.27	2.06

Note. ***<.001. **<.01. *<.05.

Table 12. Predicted Margins of Mean Asthma ED Visits from Moderation Model

Poverty	Neighborhood Housing Age	Margin	SE	z	P>|z|	Lower	Upper
Low	1965-2020	14.48	0.70	20.66	0.000	13.11	15.85
	Pre-1964	11.71	0.85	13.76	0.000	10.04	13.38
Mid	1965-2020	14.63	0.59	24.66	0.000	13.47	15.79
	Pre-1964	18.61	1.21	15.39	0.000	16.24	20.98
High	1965-2020	20.36	0.62	32.98	0.000	19.15	21.57
	Pre-1964	24.21	1.01	23.85	0.000	22.22	26.20

Chapter 4. Study 2: An Ecological Analysis of Air Pollution and Environmental Degradation on Asthma-Related Emergency Department Visits Among Hispanics/Latinxs

Abstract

Background. In California, Hispanic/Latinx populations are exposed to the highest degree of cumulative toxic environmental hazards than any other racial/ethnic group. **Objective.** The objective is to understand the extent to which air pollution and environmental degradation sites contribute to Hispanic/Latinx asthma emergency department visits. **Methods.** Using data from the Office of Statewide Health Planning and Development (OSHPD), the 2016-2017 U.S. Census, and the CalEnviroScreen version 4 a cross-sectional ecological analysis at the census tract-level was conducted. Negative binomial regression was used to estimate rate ratios. **Results.** The effect of air pollution on asthma-related ED visits was significant and positively associated (RR= 1.20, 95% CI 1.16, 1.25). The effect of environmental degradation on asthma-related ED visits was significant and positively associated (RR = 1.09, 95% CI 1.04, 1.13). **Conclusion.** Reducing air pollution and environmental degradation site effect will improve the health of Hispanics/Latinxs.

Background

Affecting more than twenty million individuals in the United States, asthma is the most disparate common disease by race/ethnicity with a prevalence fourfold greater in African Americans than Whites (Oh et al., 2016). Recently, researchers have made considerable progress in understanding how the effects of racial/ethnic composition on asthma and to what extent is this effect attenuated or explained by the place in which people live. For example, Alexander and Currie (Alexander & Currie, 2017) show that much of the gap in asthma incidence between African American children and other

racial/ethnic groups can be attributed to the place, Alcala, Capitman, and Cisneros, show that community-level concentrated poverty accounts for the person-level effect of Medi-Cal (Medicaid in California) on asthma-related emergency department visits (Emanuel Alcala, Cisneros, et al., 2017), and Nardone et al. show how historical residential redlining (i.e., current poor quality housing and associated effects) is associated with age-adjusted rates of asthma-related emergency department visits (Nardone et al., 2020).

In California, Hispanic/Latinx predominantly live in neighborhoods with poor quality housing (Bradman et al., 2005) and are exposed to the highest degree of cumulative toxic environmental hazards than any other racial/ethnic group (Cushing et al., 2015; Liévanos, 2018). At least housing, zoning, and banking policies, with governmental support have contributed to the racial/ethnic distribution of California (Rothstein, 2017). Moreover, historical redlining policies have also contributed to the distribution of present-day day air pollution (Lane et al., 2022). The effects of poor air quality have been demonstrated from single-pollutant models (Cisneros et al., 2021; Entwistle et al., 2019) to multi-pollutant models (Tavallali et al., 2020) in relationships to asthma-related emergency department visits.

The objective of this study was to explore the association between air pollution, environmental degradation, and asthma-related emergency department visits among a Hispanic/Latinx population. One objective was to understand which specific types of air pollutants cluster geographically with one another and which environmental degradation sites cluster with one another. Secondly, an objective was to differentiate the effects of air pollution and environmental degradation sites on asthma-related emergency department visits, adjusting for known confounding.

METHODS

A cross-sectional ecological study design was implemented where the unit of analysis was the census tract. Asthma-related emergency department events between 2016-2017 were collected from the Office of Statewide Health Planning and Development (OSHPD). Hospitals are mandated to report all hospital and emergency department events to OSHPD. A research protocol was approved by the Committee for the Protection of Human Subjects Internal Review Board by the California Health and Human Services Agency.

Outcome Variable

The outcome of interest was the census tract-level rate of Hispanic/Latino asthma-related emergency department (ED) visits. Asthma diagnoses were identified using the single-level Clinical Classifications Software (CCS) diagnosis category of 128. The numerator was the count of asthma-related ED visits. The denominator was the estimated number of Hispanics/Latinos in a census tract. In Poisson and negative binomial analyses, the natural log of the estimated number of Hispanics/Latinos in each census tract was entered into models which allows exponentiated coefficients to be interpreted as rate ratios (Osgood, 2000).

Health records from the OSHPD provide the patients' zip code of residence so counts of ED visits can only be aggregated to the zip code-level—not the census tract. Therefore, an area apportionment method (Din & Wilson, 2020) was used to relate aggregated zip code-level data to census tract-level data using a crosswalk file from the U.S. Department of Housing and Urban Development (Wilson & Din, 2018). The complete description of this method can be found in Appendix A.

Air Quality and Environmental Degradation Composite Scores

Composite scores of *air quality* and *environmental degradation* were computed using indicators from the CalEnviroScreen version 4.0. All pollution indicators were transformed into z-scores for standardization including ozone, particulate matter 2.5 (PM2.5), diesel particulate matter, drinking water, lead, pesticides, toxic release sites, traffic-related pollution, groundwater threats, hazardous waste sites, impaired water bodies, solid waste sites, and cleanup sites. Following the method outlined by Kim and Mueller (Kim et al., 1978), an exploratory factor analysis was conducted using all indicators listed. Two factors were retained with factor with eigenvalues greater than one. Varimax and Promax rotations were used to examine item loadings. Individual items were examined and only items with a factor loading greater than 0.5 were considered for creation of the composite score and examined for internal consistency. Cronbach's alpha was used to examine internal consistency and item-deletion methods and face validity were used to enhance internal consistency. The two final composite scores were *air quality* and *environmental degradation site*. *Air quality* was computed as the mean scores of standardized ozone and PM2.5. Ozone was the mean of summer months of the daily maximum 8-hour ozone concentration (ppm), averaged over three years (2017-2019). PM2.5 was the weighted average of measured monitor concentration sand satellite observations ($\mu g/m^3$), over three years (2017-2019). *Environmental degradation* was computed as the mean scores of standardized cleanup sites, solid waste sites and facilities, and groundwater threats. Cleanup sites was the sum of sites within each census tract (July 2021) weighted by nature and magnitude of the threat and burden posed by the hazardous substances. Solid waste sites and facilities was the sum of solid waste sites and

facilities in each census tract that are out of compliance, illegal, or contribute to odors, vermin, and increased truck traffic (as of July 2021). Cronbach's alpha and descriptive statistics for each composite score can be found in Table 14.

Independent Variables

Neighborhood housing age was measured as the median year of housing structures built in a census tract. The American Community Survey (2016-2020) 5-year estimates provides a definitive median year of the building structures across census tracts. Neighborhood housing age was treated dichotomously in analyses. A cut point for census tracts was made at the median year of 1964. Census tracts with a median year of 1964 and prior (27%) was recoded to one and census tracts with a median year between 1965 to 2020 was recoded to zero (reference group).

Poverty was measured as the percent of individuals living two times below the federal poverty level from 2015-2019 in a census tract. Poverty was transformed by creating two cut points that split the variable into approximately three quantiles. The two cut points were 19.1% and 37.9% where low poverty ranged from 0% - 19%, mid poverty ranged from 19.1% - 37.8%, and high poverty ranged from 37.9% - 92%. The percent of foreign-born Hispanics/Latinos was the number of individuals born in Hispanic/Latin countries divided by the total populations residing in a census tract. The percent of Spanish-speaking linguistic isolation was the number of individuals with limited English-speaking from Spanish-speaking households divided by the total population residing in a census tract. Foreign-born Hispanics/Latinos and Spanish-speaking linguistic isolation were treating continuously in subsequent analyses.

Analytic Techniques

A negative binomial regression was the primary multivariate statistical test used to estimate relationships at the census tract-level and is presented in Table 16. Sensitivity analyses were conducted by comparing ordinary least squares (transformed outcome to a rate), Poisson, and negative binomial as well as to compare model fit and can be found in the Appendix. It was most appropriate to present results of the negative binomial due to the discrete nature of the outcome variable, overdispersion of the outcome, and residual plots did not suggest major biases. Negative binomial closely resembles model assumptions of a Poisson regression with the added benefit of accounting for excess zeros in the outcome variable as well as to model rate ratios by using the natural log of the population at risk (natural log of Hispanic/Latino population in each census tract). The robust VCE option was used to estimate conservative standard errors and protect against type II errors. Prior to developing the negative binomial regression, a correlation matrix or Pearson's r was used to identify variables that were highly correlated with each other. Variables that had a Pearson's r greater than .40 were closely examined using standard collinearity diagnostics when using ordinary least squares regression (with the outcome transformed to a continuous rate). Poverty, % foreign-born, and % linguistic isolation were examined with high scrutiny where leverage, tolerance, and variance inflation factor where examined. Leverage was determined by $(2k + 2)/n$ where k is the number of predictors and n is the number of observations. There were 16 cases with a leverage higher than 0.0234 and were dropped. Tolerance was determined by 1/VIF (variance inflation factor) where a value lower than 0.1 would be dropped. No cases were dropped due to tolerance. Variance inflation factor was examined where values greater than ten

would be dropped. The mean VIF was 2.86 with a max of 3.43 and no variables were greater than 10. No variables were dropped due to variance inflation factor.

RESULTS

Table 13 shows the descriptive statistics by county. The mean rate of asthma-related ED visits across census tracts was 4.9 (SD=2.9) with a minimum of zero and a maximum of 1.3 per 1,000 in the population. Fresno County had the highest average rate of asthma-related ED visits with 7.6 per 1,000 in the population and had the highest percent of census tracts at 16% (n=156). Kings County had the second highest mean rate of 7.3 per 1,000 in the population and 2% (n=18) of the sample census tracts. In contrast, Santa Cruz and San Luis Obispo Counties had lowest mean rates at 2.4 and 2.8 per 1,000 in the population, respectively.

Table 13. Descriptive Statistics of Hispanic/Latino Asthma-Related ED Visits at the Census Tract-Level by County, 2016-2017

County	Mean Rate/ 1,000	SD	n	%
Fresno	7.6	2.7	156	16%
Kings	7.3	2.6	18	2%
Merced	6.8	2.5	34	3%
Stanislaus	5.5	2.5	79	8%
Madera	5.4	2.4	10	1%
Kern	5.1	3.0	76	8%
San Joaquin	4.9	2.3	108	11%
Sonoma	4.4	2.6	74	7%
San Francisco	4.1	2.6	139	14%
Santa Barbara	3.9	2.1	64	6%
Ventura	3.7	2.0	128	13%
Tulare	3.3	2.4	52	5%
San Luis Obispo	2.8	1.3	30	3%
Santa Cruz	2.4	1.7	34	3%
Total Sample	4.9	2.9	1,002	100%

Table 14 shows the reliability and summary statistics for each factor as well as the items used in each factor. There was a total of 1,002 census tracts used in the final analysis. Cronbach's alpha for air quality and environmental degradation was 0.91 and 0.56, respectively. Air quality ranged from 2.54 to 8.22 (M = 5.2; SD = 1.32). Environmental degradation sites ranged from 0 to 234 (M = 8.15; SD = 15).

Table 14. Items, Cronbach's alpha, and Descriptive Statistics by Factor (n=1,002)

Factor	*Items*	alpha	M	SD	Min	Max
Air Quality	*Particulate matter 2.5 (PM2.5).* *Ozone.*	0.91	5.24	1.32	2.54	8.22
Environmental Degradation Sites	*Cleanup sites.* *Solid waste sites and facilities.* *Groundwater threats.*	0.56	8.15	15.0	0.0	234

Table 15 shows summary statistics of the ecological variables used in the analysis. The mean asthma count (event) per census tract was 18.7 (SD = 18.1). The mean air quality and environmental degradation site values were 5.23 (SD = 1.32) and 8.17 (SD = 15), respectively. The mean percentage of Hispanic/Latinx foreign-born and percentage of Spanish-speaking populations across census tracts were 11.9% (SD = 10%) and 1.83% (SD = 2.19%), respectively. The percentage of individuals living below the federal poverty level was stratified into three quantiles where low, mid, and high poverty represented 26%, 33%, and 41% of observations. In terms of concentration of individuals living below the Federal Poverty level, *low poverty* ranged from 3.3% to 19.1%, *mid poverty* ranged from 19.2% to 37.8%, and *high poverty* ranged from 38% to 91.6%. Census tracts with housing structures built between 1965 to 2020 represented 73% of observations and those with housing built prior to 1965 were 27%. Table 16 shows rate ratios and 95% confidence intervals of four multivariate negative binomial models. The base model does not include air pollution or environmental degradation for reference. High poverty was associated with a rate ratio (RR) of 1.41 (95% CI 1.25 - 1.59) times greater than low poverty census tracts, adjusting for covariates. Housing built in 1964 and

prior was associated with a RR of 0.81 (95% CI 0.69 - 0.95) indicating 19% decrease in the rate of asthma-related ED visits compared to housing built between 1965 and 2020, adjusting for covariates and the interaction effect between poverty and median year of housing built. The interaction of poverty and median year of housing built showed that the effect of housing year is significantly different across levels of poverty. The RR of housing built prior to 1965 was 1.57 (95% CI 1.27 - 1.95) in mid poverty communities and 1.47 (95% CI 1.22 - 1.77) in high poverty communities in comparison to the effect of housing built prior to 1965 in low poverty (affluent) communities.

The Air Pollution Model shows that the RR of air pollution showed that asthma-related ED visits increased by 1.19 (95% CI 1.15 - 1.24) for every standard deviation increase in air pollution, adjusting for covariates. The Environmental Degradation Sites Model shows that environmental degradation sites was associated with an increase in the rate of asthma-related ED visits where the RR increased by 1.05 (95% CI 1.01 - 1.09) for every standard deviation increase in environmental degradation. The final model, Air Pollution + Environmental Degradation Sites Model, includes both air pollution and environmental degradation sites as well as covariates. A slight increase in the effects of air pollution (RR = 1.20, 95% CI 1.16 – 1.25) and environmental degradation sites (RR = 1.09, 95% CI 1.04 – 1.13) was observed and the effect of high poverty was attenuated (RR = 1.17, 95% CI 1.04 – 1.33) although remained significant.

Table 15. Summary Statistics of Variables at the Census Tract-Level (n=1,002)

Variable	Mean or %	(SD) or n
Asthma Count	18.7	(18.1)
% Hispanic/Latinx Foreign-born	11.9%	(10.0)
% Spanish-Speaking Linguistic Isolation	1.83%	(2.19)
Air Quality	5.24	(1.32)
Environmental Degradation Sites	8.17	(15.0)
Quantiles of Poverty (indicator)		
Low Poverty (Q1)	26%	266
Mid Poverty (Q2)	33%	329
High Poverty (Q3)	41%	407
Median Year House Built (indicator)		
House Built 1965 - 2020	73%	728
House Built Pre-1964	27%	274
Hispanic Population Count	1,887	(1,385)

Note. Air quality and environmental degradation sites display means and standard deviations prior to standardizing to z-scores. Values for quantiles of poverty and median year house built represent percentage of observations.

Table 16. Rate Ratios and 95% Confidence Intervals of Asthma Emergency Department Visits on Predictor Variables from Four Negative Binomial Models (n=1,002)

Variables	Base Model		Air Pollution Model		Environmental Degradation Sites Model		Air Pollution + Environmental Degradation Sites Model	
	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI
Variables of Interest								
Air Pollution	-	-	1.19***	1.15 - 1.24	-	-	1.20***	1.16 - 1.25
Environmental Degradation Sites	-	-	-	-	1.05**	1.01 - 1.09	1.09***	1.04 - 1.13
Covariates								
Poverty								
Low Poverty	Ref		Ref		Ref		Ref	
Mid Poverty	1.01	0.90 - 1.13	0.97	0.88 - 1.08	1.01	0.91 - 1.13	0.97	0.88 - 1.07
High Poverty	1.41***	1.25 - 1.59	1.19***	1.05 - 1.34	1.40***	1.25 - 1.58	1.17***	1.04 - 1.33
Median Year								

House Built								
House Built 1965-2020	Ref		Ref		Ref		Ref	
House Built Pre-1964	0.81***	0.69 - 0.95	0.98	0.83 - 1.14	0.81***	0.70 - 0.95	1.00	0.85 - 1.17
% Hispanic/Latinx	0.98***	0.97 - 0.98	0.98***	0.98 - 0.99	0.98***	0.97 - 0.98	0.98***	0.98 - 0.99
Foreign-born	1.05***	1.02 - 1.08	1.02*	1.00 - 1.05	1.05***	1.02 - 1.08	1.02*	1.00 - 1.05
% Spanish-Speaking Linguistic Isolation								
Interaction Terms								
Mid Poverty X House Built Pre-1964	1.57***	1.27 - 1.95	1.49***	1.21 - 1.82	1.56***	1.26 - 1.93	1.47***	1.20 - 1.79
High Poverty X House Built Pre-1964	1.47***	1.22 - 1.77	1.23**	1.02 - 1.47	1.47***	1.22 - 1.77	1.21**	1.01 - 1.45
Constant	0.01***	0.01 - 0.01	0.01***	0.01 - 0.01	0.01***	0.01 - 0.01	0.01***	0.01 - 0.01

DISCUSSION

The primary contribution of this study is to demonstrate that neighborhood-level concentrations of air pollution, environmental degradation sites, and poor housing quality significantly increase the risk for asthma-related ED visits among a strictly Hispanic/Latinx population. The Hispanic/Latinx population is the largest racial/ethnic group in California and live in proximity to and are exposed to a greater pollution burden than any other racial/ethnic group in the state.

This study suggests that spatial distributions of PM2.5 and ozone significantly contribute to and are associated with increases in rates of asthma-related ED visits. This finding aligns well with previous work done in the same region that has used different

methodologies. A time-stratified case-crossover analysis showed that ozone pollution is positively associated with asthma-related ED visits through time in the summer when ozone levels tends to spike (Gharibi et al., 2019). Similarly, another time-stratified case-crossover analysis showed that nitrogen dioxide (a contaminant of PM2.5) is positively associated with asthma-related ED visits in the winter months when PM2.5 tends to spike (Cisneros et al., 2021). The two studies mentioned previously strongly demonstrate *when* the causal link between air pollutants and asthma occurs. The present study demonstrates *where* the phenomenon takes place. Moreover, PM2.5 and ozone tend to have different peak seasons suggesting that populations living in communities with rates of high poverty and poor housing quality tend to be chronically exposed to air pollution throughout the year.

This study demonstrates that living in proximity to environmental degradation sites (i.e., cleanup sites, solid waste sites, and groundwater threats) is positively associated with rates of asthma-related ED visits independent of air pollution, poverty, and poor housing conditions. Many studies that investigate environmental degradation sites in relation to asthma tend to focus on pediatric asthma (Carpenter et al., 2008; Carrillo et al., 2018; Ma et al., 2007). For example, one study found that the asthma prevalence is 21% higher among children living closest to industrial zones in comparison to children who live more than one kilometer away (Mock, 2021). In a study that included individuals of all ages, the authors illustrate that children and older adults are at greatest risk of hospitalization for asthma and infectious respiratory disease and that living near a hazardous waste site increases the risk of hospitalization for asthma, chronic obstructive pulmonary disorder (COPD), and infectious respiratory disease (Carpenter et al., 2008).

Particularly, the risk for these poor health outcomes increases when living near hazardous waste sites that omit persistent organic pollutants.

Although the results of a negative binomial are shown in Table 16, in preliminary analyses ordinary least squares regression (OLS) was used with rates of asthma-related ED visits transformed into a continuous variable. OLS regression lends itself to direct interpretation of variance accounted for by predictor variables. The Base Model accounted for 12.3% ($R^2 = 0.123$) of the variation in rates of asthma-related ED visits. By adding air pollution to the model, a total of 20% ($R^2 = 0.200$) of the variation in rates of asthma-related ED visits across census tracts indicating that air pollution explained approximately 8%. In contrast, when environmental degradation was added to the Base Model a total of 12.6% ($R^2 = 0.126$) of the variation was accounted for suggesting that environmental degradation only accounts for 0.3%.

A study by Alcala, Brown, Capitman, Gonzalez, and Cisneros suggests that racial/ethnic segregation is a stronger predictor of place-based variation in pediatric asthma in comparison to poverty, diesel particulate matter, and linguistic isolation (Emanuel Alcala et al., 2019). The current study builds on that finding by only including the Hispanic/Latinx population with the goal of isolating environmental effects on asthma among one racial/ethnic group that is segregated in communities of high poverty. Clearly there are many racial/ethnic groups that identify as Hispanic/Latinx so subsequent studies should continue to investigate racial/ethnic effects among those that identify as Hispanic/Latinx.

At the census tract-level, Spanish-speaking linguistic isolation was associated with increased rates of asthma-related ED visits (RR = 1.02, 95% CI 1.00 – 1.05). This finding

is contrary to other studies investigating linguistic isolation and asthma. In a multilevel analysis of asthma ED visits, Alcala, Capitman, Brown, Gonzalez, and Cisneros found that linguistic isolation was associated with a decrease in rates. The authors attributed the negative association to clustering of non-English-speaking adults as well immigrant enclaves and overall lower educational attainment. At least one study found no effect of linguistic isolation and asthma (Saha et al., 2005). A key difference in the present study is that the variable was computed specifically to Spanish-speaking linguistic isolation as opposed to all non-English-speaking linguistic isolation. More than forty non-English languages are common in the region of study. The current finding suggests a need for deeper investigation in understanding why different speaking populations may use health care services at different rates.

In alignment with the healthy immigrant hypothesis (Abraido-Lanza et al., 1999; Cabieses et al., 2014), this study found that the concentration of Hispanics/Latinxs born outside of the U.S. is negatively associated with rates of asthma-related ED visits (RR = 0.98, 95% CI 0.98 – 0.99). One systematic review confirms the strong role in environment on the development of asthma (Cabieses et al., 2014). The authors demonstrate that asthma prevalence is higher in second generation than first generation immigrants and this finding is replicated across study populations, host countries, and children and adults. Among Hispanic/Latinx populations acculturation has been shown to be a driving factor of health where highly acculturated individuals tend to show worse health outcomes than less acculturated individuals (Gold & Acevedo-Garcia, 2005; Iqbal et al., 2014; Koinis-Mitchell et al., 2011). A series of studies in Chicago suggest that the

reduction in asthma prevalence is due to collective efficacy among foreign-born Hispanics/Latinxs.

Limitations

There are limitations to the data sets that were used. The study design is cross-sectional, and a causal link cannot be deduced. Given the nature of the variables used in the analysis, it is not likely that Hispanics/Latinxs who have existing asthma have systematically moved into neighborhoods that highly correlate with the geographic variations of housing quality, air pollution, and environmental degradation sites. In fact, the Hispanic/Latinx population in California is largely Mexican and Mexican-American and has consistently been show to have lower asthma prevalence compared to other racial/ethnic groups. This may present a confounding effect in the ability to identify risk factors for asthma-related ED visits. Thus, it is more likely that the estimates presented in this study are conservative in comparison to other racial/ethnic groups. Our data are limited in the ability to account for well-established, in-home triggers of asthma such as smoking, mold, and other allergens.

Chapter 5. Study 3: Major Life Experiences of Discrimination and Asthma

Abstract

Background. In Fresno County, the percentage of residents ever diagnosed with asthma is 20% and the emergency department visit rates among residents of all ages is 63.1 per 10,000 **Objective.** The objective is to understand the extent to which everyday perceived and major life experiences of discrimination are associated with ever being diagnosed with asthma. **Methods.** A convenience sample was used to distribute a questionnaire in Fresno and Madera County. Participants were asked to report their experience with everyday perceived discrimination, major life experiences of discrimination, and if they have ever been diagnosed with asthma. **Results.** Participants with at least two major experiences of discrimination had 1.98 times higher odds of ever being diagnosed with asthma than those who reported having less than two major experiences of discrimination (OR = 1.98, 95% CI 1.32, 2.97), adjusting for covariates. Experiencing socioeconomic hardship was also significant and positively associated with ever being diagnosed with asthma (OR = 1.63, 95% CI 1.15, 2.30). **Conclusion.** In Fresno and Madera County, people of color who have at least two major life experiences of discrimination are at greater risk of being diagnosed with asthma. Structural determinants of health such as the systematic denial of mortgage lending and job promotions are linked to asthma and merit continued investigation.

Background

In Fresno County, the percentage of residents ever diagnosed with asthma is 20% and the emergency department visit rates among residents of all ages is 63.1 per 10,000 (Branch, n.d.). Asthma is a costly chronic condition (Barnett & Nurmagambetov, 2011).

Fresno County and the broader San Joaquin Valley region has been shown to have a plethora of already existing socioeconomic and environmental inequities including low wages, low graduation rates, concentrated poverty, and laborious agricultural working conditions as well as various kinds of polluting industry (Cushing et al., 2015; Huang & London, 2012; London et al., 2011). All of which accumulate to induce and exacerbate observed disparities in the risk for asthma.

There is no shortage of systematic reviews that identify risk factors for asthma including genetics, tobacco, pollution, obesity, sugar consumption, allergies, microbes, and occupational exposures, to name a few (Stern et al., 2020; Toskala & Kennedy, 2015). Studies in the San Joaquin Valley have shown that increased levels of sugar consumption (Cisneros et al., 2017), diesel particulate matter (Emanuel Alcala et al., 2019), pesticide exposure (Schwartz et al., 2015), and indoor endotoxins (Tager et al., 2010). At least one study in the region focused on genetic admixture among Mexican and Puerto Rican asthmatics and found an association between European ancestry and asthma severity, among the Mexican sample (Salari et al., 2005).

According to leading researchers of race, racism, and discriminatory practices, asthma is the health condition with the largest disparate gap across racial/ethnic groups (Nardone et al., 2020; Oh et al., 2016). Moreover, the disparity among racial/ethnic groups is increasing over time (Akinbami et al., 2014, 2016). One group of researchers has proposed a model of structural racism and its pathways to asthma at the population level (Martinez et al., 2021). The model builds upon Krieger's (Krieger, 2001, 2019) framework of biological embodiment from an ecosocial perspective. This study aims to

examine the relationship between perceived discrimination and asthma at the person level.

Objective: To examine the association between perceived discrimination, economic hardship, and asthma diagnosis.

Methods

This study is an exploratory analysis of cross-sectional survey data. A community-wide survey was distributed to Fresno County residents in the Fall of 2021 to understand the health landscape and needs. The survey was composed of 68 questions. Saint Agnes Medical Center collaborated with community-based organizations to collect data from potentially vulnerable and underserved community residents. Community-based organizations provided locations and staff to facilitate completing the survey by providing technical assistance to residents when needed.

The primary outcome of interest is the risk of asthma diagnosis. Asthma risk was self-reported by survey respondents who were asked if they have ever been diagnosed with asthma. The survey item was treated as a binary outcome where respondents indicated yes or no to ever being diagnosed with asthma.

Independent Variables

Two variables were developed to measure perceived discrimination: 1) major experiences of discrimination and 2) everyday discrimination. Exploratory factor analysis was used to identify the number of factors and Cronbach's alpha was used to assess reliability of the scale (see Appendix A). Major experiences of discrimination was measured by adopting the 10-item questionnaire from Williams, et al. (Williams et al., 2008). Participants were asked to check all items that apply. Major experience of

discrimination was computed as the sum of I was not hired for a job, I was not given a promotion, I was prevented from renting or buying a home in the neighborhood you wanted, and I was prevented from remaining in a neighborhood because neighbors made life so uncomfortable. In multivariate analysis, then variable major experiences of discrimination was dummy coded where participants reporting two or more were coded as 1 and participants reporting less than two was coded as 0. Approximately 18% of the sample reported having at least two major experiences of discrimination.

Everyday discrimination was measured by adopting 8-items from the everyday discrimination scale (Williams et al., 1997). Participants were asked to indicate if they often, sometimes, rarely, or never are exposed to perceived everyday discrimination. Everyday discrimination was computed as the mean score of items including, I am treated with less courtesy than other people, I receive poorer service than other people at restaurants or stores, people act as if I am not smart, and people act as if I am not as good as they are. Everyday discrimination was computed as the mean value of 4 items. For multivariate analysis, everyday discrimination was dummy coded where the top 33 percentile, high levels of everyday discrimination, was coded as 1 and the bottom 67 percentile was coded as 0.

Socioeconomic hardship was an independent variable of interest. Participants were asked if in the past 12 months they experience trouble paying for food, utilities, transportation, housing, childcare, medical care, medication, or none of these. Participants checked all that apply. Socioeconomic hardship was computed the sum of the items regarding food, utilities, transportation, and housing. Socioeconomic hardship was dummy coded where individuals who reported more than two types of economic

hardship were codes as 1 and participants who reported less than two economic hardships were codes as 0. Approximately 26% of the participants reported having two or more economic hardships.

Covariates were treated as nominal in analyses and included gender, age, race/ethnicity, annual income, education, language spoken, insurance coverage, and self-rated health. Gender was measured as man, women, non-binary, or prefer not to answer. Only male or female were used in analysis. Age was categorized into four groups including 18 to 24, 25 to 34, 35 to 54, and 55 years of age and older. Race and ethnicity were asked in two separate questions. In this study, non-Hispanic white was defined as participants who stated white as their race and non-Hispanic as their ethnicity. The same coding scheme was used for participants who identified their ethnicity as non-Hispanic and their race as Asian, American Indian/Alaska Native, or Black/African American. Participants who identified their ethnicity as Hispanic and their race as either white or "other race" were categorized as Latino/Hispanic. Participants who identified their ethnicity as non-Hispanic and their race as "other race" were categorized as other race/ethnicity. Annual income was categorized as less than $34,999, $35K to $99,999, or greater than $100,000. Highest education was categorized as less than a High School Diploma, Diploma/some college, or Bachelor's degree or higher. Language spoken was categorized as English-speaking or no English. Participants were asked how well do you speak English? Participants responded very well, well, not well, or not at all. Participants who responded not well or not at all were categorized as no English. Participants were asked to rate their general health on a 5-point scale including excellent, very good, good,

fair, or poor. Self-rated health was treated continuously in analysis were excellent equals 5 and poor equals 1.

Statistical Analysis

Exploratory factor analysis was used for all scale development. The number of factors was selected by investigating eigenvalues and eigenvalue screeplots. Varimax and promax rotations were used to assess item factor loadings. Items with a factor loading greater than .5 were included in the scale. If the item was considered to have high face validity with the scale and had a factor loading greater than .4, the item was assessed for reliability with the scale. Internal consistency was determined by investigating Cronbach's alpha, the change in alpha if the item was deleted, and correlation of the item with the overall scale. For detailed results of these measures of internal consistency see Table 21 in the Appendix.

Sample characteristics were described using frequency, percentage, mean, standard deviation, minimum, and maximum values. Pearson's *r* was used to assess correlations among the composite scales and can be found in Table 22 of Study 3 Appendix. Statistical analysis was conducted in STATA 17.

Results

Table 17 shows frequency and percentage of selected sample characteristics used in the analysis. There were 1,238 surveys with complete data where approximately 16% (n=195) of the sample had been diagnosed with asthma at least once in their lifetime. Approximately 70% were female, 38% were 35 to 54 years of age, and 20% were 55 years of age or older. The racial/ethnic composition was approximately 56% Hispanic/Latino, 20% were Other Race/Ethnicity, 9% were NH Asian, 8% were NH

American Indian/Alaska Native, and 8% NH Black/African American persons. In terms of socioeconomic status, 51% had an annual income of less than $35,000, 14% had an annual income of greater than $100,000, 30% did not have a High School diploma, 28% had a bachelor's degree or higher education, 44% were privately insured, 41% were using Medi-Cal or Medicare, and 10% were uninsured. In the sample there were 17% who did not speak English. When participants were asked to assess their general health 9% stated poor, 22% fair, 34% good, 23% very good, and 12% excellent.

Table 18 shows Cronbach's alpha (a measure of internal consistency) and descriptive statistics for the factors of interest including everyday discrimination, socioeconomic hardship, and major experiences of discrimination. Everyday discrimination and socioeconomic hardships had a high to low Cronbach's alpha of 0.89 and 0.60, respectively. Everyday discrimination ranged from 0 to 3, a mean of 1.21, and standard deviation of 0.82. Socioeconomic hardship had a range of 0 to 4, a mean of 0.88, and a standard deviation of 1.09. Major experiences of discrimination had a very low Cronbach's alpha of 0.42. Major experiences of discrimination had a range from 0 to 2, a mean of 0.33, and a standard deviation of 0.61.

Table 17. Frequency and Percent of Sample Characteristics (n=1,238)

Variable	n	%
Ever Diagnosed with Asthma		
No	1,043	84.3%
Yes	195	15.8%
Gender		
Male	366	29.6%
Female	872	70.4%
Age Group		
18 to 24	153	12.4%
25 to 34	369	29.8%
35 to 54	470	38.0%
55+	246	20.0%
Race/Ethnicity		
Hispanic/Latino	691	55.8%
NH Asian	108	8.7%
NH American Indian/Alaska Native	94	7.6%
NH Black/African American	96	7.8%
Other Race/Ethnicity	249	20.1%
Annual Income		
< $35,000	626	50.6%
$35K to $99,999	440	35.5%
> $100K	172	14.0%
Highest Education		
< HS Diploma	360	29.1%
Diploma/Some College	443	35.8%
BA or Higher	342	27.6%
missing	93	7.5%
Language		
English Speaking	999	82.8%
No English	233	16.6%
missing	6	0.5%
Insurance Coverage		
Private	541	43.7%
Medi-Cal or Medicare	501	40.5%
No Insurance	118	9.5%
Other Payer	68	5.5%
missing	10	0.8%
Self-Rated Health		
Poor	109	8.8%
Fair	273	22.0%
Good	422	34.1%
Very Good	282	22.8%
Excellent	152	12.3%

Table 18. Items, Cronbach's alpha, and Descriptive Statistics by Factor (n=1,238)

Factor	*Items*	Cronbach's alpha	M	SD	Min	Max
Everyday Discrimination	*I am treated with less courtesy than other people. I receive poorer service than other people at restaurants or stores. People act as if I am not smart. People act as if I am not as good as they are.*	0.89	1.21	0.82	0	3
Socioeconomic Hardship	*Within the past 12 months had trouble paying for food. Within the past 12 months had trouble paying for utilities. Within the past 12 months had trouble paying for transportation. Within the past 12 months had trouble paying for housing.*	0.60	.88	1.09	0	4
Major Experience of Discrimination	*I was not hired for a job. I was not given a promotion. I was prevented from renting or buying a home in the neighborhood you wanted. I was prevented from remaining in a neighborhood because neighbors made life so uncomfortable.*	0.42	0.33	0.61	0	2

Table 19 shows mean and standard deviation values of ever being diagnosed with asthma by the factor variables of interest. Asthma is dichotomously coded where one is equal to ever being diagnosed with asthma and zero is never being diagnosed. So, means in Table 19 can be interpreted as percentages of the sample. When comparing participants with low to high levels of everyday discrimination, responses yielded 14% and 18% ever being diagnosed with asthma, respectively (χ^2=3.80; p=.051). There was a significant difference in asthma when comparing low (13%) to high (21%) economic hardship (χ^2=13.69; p<.001). Similarly, there was a significant difference in asthma rates when comparing low (13%) to high (22%) levels of major experiences of discrimination (χ^2=14.85; p<.001).

Table 19. Mean and Standard Deviation of Ever Being Diagnosed with Asthma by Dichotomously Coded Composite Factor (n=1,238)

Factor	M	SD
Everyday Discrimination^{+}		
Low (n=769)	0.14	(0.35)
High (n=469)	0.18	(0.39)
Economic Hardship***		
Low (n=789)	0.13	(0.34)
High (n=440)	0.21	(0.41)
Major Experiences of Discrimination***		
Low (n=769)	0.13	(0.34)
High (n=469)	0.22	(0.42)

Note. Ever being diagnosed with asthma is dichotomously coded so mean scores can be interpreted as percentage of the sample. χ^2 test was conducted to examine expected values. Significance is indicated by $^{+}p<0.051$; ** $p<0.01$; *** $p<0.001$.

Table 20 shows the results of four multivariate logistic regressions. There is a logistic regression model for each of the three factors, adjusting for covariates, and there is a Final Model that includes all three factors simultaneously. Covariates include gender, age, race/ethnicity, income, and self-rated health. Individuals who reported having high levels of everyday discrimination had 1.46 times higher odds of ever being diagnosed with asthma than those who reported low levels of everyday discrimination (OR = 1.46, 95% CI [1.06, 2.03]). Respondents with at least two economic hardships in the past 12 months had 1.89 times higher odds of ever being diagnosed with asthma in comparison with respondents with less than two economic hardships (OR = 1.89, 95% CI [1.36, 2.81]). Participants with at least two major experiences of discrimination had 2.42 times higher odds of ever being diagnosed with asthma than those who reported having less than two major experiences of discrimination (OR = 2.23, 95% CI [1.57, 3.18]). In the

Final Model with the three factors entered simultaneously, only socioeconomic hardship (OR = 1.63, 95% CI [1.15, 2.30]) and major experiences of discrimination (OR = 1.98, 95% CI [1.32, 2.97]) remained significant. Everyday discrimination was no longer significant.

Table 20. Results of Four Multivariate Logistic Models for Ever Diagnosed with Asthma (n=1,238)

Variable	Everyday Discrimination		Socioeconomic Hardship		Major Experience of Discrimination		Final Model	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Everyday Discrimination	1.46*	[1.06, 2.03]	-	-	-	-	0.97	[0.70, 1.42]
Socioeconomic Hardship	-	-	1.89***	[1.36, 2.61]	-	-	1.63**	[1.15, 2.30]
Major Experience of Discrimination	-	-	-	-	2.23***	[1.57, 3.18]	1.98**	[1.32, 2.97]

Note. *p<0.05; ** p<0.01; *** p<0.001. Adjusted for gender, age, race/ethnicity, income, and self-rated health. Full model can be found in Appendix B.

Discussion

This study suggests that acts of discrimination that are perceived daily and major life experiences of discrimination are distinct and linked to ever being diagnosed with asthma. Moreover, major experiences of discrimination and economic hardships are strongly linked to ever being diagnosed with asthma, adjusted for covariates across racial/ethnic groups in a non-white sample. To the best of my knowledge, this is the first study to simultaneously examine perceived discrimination, major experiences of discrimination, and economic hardships in association with asthma in California's San Joaquin Valley.

Major experiences of discrimination represent denial of life opportunities for upward mobility either economically or socially. This study defined major experiences of discrimination as self-reported events of being denied opportunity toward employment, promotion, renting or buying a home in a desirable neighborhood, and remaining in a neighborhood because neighbors made life uncomfortable. Researchers have made progress in uncovering potential mechanisms along the pathway of discrimination and poor health outcomes among African American populations. One study (de Mendoza et al., 2018) found that among African American women, major life discrimination was associated with DNA methylation at sites that are disease-associated genes including asthma. A review by Legaki, Arsenis, Taka, and Papadopoulos suggests that researchers are well on their way toward identifying specific genes and DNA methylation regions (CpG) that link gene-environment interactions with asthma-related outcomes (Legaki et al., 2022). Researchers who have focused on physiological and psychosocial processes suggest that allostatic load, the accumulation of wear and tear on adaptive physiological

processes (Carlson & Chamberlain, 2005), is predictive of asthma-related events (Hassan, 2021; Kern, 2022). For example, Hassan (2021) showed that having high allostatic load was associated with 28% higher odds of reporting asthma, adjusting for covariates in a logistic regression.

Much of the literature on discrimination and health has focused on interpersonal discrimination, an adverse discriminatory act between individuals. The current study finds that interpersonal discrimination (i.e., perceived discrimination in this article) is positively correlated with ever being diagnosed with asthma. However, after adjusting for major experiences of discrimination and economic hardships the relationship between perceived discrimination and asthma was no longer significant. Thakur et al. conducted a case-control study on perceived discrimination associated with asthma among minority youth (Thakur et al., 2017). They found that among African Americans there was a 78% increase in odds of experiencing asthma in comparison to those who did not report discrimination. Although the authors did not find the same relationship among Hispanic/Latino children, they did find that discrimination increased the odds of having asthma among low and high socioeconomic status Mexican youth. The study by Thakur et al. (2017) is stronger in design than the current study. There are notable differences including that they recruited youth from large metropolitan cities across the United States and Puerto Rico as compared to adults in the San Joaquin Valley and they could not measure major life experiences of discrimination because the sample were composed of youth as compared to adults who have been potentially denied loans.

In comparison to NH Black/African American persons, a larger proportion of NH American Indians/Alaskan Natives and NH Asians reported a high level of perceived

discrimination (52.1%, 55.1%, 58.3%, respectively) and major experiences of discrimination (42.7%, 45.4%, 51.1%, respectively). The scientific literature largely suggests that experiences of racism or discrimination among African Americans is higher than other racial/ethnic groups and is more frequent (Kessler et al., 1999; Thompson, 2002). However, there is evidence and documentation of racism toward Chinese and Hmong (Gee, 2008; Gee et al., 2009; Hein, 2000; Swartz et al., 2022) populations even prior to the COVID-19-related discriminatory acts throughout the pandemic (Choi & Lee, 2021; Gover et al., 2020). It is plausible that the increase in recent violence toward Asian Americans explains the high levels of reported discrimination among this population and there is a long history in the region of systemic oppression toward many Asian groups from the building of the railroads (Chacon, 1988), redlining (Brooks, 2009), internment camps (Lau-Ozawa, 2019), and more recently refugee camps (Ali, 2021).

American Indians and Alaskan Native were the only racial/ethnic group who had a significant and positive association with asthma when adjusting for everyday discrimination and economic hardships. American Indians and Alaskan Natives were the second largest racial/ethnic group to report a high level of everyday discrimination and major life experiences of discrimination suggesting that this population contributes to the effect observed between major life experiences of discrimination and asthma. One study showed the multiracial American Indians/Alaskan Natives reported a higher prevalence of lifetime asthma and current asthma than single race American Indians/Alaskan Natives. Moreover, multiracial American Indians/Alaskan Natives who identified as Latinx had 1.77 (95% CI 1.08 – 2.94) probability of currently having asthma than non-Latinx American Indians/Alaskan Natives.

This study shows that Hispanic/Latinx individuals reported relatively low levels of perceived discrimination, major life experiences of discrimination, and asthma. Among Hispanics/Latinos there may be buffering effects of population majority and ethnic identity. A meta-analysis of 51 studies showed that ethnic/racial identity among Latinx individuals worked to buffer the negative effects of discrimination on adjustment outcomes (Yip et al., 2019). The risk of asthma might depend on nativity and acculturation. It has been shown that US-born Mexican Americans have higher rates of asthma in comparison to Mexican-born Mexican Americans (Sy & Ditto, 2020). A study by Cagney (Cagney et al., 2007) showed that foreign-born Latinx populations have low rates of asthma in concentrated enclaves. Recent research has documented the need to understand intra-ethnic asthma disparities among Mexican Americans where Black Mexicans have been shown to have significant greater risk for asthma than their White counterparts (Marquez-Velarde, 2020).

Limitations

Self-report measures are limited to what the respondent is willing to share. Participant responses may be shaped by fear, social desirability, trauma, internalized oppression, and lack of knowledge. There is the possibility of participants from the privileged group to report reverse discrimination that represents a reduction in privilege. This study does not adjust for smoking and is highly associated with asthma prevalence in the American Indian and Alaskan Native population (Sy & Ditto, 2020).

Study 1 Appendix

Cronbach's alpha is reported for each scale to illustrate internal consistency. Alpha item deleted is the Cronbach's alpha given that the specific item is not included in the overall scale. Item-test correlation shows the Pearson's correlation of an item with the overall scale. Item-rest shows the correlation of the item with the scale of all other items.

Table 21. Internal Consistency of Scales and Items (n=1,238)

Scale and Item	alpha	alpha if item deleted	Item-test corr.	Item-rest corr.	Average interitem covariance
Everyday Discrimination	0.89	-	-	-	0.56
I am treated with less courtesy than other people		0.85	0.86	0.75	0.6
I receive poorer service than other people at restaurants or stores		0.84	0.88	0.78	0.59
People act as if I am not smart		0.85	0.86	0.75	0.58
People act as if I am not as good as they are		0.86	0.85	0.73	0.59
Socioeconomic Hardship Scale	0.60	-	-	-	0.06
Within the past 12 months had trouble paying for food		0.52	0.71	0.39	0.04
Within the past 12 months had trouble paying for utilities		0.49	0.73	0.42	0.04
Within the past 12 months had trouble paying for transportation		0.57	0.54	0.33	0.06
Within the past 12 months had trouble paying for housing		0.51	0.7	0.4	0.04
Major Experience of Discrimination Scale	0.42	-	-	-	0.01
I was not hired for a job		0.31	0.72	0.27	0.01
I was not given a promotion		0.26	0.68	0.31	0.01
I was prevented from renting or buying a home in the neighborhood you wanted		0.39	0.51	0.18	0.02
I was prevented from remaining in a neighborhood because neighbors made life so uncomfortable		0.39	0.47	0.18	0.02

Table 22. Pearson's r Correlations (n=1,238)

Variable	Asthma	Major Experience of Discrimination Scale	Everyday Discrimination
Major Experience of Discrimination Scale	0.106*		
Socioeconomic Hardship Scale	0.083	0.223*	
Everyday Discrimination	0.072	0.352*	0.258*

Note. *p<0.001.

Table 23. Results of Four Multivariate Logistic Regressions for Ever Diagnosed with Asthma (n=1,238)

Variable	Everyday Discrimination		Economic Hardship		Major Experiences of Discrimination		Full Model	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Female	1.45**	1.00 - 2.10	1.47**	1.01 - 2.13	1.59**	1.09 - 2.33	1.64**	1.12 - 2.40
Age Group								
18 to 24	1.63*	0.95 - 2.82	1.66*	0.96 - 2.86	1.65*	0.95 - 2.84	1.66*	0.96 - 2.87
25 to 34								
35 to 54	1.60**	1.06 - 2.40	1.62**	1.08 - 2.43	1.74**	1.15 - 2.63	1.78***	1.17 - 2.69
55+	1.37	0.84 - 2.24	1.40	0.85 - 2.29	1.52	0.92 - 2.50	1.57*	0.95 - 2.60
Race/Ethnicity								
Hispanic/Latino	Ref							
Asian	0.67	0.34 - 1.31	0.73	0.37 - 1.43	0.63	0.32 - 1.24	0.65	0.33 - 1.28
American Indian/Alaska Native	1.61*	0.92 - 2.82	1.66*	0.95 - 2.91	1.46	0.83 - 2.58	1.46	0.83 - 2.59
Black/African American	1.34	0.77 - 2.34	1.42	0.82 - 2.46	1.21	0.69 - 2.12	1.23	0.70 - 2.16
Other Race/Ethnicity	0.79	0.52 - 1.22	0.79	0.51 - 1.21	0.80	0.52 - 1.23	0.80	0.52 - 1.23
Income								
< $34,999								
$35k to $99,999	1.17	0.83 - 1.65	1.24	0.87 - 1.76	1.08	0.76 - 1.54	1.16	0.81 - 1.65
> $100k	1.24	0.77 - 2.00	1.47	0.91 - 2.39	1.22	0.75 - 1.96	1.38	0.85 - 2.25
Self-Rated Health	0.79***	0.68 - 0.91	0.80***	0.70 - 0.93	0.79***	0.69 - 0.91	0.81***	0.70 - 0.93
Perceived Discrimination	1.46**	1.06 - 2.03					0.97	0.66 - 1.42
Economic Hardship			1.89***	1.36 - 2.61			1.63***	1.15 - 2.30
Major Experiences of Discrimination					2.23***	1.57 - 3.18	1.98***	1.32 - 2.97
Constant	0.17*	0.08 -	0.13	0.07 -	0.14*	0.07 -	0.11	0.05 -

	**	0.33	***	0.26	**	0.27	***	0.22

*** p<0.01, ** p<0.05,
* p<0.1

Chapter 6. Conclusion

In summation, this dissertation shows that discriminatory acts are associated with poor asthma outcomes at multiple levels. Study 1 demonstrates that communities with poor housing quality are associated with increased rates of asthma-related ED visits. Study 2 takes this idea a bit further by introducing environmental justice measures of air pollution and environmental degradation. The major finding is that air pollution and environmental degradation are independently and strongly associated with asthma-related ED visits. Study 3 demonstrates that the denial of a mortgage loan, job promotion, or other ways to amass wealth is associated with an increased risk of being diagnosed with asthma. In turn, the denial of mortgage loan and economic opportunities tend to confine the neighborhoods that one can live in.

This dissertation demonstrates that easy-to-access measures such as the median year of housing structures built in a census tract can be used as a proxy for depravation sites and risk for poor asthma outcomes. Although there is a need to complete in-depth longitudinal cohort studies to establish causality, there is enough evidence to suggest that housing quality increases the risk of poor asthma outcomes, and not in reverse order. Similarly, measures of air pollution and environmental degradation were used from easy-to-access publicly available data sources. In addition to the current literature on environmental hazards and health, this study shows that spatial variation in air pollution and environmental hazards have independent effects on asthma above measures of socioeconomic status. Research translation is needed to connect the effects of air pollution and environmental hazards for community members to readily access this vital

information and use it to inform elected officials on the impacts to health. Lastly, more research should be conducted on understanding how person-level discriminatory acts have forced individuals to live in unfavorable communities with elevated levels of poor housing quality and environmental toxins. Methods to isolate policies enacted at the federal, state, and local levels as well as those that are enacted at the same time need to be enhanced. The causal relationship between enacted policies and health inequities is vague and most likely small given modern techniques to estimate effect sizes.

Table 24 describes policy implications that result from the major findings of each study. Major findings from this dissertation suggest that affordable quality housing should be made available to all Californians to promote the reduction of asthma. Furthermore, affordably housing should be equitably distributed across communities of affluence so that educational and economic opportunities can be more readily available to low-income populations. Equitable distribution of housing resources would also alleviate exposure to toxins from air pollution and environmental degradation sites because affluent communities tend to have better quality air and are situated further away from cleanup sites. Lastly, at the person-level, training opportunities on discrimination/implicit bias would help to reduce exposure to interpersonal discriminatory acts and may reduce microaggressions based on racial/ethnic composition.

Study Number	Policy Implication
Study 1	-Affordable housing distributed across Californian neighborhoods to promote social opportunities that may help to reduce asthma ED visits. -Affordable housing opportunities distributed across Californian school districts to promote equitable educational opportunities that may help to reduce asthma ED visits. -Employment opportunities equitably distributed across Californian Communities. -Develop neighborhood screening tool for communities at risk for poor asthma outcomes.
Study 2	-Affordable housing distributed across Californian neighborhoods to promote social opportunities that may help to reduce asthma -Affordable housing opportunities distributed across. Californian school districts to promote equitable educational opportunities that may help to reduce asthma ED visits -Employment opportunities equitably distributed across Californian Communities. -Develop neighborhood screening tool for communities at risk for poor asthma outcomes. -Training opportunities on discrimination and health for community residents.
Study 3	-Training opportunities on discrimination and health for community residents. -Discrimination/implicit bias training in school. -Develop household screening tool for in home asthma preventive programming.

References

Abraido-Lanza, A. F., Dohrenwend, B. P., Ng-Mak, D. S., & Turner, J. B. (1999). The Latino mortality paradox: a test of the" salmon bias" and healthy migrant hypotheses. *American Journal of Public Health*, *89*(10), 1543–1548.

Akinbami, L. J., Bailey, C. M., Johnson, C. A., King, M. E., Liu, X., Moorman, J. E., & Zahran, H. S. (2012). *Trends in asthma prevalence, health care use, and mortality in the United States, 2001-2010*.

Akinbami, L. J., Moorman, J. E., Simon, A. E., & Schoendorf, K. C. (2014). Trends in racial disparities for asthma outcomes among children 0 to 17 years, 2001-2010. *Journal of Allergy and Clinical Immunology*, *134*(3), 547–553.

Akinbami, L. J., & Schoendorf, K. C. (2002). Trends in childhood asthma: prevalence, health care utilization, and mortality. *Pediatrics*, *110*(2), 315–322.

Akinbami, L. J., Simon, A. E., & Rossen, L. M. (2016). Changing trends in asthma prevalence among children. *Pediatrics*, *137*(1), e20152354.

Alcala, E., Cisneros, R., & Capitman, J. A. (2017). Health care access, concentrated poverty, and pediatric asthma hospital care use in California's San Joaquin Valley: A multilevel approach. *Journal of Asthma*. https://doi.org/10.1080/02770903.2017.1409234

Alcala, Emanuel, Brown, P., Capitman, J. A., Gonzalez, M., & Cisneros, R. (2019). Cumulative Impact of Environmental Pollution and Population Vulnerability on Pediatric Asthma Hospitalizations: A Multilevel Analysis of CalEnviroScreen. *INTERNATIONAL JOURNAL OF ENVIRONMENTAL RESEARCH AND PUBLIC HEALTH*, *16*(15). https://doi.org/10.3390/ijerph16152683

Alcala, Emanuel, Brown, P., Capitman, J. A., Gonzalez, M., Cisneros, R., Mendell, M. J., Kumagai, K., Feng, X., & Astell-Burt, T. (2017). Cumulative Impact of Environmental Pollution and Population Vulnerability on Pediatric Asthma Hospitalizations: A Multilevel Analysis of CalEnviroScreen. *INTERNATIONAL JOURNAL OF ENVIRONMENTAL RESEARCH AND PUBLIC HEALTH*, *14*(5), 506–517. https://doi.org/10.3390/ijerph14050543

Alcala, Emanuel, Cisneros, R., & Capitman, J. A. (2017). Health care access, concentrated poverty, and pediatric asthma hospital care use in California's San Joaquin Valley: A multilevel approach. *Journal of Asthma*, 1–9.

Alexander, D., & Currie, J. (2017). Is it who you are or where you live? Residential segregation and racial gaps in childhood asthma. *Journal of Health Economics*, *55*, 186–200.

Ali, F. S. (2021). The conditions of Lao Hmong refugees in Thailand and the United States of America during the term (1975-1995). *Journal of Social Sciences and Humanities Research*, *9*(02), 1–10.

American Community Survey 1-Year Estimates Selected Population Profiles. (2021). https://data.census.gov/cedsci/table?t=-00&g=0400000US06&tid=ACSSPP1Y2021.S0201

Ayón, C. (2015). Economic, social, and health effects of discrimination on Latino immigrant families. *Migration Policy Institute*.

Barnett, S. B. L., & Nurmagambetov, T. A. (2011). Costs of asthma in the United States: 2002-2007. *Journal of Allergy and Clinical Immunology*, *127*(1), 145–152.

Beck, A. F., Huang, B., Chundur, R., & Kahn, R. S. (2014). Housing code violation density associated with emergency department and hospital use by children with asthma. *Health Affairs*, *33*(11), 1993–2002.

Belova, A., Fann, N., Haskell, J., Hubbell, B., & Narayan, T. (2020). Estimating lifetime cost of illness. An application to asthma. *Annals of the American Thoracic Society*, *17*(12), 1558–1569.

Benka-Coker, W., Hoskovec, L., Severson, R., Balmes, J., Wilson, A., & Magzamen, S. (2020). The joint effect of ambient air pollution and agricultural pesticide exposures on lung function among children with asthma. *Environmental Research*, *190*, 109903.

Bhan, N., Kawachi, I., Glymour, M. M., & Subramanian, S. V. (2015). Time trends in racial and ethnic disparities in asthma prevalence in the United States from the Behavioral Risk Factor Surveillance System (BRFSS) Study (1999–2011). *American Journal of Public Health*, *105*(6), 1269–1275.

Bose, S., Madrigano, J., & Hansel, N. N. (2022). When Health Disparities Hit Home: Redlining Practices, Air Pollution, and Asthma. *American Journal of Respiratory and Critical Care Medicine*, *ja*.

Bradman, A., Chevrier, J., Tager, I., Lipsett, M., Sedgwick, J., Macher, J., Vargas, A. B., Cabrera, E. B., Camacho, J. M., & Weldon, R. (2005). Association of housing disrepair indicators with cockroach and rodent infestations in a cohort of pregnant Latina women and their children. *Environmental Health Perspectives*, *113*(12), 1795–1801.

Braman, S. S. (2006). The global burden of asthma. *Chest*, *130*(1), 4S-12S.

Branch, C. D. of P. H. E. H. I. (n.d.). *California Asthma Dashboard*. Retrieved September 7, 2022, from https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/EHIB/CPE/Pages/CaliforniaBreathingCountyAsthmaProfiles.aspx

Brooks, C. (2009). Alien Neighbors, Foreign Friends. In *Alien Neighbors, Foreign Friends*. University of Chicago Press.

Bryant-Stephens, T. C., Strane, D., Robinson, E. K., Bhambhani, S., & Kenyon, C. C. (2021). Housing and asthma disparities. *Journal of Allergy and Clinical*

Immunology, *148*(5), 1121–1129.

Cabieses, B., Uphoff, E., Pinart, M., Antó, J. M., & Wright, J. (2014). A systematic review on the development of asthma and allergic diseases in relation to international immigration: the leading role of the environment confirmed. *PloS One*, *9*(8), e105347.

Cagney, K. A., & Browning, C. R. (2004a). Exploring Neighborhood-level Variation in Asthma and other Respiratory Diseases. *Journal of General Internal Medicine*, *19*(3), 229–236.

Cagney, K. A., & Browning, C. R. (2004b). Exploring Neighborhood-level Variation in Asthma and other Respiratory Diseases. *Journal of General Internal Medicine*, *19*(3), 229–236.

Cagney, K. A., Browning, C. R., & Wallace, D. M. (2007). The Latino paradox in neighborhood context: the case of asthma and other respiratory conditions. *American Journal of Public Health*, *97*(5), 919–925.

Camacho-Rivera, M., Kawachi, I., Bennett, G. G., & Subramanian, S. V. (2014). Perceptions of Neighborhood Safety and Asthma among Children and Adolescents in Los Angeles: A Multilevel Analysis. *PLOS ONE*, *9*(1). https://doi.org/10.1371/journal.pone.0087524

Camacho-Rivera, M., Kawachi, I., Bennett, G. G., & Subramanian, S. V. (2015). Revisiting the Hispanic Health Paradox: The Relative Contributions of Nativity, Country of Origin, and Race/Ethnicity to Childhood Asthma. *JOURNAL OF IMMIGRANT AND MINORITY HEALTH*, *17*(3), 826–833. https://doi.org/10.1007/s10903-013-9974-6

Cantu, P., Kim, Y., Sheehan, C., Powers, D., Margerison, C. E., & Cubbin, C. (2019). Downward Neighborhood Poverty Mobility during Childhood Is Associated with Child Asthma: Evidence from the Geographic Research on Wellbeing (GROW) Survey. *JOURNAL OF URBAN HEALTH-BULLETIN OF THE NEW YORK ACADEMY OF MEDICINE*, *96*(4), 558–569. https://doi.org/10.1007/s11524-019-00356-2

Carlson, E. D., & Chamberlain, R. M. (2005). Allostatic load and health disparities: a theoretical orientation. *Research in Nursing & Health*, *28*(4), 306–315.

Carpenter, D. O., Ma, J., & Lessner, L. (2008). Asthma and infectious respiratory disease in relation to residence near hazardous waste sites. *Annals of the New York Academy of Sciences*, *1140*(1), 201–208.

Carrillo, G., Patron, M. J. P., Johnson, N., Zhong, Y., Lucio, R., & Xu, X. (2018). Asthma prevalence and school-related hazardous air pollutants in the US-Mexico border area. *Environmental Research*, *162*, 41–48.

Chacon, R. D. (1988). The beginning of racial segregation: The Chinese in West Fresno and Chinatown's role as red light district, 1870s-1920s. *Southern California*

Quarterly, *70*(4), 371–398.

Chang, J., Patel, I., Liu, S. T., Ortega, A., Srivastava, J., Park, Y., & Balkrishnan, R. (2011). Disparities in health care utilization among Latino children suffering from asthma in California. *Pediatric Health, Medicine and Therapeutics*, *2*, 1–8.

Chen, E., & Miller, G. E. (2013). Socioeconomic status and health: mediating and moderating factors. *Annual Review of Clinical Psychology*, *9*, 723–749.

Chen, E., Miller, G. E., Walker, H. A., Arevalo, J. M., Sung, C. Y., & Cole, S. W. (2009). Genome-wide transcriptional profiling linked to social class in asthma. *Thorax*, *64*(1), 38–43.

Choi, H. A., & Lee, O. E. (2021). To mask or to unmask, that is the question: Facemasks and anti-asian violence during COVID-19. *Journal of Human Rights and Social Work*, *6*(3), 237–245.

Cisneros, R., Gharibi, H., Entwistle, M. R., Tavallali, P., Singhal, M., & Schweizer, D. (2021). Nitrogen dioxide and asthma emergency department visits in California, USA during cold season (November to February) of 2005 to 2015: A time-stratified case-crossover analysis. *Science of The Total Environment*, *754*, 142089.

Cisneros, R., Gonzalez, M., Brown, P., & Schweizer, D. (2017). Soda consumption and hospital admissions among Californian adults with asthma. *Journal of Asthma*, *54*(4), 371–375.

Collins, T. W., Kim, Y., Grineski, S. E., & Clark-Reyna, S. (2014). Can Economic Deprivation Protect Health? Paradoxical Multilevel Effects of Poverty on Hispanic Children's Wheezing. *INTERNATIONAL JOURNAL OF ENVIRONMENTAL RESEARCH AND PUBLIC HEALTH*, *11*(8), 7856–7873. https://doi.org/10.3390/ijerph110807856

Cushing, L., Faust, J., August, L. M., Cendak, R., Wieland, W., & Alexeeff, G. (2015). Racial/ethnic disparities in cumulative environmental health impacts in California: evidence from a statewide environmental justice screening tool (CalEnviroScreen 1.1). *American Journal of Public Health*, *105*(11), 2341–2348.

Dannemiller, K C, Gent, J. F., Leaderer, B. P., & Peccia, J. (2016). Influence of housing characteristics on bacterial and fungal communities in homes of asthmatic children. *Indoor Air*, *26*(2), 179–192. https://doi.org/10.1111/ina.12205

Dannemiller, Karen C, Mendell, M. J., Macher, J. M., Kumagai, K., Bradman, A., Holland, N., Harley, K., Eskenazi, B., & Peccia, J. (2014). Next-generation DNA sequencing reveals that low fungal diversity in house dust is associated with childhood asthma development. *Indoor Air*, *24*(3), 236–247.

de Mendoza, V. B., Huang, Y., Crusto, C. A., Sun, Y. V, & Taylor, J. Y. (2018). Perceived racial discrimination and DNA methylation among African American women in the InterGEN study. *Biological Research for Nursing*, *20*(2), 145–152.

Delfino, R. J., Wu, J., Tjoa, T., Gullesserian, S. K., Nickerson, B., & Gillen, D. L. (2014). Asthma morbidity and ambient air pollution: effect modification by residential traffic-related air pollution. *Epidemiology, 25*(1), 48–57.

Din, A., & Wilson, R. (2020). Crosswalking ZIP codes to census geographies: geoprocessing the US Department of Housing & Urban Development's ZIP code crosswalk files. *UMBC Geography and Environmental Systems Department*.

Entwistle, M. R., Gharibi, H., Tavallali, P., Cisneros, R., Schweizer, D., Brown, P., & Ha, S. (2019). Ozone pollution and asthma emergency department visits in Fresno, CA, USA, during the warm season (June–September) of the years 2005 to 2015: a time-stratified case-crossover analysis. *Air Quality, Atmosphere & Health*, *12*(6), 661–672.

Gage, L. (2006). Comparison of census 2000 and American community survey 1999–2001 estimates: San Francisco and Tulare Counties, California. *Population Research and Policy Review*, *25*(3), 243–256.

Galanter, J. M., Gignoux, C. R., Oh, S. S., Torgerson, D., Pino-Yanes, M., Thakur, N., Eng, C., Hu, D., Huntsman, S., & Farber, H. J. (2017). Differential methylation between ethnic sub-groups reflects the effect of genetic ancestry and environmental exposures. *Elife*, *6*, e20532.

Gale, S. L., Noth, E. M., Mann, J., Balmes, J., Hammond, S. K., & Tager, I. B. (2012). Polycyclic aromatic hydrocarbon exposure and wheeze in a cohort of children with asthma in Fresno, CA. *Journal of Exposure Science & Environmental Epidemiology*, *22*(4), 386–392.

Gee, G. C. (2008). A multilevel analysis of the relationship between institutional and individual racial discrimination and health status. *American Journal of Public Health*, *98*(Supplement_1), S48–S56.

Gee, G. C., Ro, A., Shariff-Marco, S., & Chae, D. (2009). Racial discrimination and health among Asian Americans: evidence, assessment, and directions for future research. *Epidemiologic Reviews*, *31*(1), 130–151.

Gharibi, H., Entwistle, M. R., Ha, S., Gonzalez, M., Brown, P., Schweizer, D., & Cisneros, R. (2019). Ozone pollution and asthma emergency department visits in the Central Valley, California, USA, during June to September of 2015: a time-stratified case-crossover analysis. *Journal of Asthma*, *56*(10), 1037–1048.

Gold, D. R., & Acevedo-Garcia, D. (2005). Immigration to the United States and acculturation as risk factors for asthma and allergy. *Journal of Allergy and Clinical Immunology*, *116*(1), 38.

Gover, A. R., Harper, S. B., & Langton, L. (2020). Anti-Asian hate crime during the COVID-19 pandemic: Exploring the reproduction of inequality. *American Journal of Criminal Justice*, *45*(4), 647–667.

Grant, T., Croce, E., & Matsui, E. C. (2022). Asthma and the social determinants of

health. *Annals of Allergy, Asthma & Immunology*, *128*(1), 5–11.

Gupta, R. S., Carrión-Carire, V., & Weiss, K. B. (2006). The widening black/white gap in asthma hospitalizations and mortality. *Journal of Allergy and Clinical Immunology*, *117*(2), 351–358.

Hassan, M. M. (2021). *The Predictive Relationship of Allostatic Load in Asthma*. Walden University.

Health, C. D. of P. (2019). *Asthma ED visit rates in California, by age or race/ethnicity*. https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/EHIB/CPE/Pages/CaliforniaBreathingCountyAsthmaProfiles.aspx

Hein, J. (2000). Interpersonal discrimination against Hmong Americans: parallels and variation in microlevel racial inequality. *Sociological Quarterly*, *41*(3), 413–429.

Heintzman, J., Ezekiel-Herrera, D., Bailey, S. R., Garg, A., Lucas, J., Suglia, S., Cowburn, S., Puro, J., & Marino, M. (2022). Latino-white disparities in ICD-coded asthma diagnosis among US children. *Journal of Asthma*, *59*(3), 514–522.

Hossain, R., Zhao, F., Michenkova, M., Kaelber, D., & Tarabichi, Y. (2022). Trends in racial disparities of emergency department utilization for asthma in coronavirus disease 2019. *Annals of Allergy, Asthma & Immunology*, *128*(1), 95–97.

Huang, G., & London, J. K. (2012). Cumulative environmental vulnerability and environmental justice in California's San Joaquin Valley. *International Journal of Environmental Research and Public Health*, *9*(5), 1593–1608.

Iqbal, S., Oraka, E., Chew, G. L., & Flanders, W. D. (2014). Association between birthplace and current asthma: the role of environment and acculturation. *American Journal of Public Health*, *104 Suppl*, S175-82. https://doi.org/10.2105/AJPH.2013.301509

Keet, C. A., McCormack, M. C., Pollack, C. E., Peng, R. D., McGowan, E., & Matsui, E. C. (2015). Neighborhood poverty, urban residence, race/ethnicity, and asthma: Rethinking the inner-city asthma epidemic. *Journal of Allergy and Clinical Immunology*, *135*(3), 655–662.

Kern, V. (2022). *Perceived Discrimination as a Moderator of the Relationship Between Allostatic Load and Asthma Control*. Walden University.

Kessler, R. C., Mickelson, K. D., & Williams, D. R. (1999). The prevalence, distribution, and mental health correlates of perceived discrimination in the United States. *Journal of Health and Social Behavior*, 208–230.

Kim, J.-O., Ahtola, O., Spector, P. E., Kim, J.-O., & Mueller, C. W. (1978). *Introduction to factor analysis: What it is and how to do it* (Issue 13). Sage.

Kneebone, E., & Holmes, N. (2016). Concentrated poverty in the wake of the Great Recession. *Brookings. Available at: Https://Www. Brookings. Edu/Research/Us-Concentrated-Poverty-in-Thewake-of-the-Great-Recession*.

Koinis-Mitchell, D., Sato, A. F., Kopel, S. J., McQuaid, E. L., Seifer, R., Klein, R., Esteban, C., Lobato, D., Ortega, A. N., Canino, G., & Fritz, G. K. (2011). Immigration and Acculturation-Related Factors and Asthma Morbidity in Latino Children. *JOURNAL OF PEDIATRIC PSYCHOLOGY*, *36*(10), 1130–1143. https://doi.org/10.1093/jpepsy/jsr041

Krieger, N. (2001). Theories for social epidemiology in the 21st century: an ecosocial perspective. *International Journal of Epidemiology*, *30*(4), 668–677.

Krieger, N. (2019). Measures of Racism, Sexism, Heterosexism, and Gender Binarism for Health Equity Research: From Structural Injustice to Embodied Harm-An Ecosocial Analysis. *Annual Review of Public Health*, *41*, 37–62.

Lago, S., Cantarero, D., Rivera, B., Pascual, M., Blázquez-Fernández, C., Casal, B., & Reyes, F. (2018). Socioeconomic status, health inequalities and non-communicable diseases: a systematic review. *Journal of Public Health*, *26*(1), 1–14.

Lane, H. M., Morello-Frosch, R., Marshall, J. D., & Apte, J. S. (2022). Historical redlining is associated with present-day air pollution disparities in US cities. *Environmental Science & Technology Letters*, *9*(4), 345–350.

Lau-Ozawa, K. (2019). Dissonant memories of Japanese American incarceration. *International Journal of Heritage Studies*, *25*(7), 656–670.

Legaki, E., Arsenis, C., Taka, S., & Papadopoulos, N. G. (2022). DNA methylation biomarkers in asthma and rhinitis: Are we there yet? *Clinical and Translational Allergy*, *12*(3), e12131.

Lievanos, R. S. (2019). Racialized Structural Vulnerability: Neighborhood Racial Composition, Concentrated Disadvantage, and Fine Particulate Matter in California. *INTERNATIONAL JOURNAL OF ENVIRONMENTAL RESEARCH AND PUBLIC HEALTH*, *16*(17). https://doi.org/10.3390/ijerph16173196

Liévanos, R. S. (2018). Retooling CalEnviroScreen: Cumulative pollution burden and race-based environmental health vulnerabilities in California. *International Journal of Environmental Research and Public Health*, *15*(4), 762.

Lin, Z., Zhao, Z., Xu, H., Zhang, X., Wang, T., Kan, H., & Norback, D. (2015). Home Dampness Signs in Association with Asthma and Allergic Diseases in 4618 Preschool Children in Urumqi, China-The Influence of Ventilation/Cleaning Habits. *PloS One*, *10*(7), e0134359. https://doi.org/10.1371/journal.pone.0134359

London, J., Huang, G., & Zagofsky, T. (2011). Land of risk/land of opportunity: Cumulative environmental vulnerability in California's San Joaquin valley. *Davis, CA: UC Davis Center for Regional Change*.

Ma, J., Kouznetsova, M., Lessner, L., & Carpenter, D. O. (2007). Asthma and infectious respiratory disease in children–correlation to residence near hazardous waste sites. *Paediatric Respiratory Reviews*, *8*(4), 292–298.

Mann, J. K., Balmes, J. R., Bruckner, T. A., Mortimer, K. M., Margolis, H. G., Pratt, B., Hammond, S. K., Lurmann, F. W., & Tager, I. B. (2010). Short-term effects of air pollution on wheeze in asthmatic children in Fresno, California. *Environmental Health Perspectives*, *118*(10), 1497–1502.

Markides, K. S., & Coreil, J. (1986). The health of Hispanics in the southwestern United States: an epidemiologic paradox. *Public Health Reports*, *101*(3), 253.

Marmot, M. G., Rose, G., Shipley, M., & Hamilton, P. J. (1978). Employment grade and coronary heart disease in British civil servants. *Journal of Epidemiology & Community Health*, *32*(4), 244–249.

Marquez-Velarde, G. (2020). The paradox does not fit all: Racial disparities in asthma among Mexican Americans in the US. *Plos One*, *15*(11), e0242855.

Martinez, A., de la Rosa, R., Mujahid, M., & Thakur, N. (2021). Structural racism and its pathways to asthma and atopic dermatitis. *Journal of Allergy and Clinical Immunology*, *148*(5), 1112–1120.

Mock, K. A. (2021). *The Effects of Industrial Zone Proximity on Pediatric Asthma and Academic Outcomes in a Predominately Latino, Low Income Community in Southern California*. University of California, Irvine.

Nardone, A., Casey, J. A., Morello-Frosch, R., Mujahid, M., Balmes, J. R., & Thakur, N. (2020). Associations between historical residential redlining and current age-adjusted rates of emergency department visits due to asthma across eight cities in California: an ecological study. *The Lancet Planetary Health*, *4*(1), e24–e31.

Nardone, A., Rudolph, K. E., Morello-Frosch, R., & Casey, J. A. (2021). Redlines and greenspace: the relationship between historical redlining and 2010 greenspace across the United States. *Environmental Health Perspectives*, *129*(1), 17006.

Neophytou, A. M., White, M. J., Oh, S. S., Thakur, N., Galanter, J. M., Nishimura, K. K., Pino-Yanes, M., Torgerson, D. G., Gignoux, C. R., & Eng, C. (2016). Air pollution and lung function in minority youth with asthma in the GALA II (Genes–Environments and Admixture in Latino Americans) and SAGE II (Study of African Americans, Asthma, Genes, and Environments) studies. *American Journal of Respiratory and Critical Care Medicine*, *193*(11), 1271–1280.

Oh, S. S., White, M. J., Gignoux, C. R., & Burchard, E. G. (2016). Making precision medicine socially precise. Take a deep breath. In *American journal of respiratory and critical care medicine* (Vol. 193, Issue 4, pp. 348–350). American Thoracic Society.

Osgood, D. W. (2000). Poisson-based regression analysis of aggregate crime rates. *Journal of Quantitative Criminology*, *16*(1), 21–43.

Perry, R., Braileanu, G., Palmer, T., & Stevens, P. (2018). The Economic Burden of Pediatric Asthma in the United States: Literature Review of Current Evidence. *PharmacoEconomics*, 1–13.

Raanan, R., Harley, K. G., Balmes, J. R., Bradman, A., Lipsett, M., & Eskenazi, B. (2015). Early-life exposure to organophosphate pesticides and pediatric respiratory symptoms in the CHAMACOS cohort. *Environmental Health Perspectives*, *123*(2), 179–185. https://doi.org/10.1289/ehp.1408235

Reiss, F. (2013). Socioeconomic inequalities and mental health problems in children and adolescents: a systematic review. *Social Science & Medicine*, *90*, 24–31.

Rosenbaum, E. (2008). Racial/ethnic differences in asthma prevalence: the role of housing and neighborhood environments. *Journal of Health and Social Behavior*, *49*(2), 131–145.

Rothstein, R. (2017). *The color of law: A forgotten history of how our government segregated America*. Liveright Publishing.

Saha, C., Riner, M. E., & Liu, G. (2005). Individual and neighborhood-level factors in predicting asthma. *Archives of Pediatrics & Adolescent Medicine*, *159*(8), 759–763.

Salari, K., Choudhry, S., Tang, H., Naqvi, M., Lind, D., Avila, P. C., Coyle, N. E., Ung, N., Nazario, S., & Casal, J. (2005). Genetic admixture and asthma-related phenotypes in Mexican American and Puerto Rican asthmatics. *Genetic Epidemiology: The Official Publication of the International Genetic Epidemiology Society*, *29*(1), 76–86.

Schwartz, N. A., von Glascoe, C. A., Torres, V., Ramos, L., & Soria-Delgado, C. (2015). "Where they (live, work and) spray": Pesticide exposure, childhood asthma and environmental justice among Mexican-American farmworkers. *Health & Place*, *32*, 83–92.

Stern, J., Pier, J., & Litonjua, A. A. (2020). Asthma epidemiology and risk factors. *Seminars in Immunopathology*, *42*(1), 5–15.

Strina, A., Barreto, M. L., Cooper, P. J., & Rodrigues, L. C. (2014). Risk factors for non-atopic asthma/wheeze in children and adolescents: a systematic review. *Emerging Themes in Epidemiology*, *11*(1), 5.

Swartz, T. T., Hartmann, D., & Vue, P. L. (2022). Race, ethnicity, and the incorporation experiences of Hmong American young adults: insights from a mixed-method, longitudinal study. *Ethnic and Racial Studies*, *45*(7), 1197–1217.

Sy, H., & Ditto, A. M. (2020). Racial and Ethnic Disparity in Allergic Diseases in the United States: Example of a Large Country with a Diverse Population. In *Health Disparities in Allergic Diseases* (pp. 73–96). Springer.

Tager, I. B., Lurmann, F. W., Haight, T., Alcorn, S., Penfold, B., & Hammond, S. K. (2010). Temporal and spatial patterns of ambient endotoxin concentrations in Fresno, California. *Environmental Health Perspectives*, *118*(10), 1490–1496.

Tavallali, P., Gharibi, H., Singhal, M., Schweizer, D., & Cisneros, R. (2020). A multi-pollutant model: a method suitable for studying complex relationships in

environmental epidemiology. *Air Quality, Atmosphere & Health*, *13*(6), 645–657.

Thakur, N., Barcelo, N. E., Borrell, L. N., Singh, S., Eng, C., Davis, A., Meade, K., LeNoir, M. A., Avila, P. C., & Farber, H. J. (2017). Perceived discrimination associated with asthma and related outcomes in minority youth: the GALA II and SAGE II studies. *Chest*, *151*(4), 804–812.

Thompson, V. L. S. (2002). Racism: perceptions of distress among African Americans. *Community Mental Health Journal*, *38*(2), 111–118.

Toskala, E., & Kennedy, D. W. (2015). Asthma risk factors. *International Forum of Allergy & Rhinology*, *5*(S1), S11–S16.

Uphoff, E., Cabieses, B., Pinart, M., Valdés, M., Antó, J. M., & Wright, J. (2015). A systematic review of socioeconomic position in relation to asthma and allergic diseases. *European Respiratory Journal*, *46*(2), 364–374.

Wang, Z., May, S. M., Charoenlap, S., Pyle, R., Ott, N. L., Mohammed, K., & Joshi, A. Y. (2015). Effects of secondhand smoke exposure on asthma morbidity and health care utilization in children: a systematic review and meta-analysis. *Annals of Allergy, Asthma & Immunology*, *115*(5), 396–401.

Williams, D. R., Gonzalez, H. M., Williams, S., Mohammed, S. A., Moomal, H., & Stein, D. J. (2008). Perceived discrimination, race and health in South Africa. *Social Science & Medicine*, *67*(3), 441–452.

Williams, D. R., Yu, Y., Jackson, J. S., & Anderson, N. B. (1997). Racial differences in physical and mental health: Socio-economic status, stress and discrimination. *Journal of Health Psychology*, *2*(3), 335–351.

Wilson, R., & Din, A. (2018). Understanding and enhancing the US Department of housing and urban development's ZIP code crosswalk files. *Cityscape*, *20*(2), 277–294.

Winquist, A., Kirrane, E., Klein, M., Strickland, M., Darrow, L. A., Sarnat, S. E., Gass, K., Mulholland, J., Russell, A., & Tolbert, P. (2014). Joint effects of ambient air pollutants on pediatric asthma emergency department visits in Atlanta, 1998-2004. *Epidemiology (Cambridge, Mass.)*, *25*(5), 666–673. https://doi.org/10.1097/EDE.0000000000000146

Yip, T., Wang, Y., Mootoo, C., & Mirpuri, S. (2019). Moderating the association between discrimination and adjustment: A meta-analysis of ethnic/racial identity. *Developmental Psychology*, *55*(6), 1274.