Geospatial Analysis of the Association between Food Deserts, Transportation, and Hypertension Prevalence in California

Grant Mendoza, MPH Candidate, Emanuel Alcala, PHD

FRESNO STATE. Central Valley Health Policy Institute

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Background

- In the United States, about 120 million adults are diagnosed with hypertension.
- In California, hypertension prevalence is 27.9%, and a mortality rate of 14.7%.
- Individual-level risk factors
  - Diet, physical activity, and genetics.
- Geospatial risk factors
  - Food deserts w/ transportation, walkability, park access, and urban/rural status at the census tract level.

- Testa (2021) and Suarez (2015) both investigated food deserts and their association with hypertension, but they used individual-level data rather than other community-level measures.
- Green and colleagues (2022) state that future research should focus on community-level socioeconomic status and hypertension prevalence to better understand the determinants of hypertension.
- Koh and colleagues (2022) suggest further research on green spaces and health outcomes to better understand green spaces.

Problem Statement

- There is a significant gap in research in understanding the association of geospatial factors with hypertension prevalence in California at the census tract level.
- To my knowledge, there is no comprehensive study that investigates the combined effects of geospatial factors such as food deserts w/ transportation, walkability, park access, and urban/rural status on hypertension prevalence in California at the census tract level.

Research Question

- Is there an association between hypertension prevalence and geospatial factors such as food deserts w/ transportation, walkability, park access, and urban/rural status in California at the census tract level?

Methods

Databases and Measures
- CDC PLACES
  - Hypertension prevalence **(DV)**
- USDA Food Access Research Atlas
  - Food desert w/ transportation and urban/rural status
- Healthy Places Index 3.0
  - Access to healthcare, park access, race/ethnicity, poverty, education
- American Community Survey
  - Age
- National Walkability Index
 - Walkability score

Data Processing
- The data was cleaned to remove missing values, outliers, or errors affecting the analysis.
- The independent variables were standardized by Z-score.
- To avoid collinearity issues, a composite score named "cumulative socioeconomic advantage" was created with the following measures:
  - access to healthcare, education, and above-poverty.

Data Analysis
- Univariate
  - Frequency distribution and descriptive statistics
- Bivariate
  - Simple linear regression
- Multivariate
  - Multiple linear regression

Results

Figure 1. Map of Hypertension Prevalence by Census Tracts, California, 2021
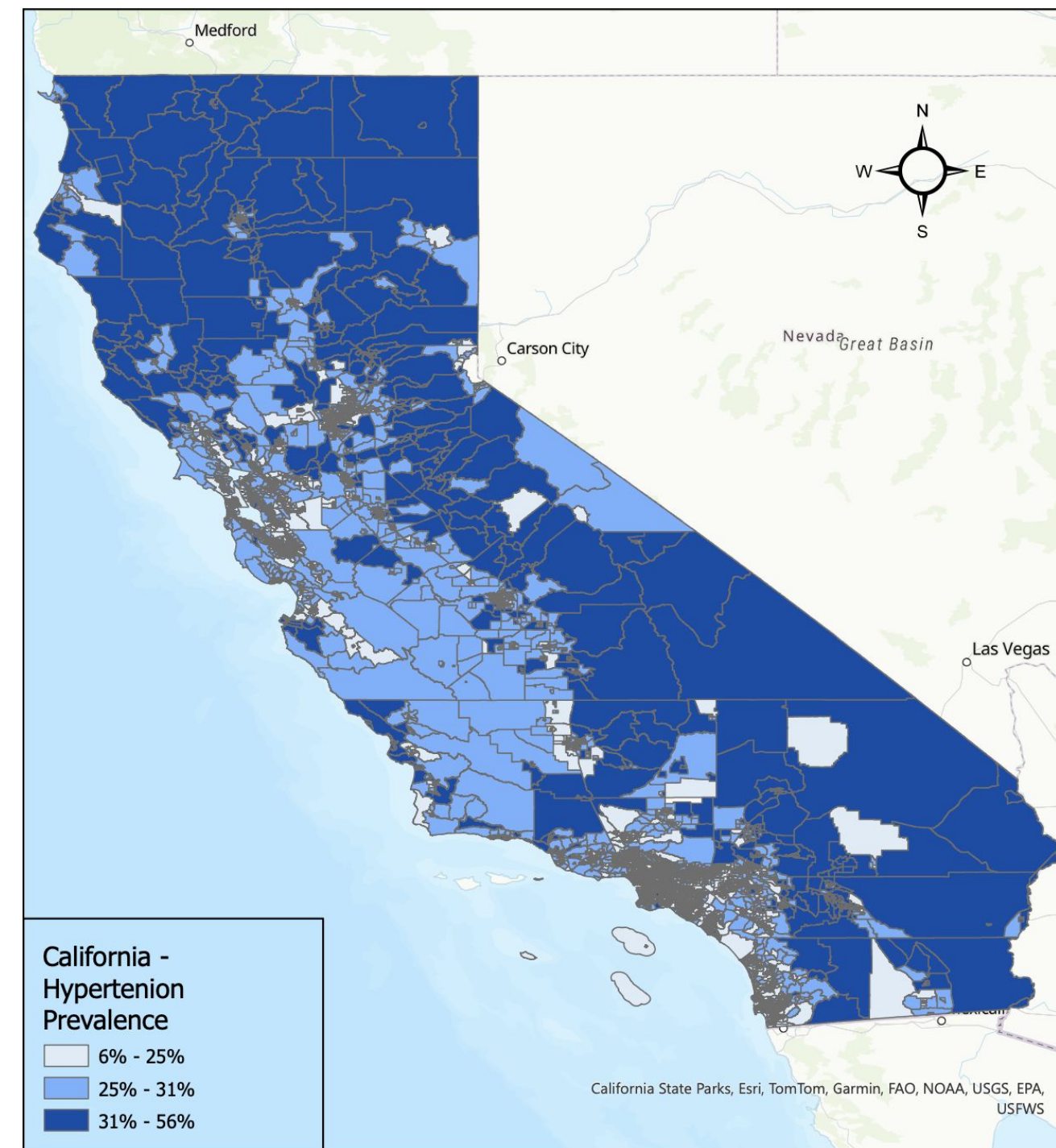
- Figure 1, shows prevalence of hypertension. The darkest shade of blue represents 31% - 56%.
- The medium shade of blue represents 25% - 31%.
- The lowest values are 6% - 25% and represent the light shade of blue.

Figure 2. Map of Food Deserts Lacking Transportation by Census Tracts, California, 2019
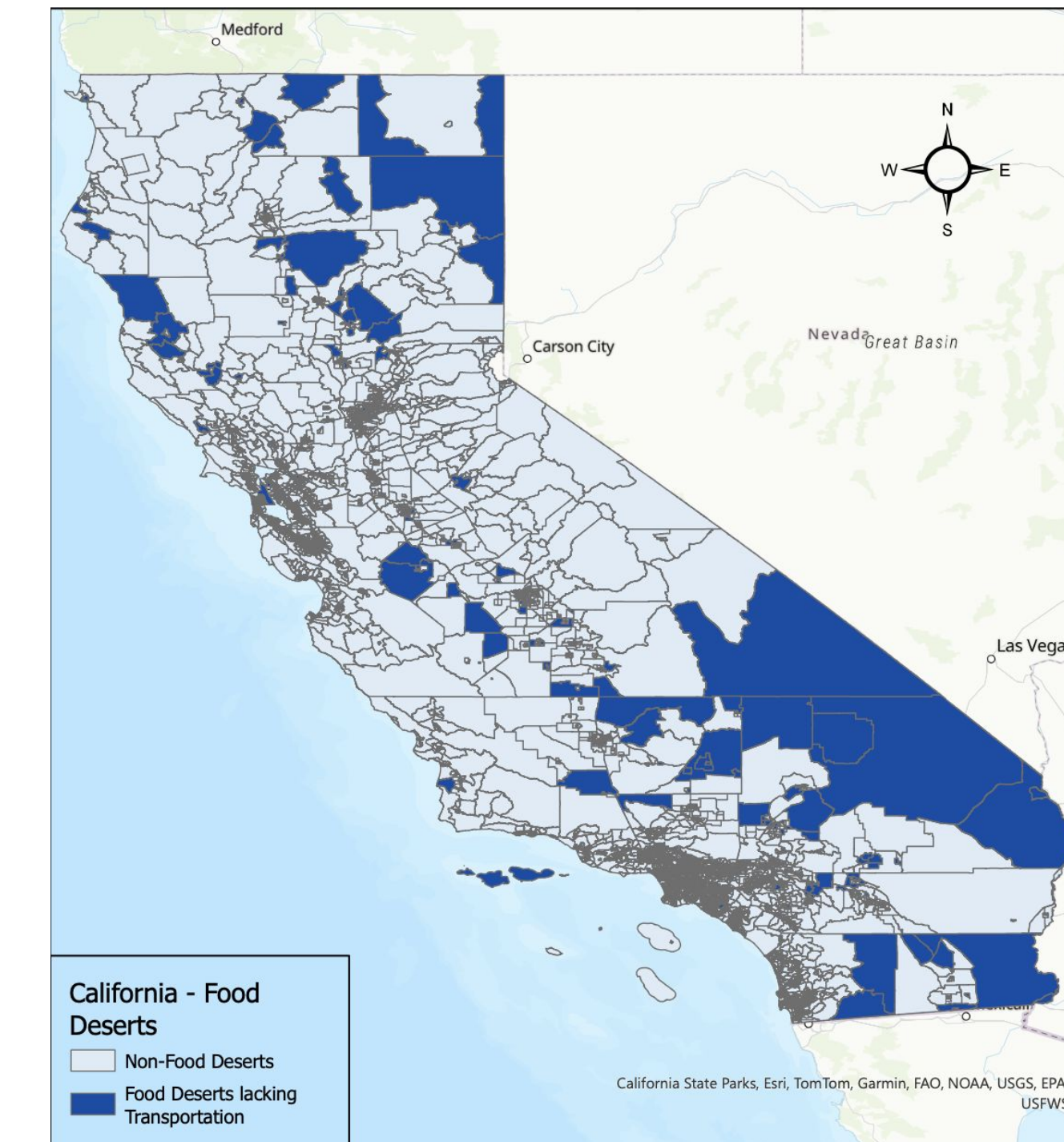

- Figure 2, shows food deserts lacking transportation. The darkest shade of blue represents food deserts lacking transportation.

Figure 3. Map of Cumulative Socioeconomic Advantage by Census Tracts, California, 2022
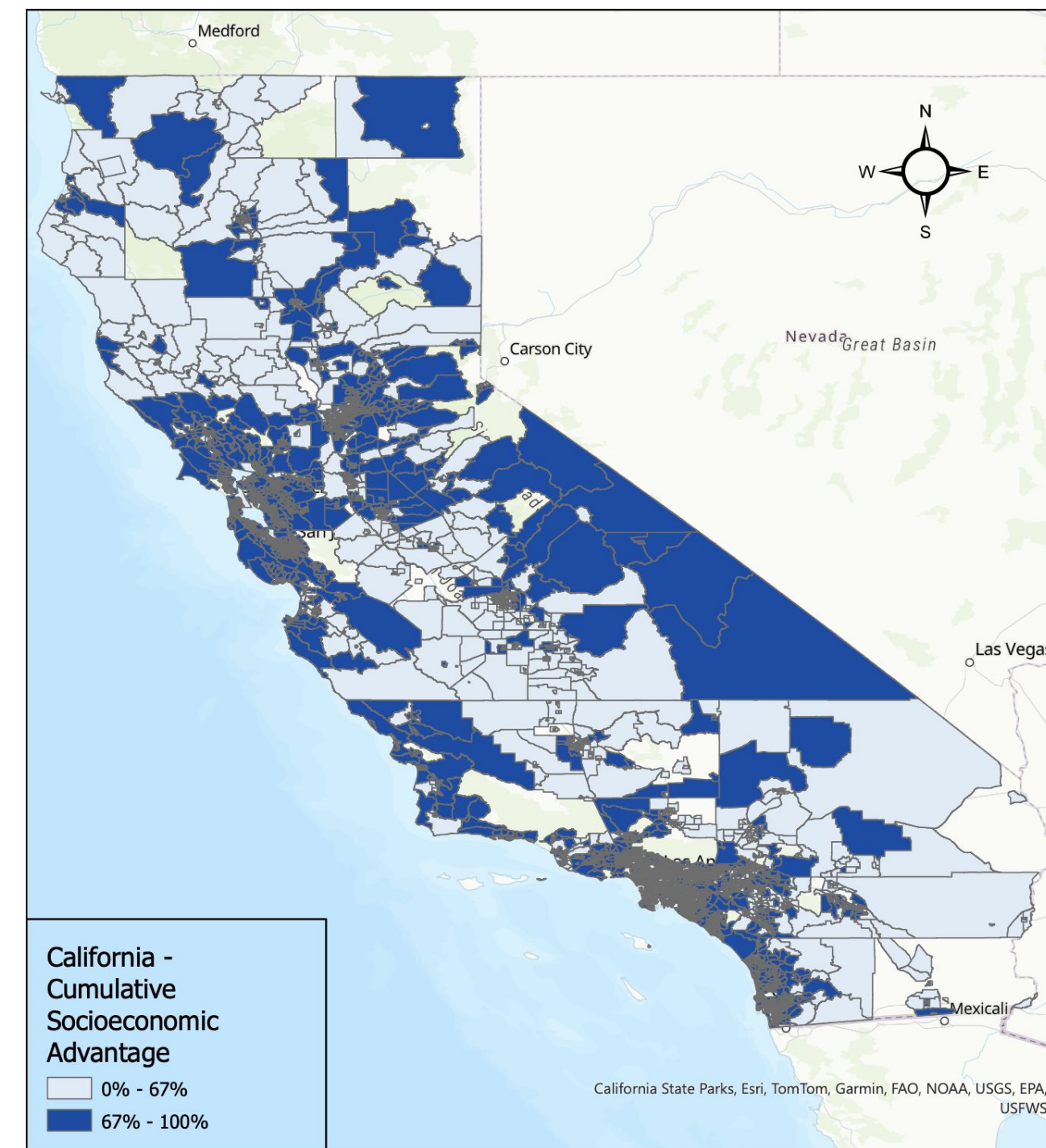
- Figure 3, shows cumulative socioeconomic advantage. The darkest shade of blue represents 67% - 100% which indicates a higher advantage.
- The lighter shade of blue represents 0% - 67%, or a disadvantaged tract.

Figure 4. Map of Percent Age 55+ by Census Tracts, California, 2019
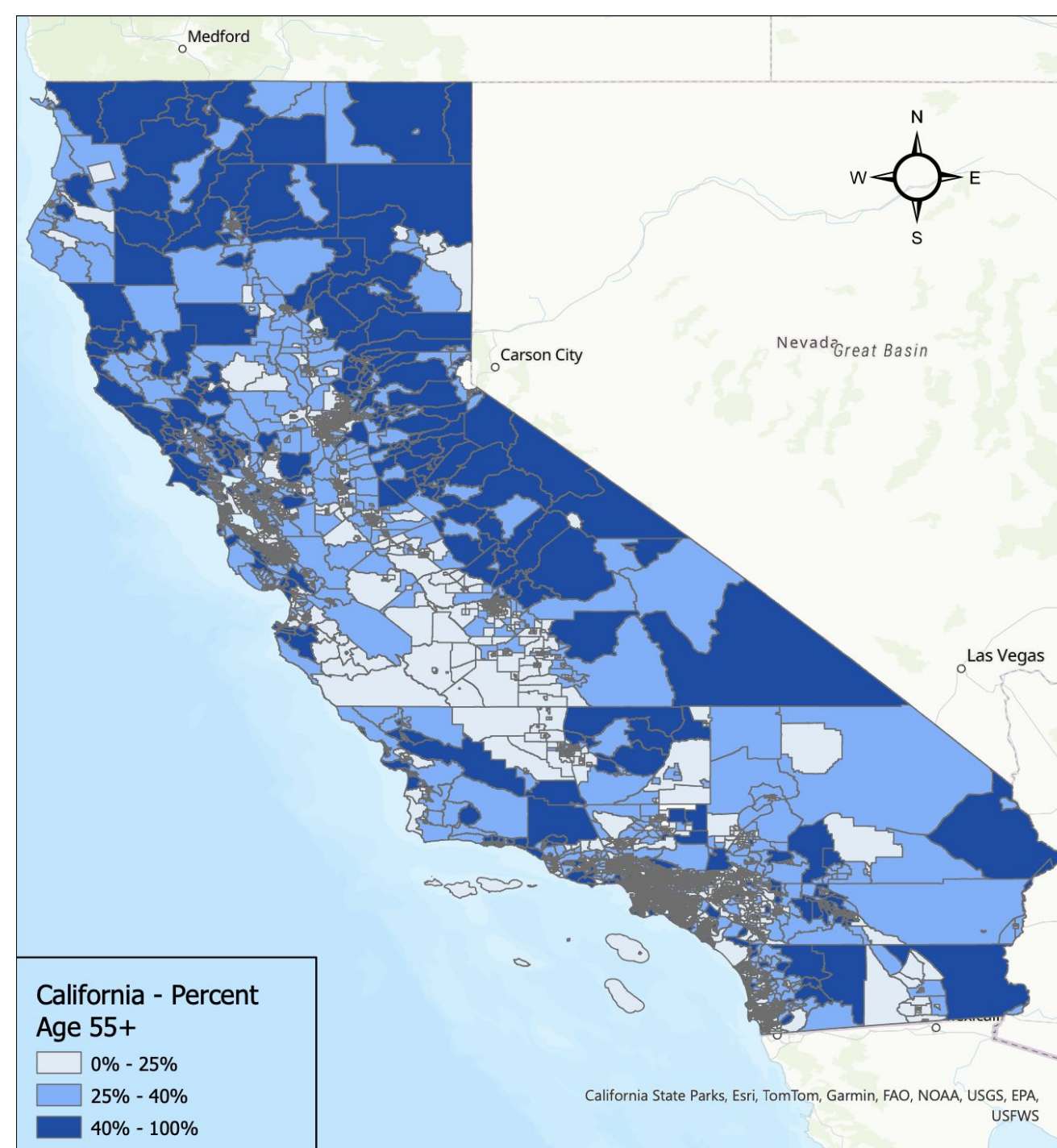
- Figure 4, shows percent age 55+. The darkest shade of blue represents 40% - 100%.
- The medium shade of blue represents 25% - 40%.
- The lowest values are 0% - 25%, and are indicated by the light shade of blue.

Frequency Statistics of Categorical Variables

Variables	N	%
Non-Food Deserts	7519	93.7
Food Deserts lacking Transportation	505	6.3
Urban	7353	91.6
Rural	671	8.4

Descriptive Statistics of Continuous Variables

Variable	N	Min	Max	Mean	SD
Geospatial factors					
Hypertension prevalence	8005	5.60	56.40	26.98	4.79
Park Access	7790	0.00	1.00	0.77	0.31
Walkability	8057	1.00	19.67	12.14	3.54
Community-level factors					
Cumulative Socioeconomic Advantage	7790	-1.70	1.35	0.07	0.14
Age 55+	8012	0.00	1.00	0.27	0.11
Percent Black	8012	0.00	0.85	0.06	0.09

N = Number of census tracts

- The walkability average of 12.14 equates to an average of 65% walkable per census tract.
- The Cumulative Socioeconomic Advantage average of 0.07 equates to 42% advantage per census tract.

Figure 5. Map of Walkability by Census Tracts, California, 2021

- Figure 5, shows walkability. The darkest shade of blue represents census tracts of high walkability.
- The medium shade of blue represents moderate walkability.
- The light shade of blue represents low walkability.

Multiple Linear Regression

Variables	B	Std. Error	95% CI	P
(Constant)	27.23	.126	26.98, 27.48	0
Food Deserts lacking Transportation	1.96	.123	1.72, 2.20	<.001
Cumulative Socioeconomic Advantage	-2.84	.040	-2.92, -2.76	<.001
Age 55+	3.94	.036	3.87, 4.01	<.001
Percent Black	1.05	.031	.99, 1.10	<.001
Walkability	-.37	.037	-.44, -.29	<.001
Park Access	-.15	.032	-.21, -.08	<.001
Urban	-.32	.132	-.58, -.06	0.015

The multiple linear regression was statistically significant (R2 = 0.684, p = <.001).

- The Final Analysis shows:
  - Areas lacking access to healthy food options due to transportation issues have a positive association with hypertension prevalence (b = 1.96; 95% CI 1.72, 2.20).
  - Higher cumulative socioeconomic advantage is associated with lower hypertension prevalence (b = -2.84; 95% CI -2.92, -2.76).
  - Communities with higher percentages of individuals aged 55 and above were found to have an increased risk of hypertension (b = 3.94; 95% CI 3.87, 4.01).
  - All variables have statistically significant relationships with hypertension prevalence (p < .001).
  - The adjusted R-squared value of .684 indicates that the model explains approximately 68.4% of the variance in hypertension prevalence.

Discussion

Hypertension Prevalence Disparities
- Significantly higher prevalence in food deserts compared to non-food desert areas.
- Hypertension prevalence increased with communities of an increased percentage of 55 and older.
- Increased socioeconomic advantage associated with reduced hypertension risk.

Consistency with Existing Literature:
- Testa and colleagues (2021) found food deserts were linked to a heightened risk of hypertension.
- Identified gaps in methodologies regarding food deserts and socioeconomic measures.
- Extension Beyond Individual-Level Analyses:
- This study utilizes a food desert measure that incorporates transportation and low income.
- Provides a comprehensive understanding beyond individual-level analyses in prior studies.

Limitations
- There was no control over how the data was collected and what quality control measures were taken, which can impact the accuracy and reliability of the findings.
- The data may have inherent biases due to the original purpose of the data collection or the source of the data.
- Due to the cross-sectional nature of the datasets, causality could not be established.

Policy Implications and Future Research
- Policy:
  - Implement community garden or farmer's markets in food deserts.
  - Enhance public transportation options.
- Future Research:
  - Prospective cohort study design.
  - Consider additional features of food environments.
  - Include a measure to account for food delivery services.

Conclusion

This study conducted a thorough analysis of secondary data obtained from various sources to assess the association between hypertension prevalence and geospatial factors such as food deserts lacking transportation, walkability, park access, and urban/rural status in California at the census tract level. The study found significant differences in hypertension prevalence between food deserts lacking transportation and non-food desert census tracts, cumulative socioeconomic advantage, age, walkability, park access, and race/ethnicity. These findings suggest that access to healthy food options plays a vital role in preserving good health, particularly in the management of hypertension.

Acknowledgements