

SENIORS' ACCESS TO PUBLIX SUPERMARKETS IN TAMPA BAY

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URP 693I



Research Topic

- Relationship between the percentage of seniors (people ages 65+) by zip code in Tampa Bay and the locations of Publix Supermarkets
- Importance- Population projections show that seniors will compose growing proportions at the local, state, and national levels.
- With cities and regions having higher percentages of seniors, planners need to know where to locate essential services (ex. Publix Supermarkets)

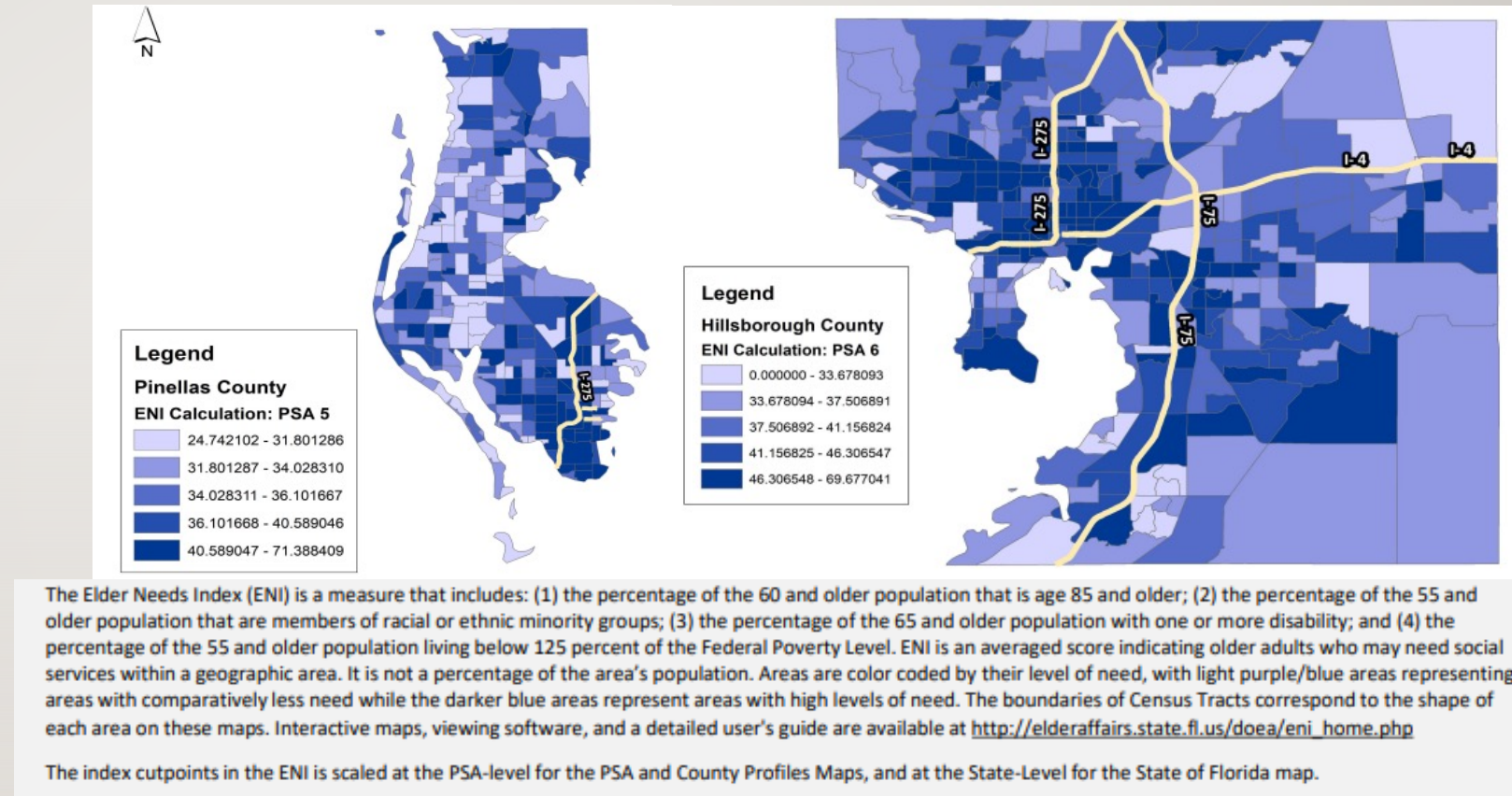
Research Question:

What is the relationship between the percentage of seniors in each zip code tabulation area (ZCTA) and proximity to a Publix Supermarket?



Literature Review Category #1- Senior Food Insecurity

- 2020 State of Senior Hunger Report: Sunbelt has high senior food insecurity levels- home to 7 of the 10 states and the 5 metropolitan areas with the highest food insecurity rates.
- Florida- 750,000 of 5.3 million seniors are eligible for benefits from the Supplemental Food Assistance Program (SNAP) and 10% are in poverty.
- Detailed assessment was conducted on local food systems policy in Hillsborough County to offer insight into the county's situation and policy recommendations.
- Homelessness increases with age and because of rapid senior growth, the number of homeless seniors in the U.S. may rise from 170,000 in 2017 to 225,000 in 2026 (Dalaker & Li, 2022) (Culhane, et. al., 2019).



Source: Florida Department of Elder Affairs (2021)

Literature Review Category #2: Accessibility Studies

- Accessibility studies show that multiple factors impact an individual's ability to regularly access nutritious food items
- A case study from Southern St. Petersburg found that access to a personal vehicle is a significant determinant (Johns, et. al., 2013)
- Another case study in Poland determined that the distance that a senior resident lives to a supermarket is a key factor (Gajda, R., Jezewska-Zychowicz, M., 2020)
- Survey of seniors in King County, WA found that in addition to the above factors, a lack of public transit options and built environment features limit seniors' ability to access nutritious food (Huang, et. al., 2012)
- In rural areas, the main barriers to older adults' access to nutritious food items are cost and quality (Shanks, et. al., 2017)
- GIS analysis that uses an accessibility metric in Cincinnati, OH found that even though seniors are more evenly distributed across the MSA than other vulnerable subpopulations, they all face similar challenges in accessing nutritious food (Farber, et. al., 2014)



Literature Review Category #3: The Gravity Model

Gravity Model- Created by Hansen in 1959, suggests a balance between impedance to and utility of a destination (Miller, 2005 in Kwon, 2019).

- Based on spatial distribution of residence, time travel, and cost between zones (Fatima, et. al., 2022)
- Trips produced at an origin and attracted to a destination are directly related to overall trip production
- Pros- Has been used to identify food access inequity by transport mode in a way that removes estimation biases, like those found in the edge effect (Chen, 2017)
- Modifications can make model more efficient in measuring a target group's ability to access healthy food options
- Cons- Fails to account for locational demand patterns
- Modified complex models capture demand patterns more effectively than simple gravity model
- Other models- Spatial Error Interaction Model
 - Used in Python to calculate the relationship between accessibility (dependent variable) and aging neighborhoods (independent variable)
 - Finds that highly accessible neighborhoods have higher building density and greater sidewalk continuity



Method: Gravity Model to get Dependent Variable

- Where A_i^H = Accessibility at location I (ZCTA), s_j = Publix Supermarkets at location I, d_{ij} = travel distance from location I, β = travel friction coefficient, and n = total number of Publix Supermarkets.
- Accessibility- dependent variable in our analysis
- We then created a distance matrix, ran GeoPandas to determine centroids with the distance, and then wrote a for loop.
- Developed the formula in Colab to define accessibility to use in our analyses (see below)
- Once we obtained a gravity model, we used seniors as the main independent variable and all other independent variables as control variables.
- Preliminary Analysis- Histograms and GIS/Moran's I analyses
- Gravity Model- Ran linear, univariate, and multivariate regressions

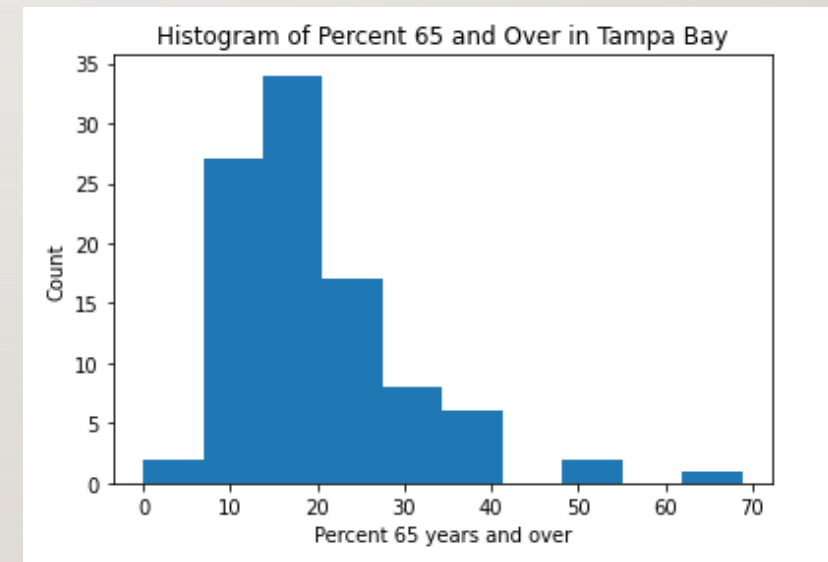
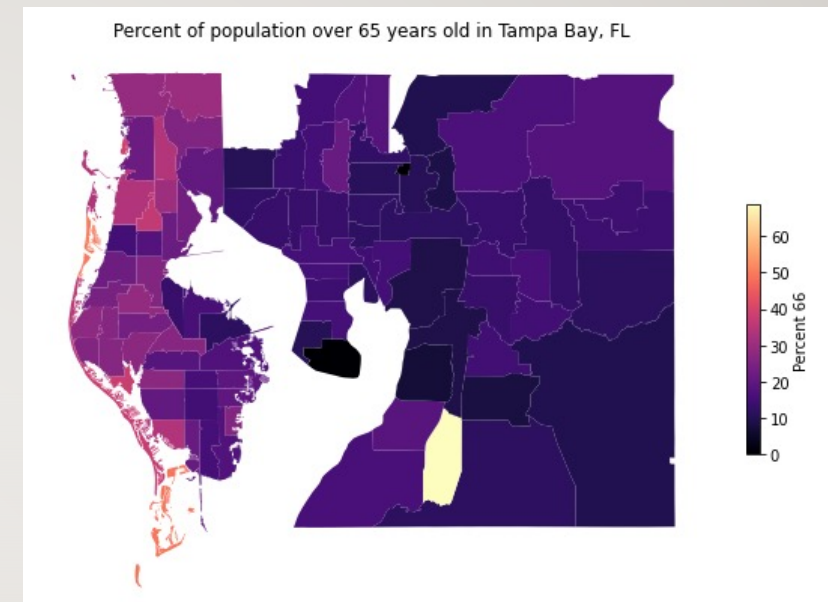
$$A_i^H = \sum_{j=1}^n s_j d_{ij}^{-\beta}$$

```
distance_matrix = np.zeros((len(florida_age_shapefile), len(florida_super_shapefile)))
for i in range(len(florida_age_shapefile)):
    for j in range(len(florida_super_shapefile)):
        distance_matrix[i,j] = florida_age_shapefile.iloc[i].centroid_coords.distance(florida_super_shapefile.iloc[j].geometry)/1609.34
distance_matrix
```

```
florida_age_shapefile['distance'] = distance_matrix.sum(axis = 1)/distance_matrix.shape[1]
florida_age_shapefile['accessibility'] = (1/distance_matrix).sum(axis = 1)
```

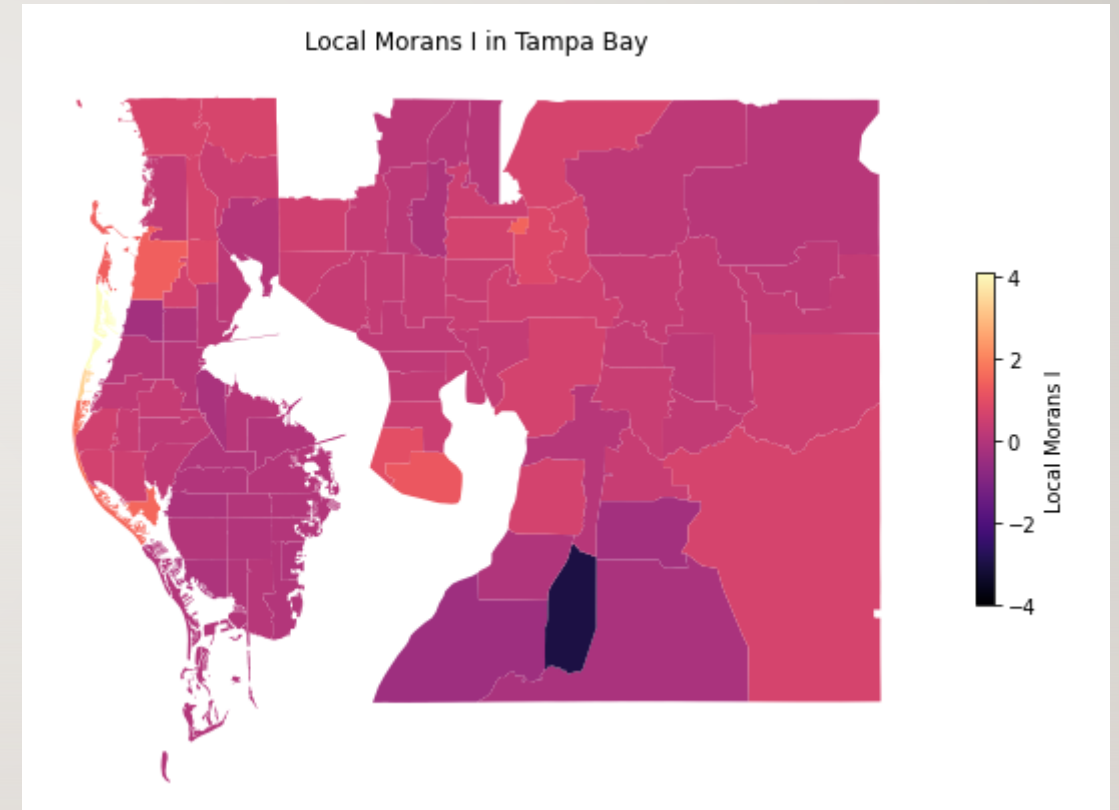

Results

- Ran GIS dataset for the percentages that the senior population composes for individual ZCTAs.
- 436 total edges, edge density of 0.046821.
- Noticeable contrast between Hillsborough and Pinellas counties in the percentages that seniors make up.
- One very notable outlier in southern Hillsborough County (Sun City Center).
- Dataset Mean: 19.76
- Dataset Median: 16.3
- Skewed-right histogram, positive skewness
- Large values to the right of mean inflate its value.



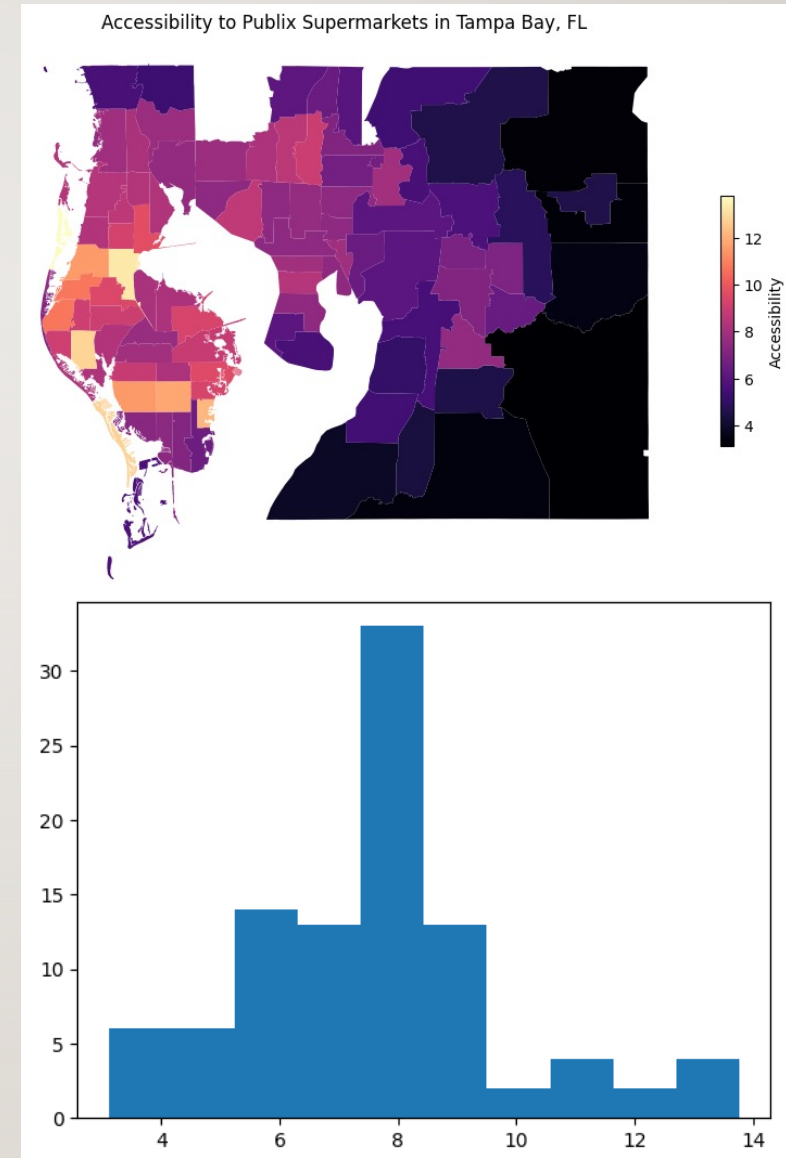
Results

- Global Moran's I value for the dataset on seniors is .363675
- Relatively weakly positive spatial autocorrelation among neighboring ZCTAs in Tampa Bay.
- On a random walk across ZCTAs, you are more likely than not to obtain similar values.
- However, it is not out of the question to get radically different numerical values on a random walk across ZCTAs (Ex. Case of Sun City Center).



Results

- Generated dependent variable (accessibility) via the gravity model
- Developed scale to assess accessibility to Publix Supermarkets
- Clear contrast in accessibility between the densely populated Southern Pinellas County (more accessible) and sparsely populated Eastern Hillsborough County (less accessible).
- Histogram shows no skew in distribution

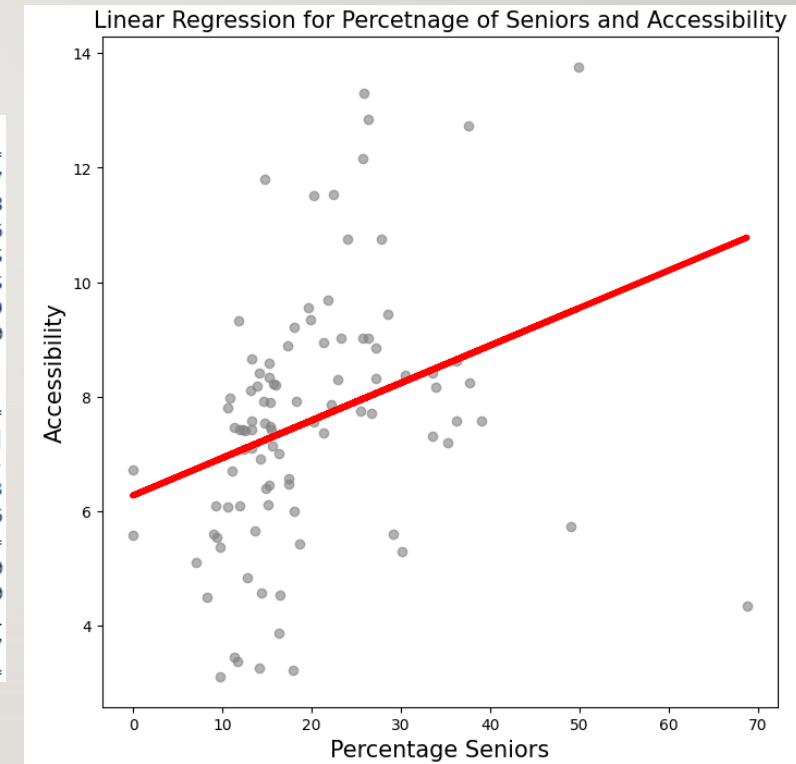


Results

- $R^2 = 0.097$
- Low positive correlation between seniors and accessibility.
- However, seniors are statistically significant

OLS Regression Results						
=====						
Dep. Variable:	accessibility		R-squared:	0.097		
Model:	OLS		Adj. R-squared:	0.088		
Method:	Least Squares		F-statistic:	10.26		
Date:	Tue, 04 Apr 2023		Prob (F-statistic):	0.00185		
Time:	19:06:15		Log-Likelihood:	-209.45		
No. Observations:	97		AIC:	422.9		
Df Residuals:	95		BIC:	428.0		
Df Model:	1					
Covariance Type:	nonrobust					
=====						
	coef	std err	t	P> t	[0.025	0.975]

const	6.2744	0.458	13.712	0.000	5.366	7.183
Percent_66	0.0655	0.020	3.203	0.002	0.025	0.106
=====						
Omnibus:	2.162	Durbin-Watson:	1.180			
Prob(Omnibus):	0.339	Jarque-Bera (JB):	1.780			
Skew:	-0.006	Prob(JB):	0.411			
Kurtosis:	3.663	Cond. No.	47.7			
=====						



Results

OLS Regression Results						
Dep. Variable:	accessibility		R-squared:	0.412		
Model:	OLS		Adj. R-squared:	0.406		
Method:	Least Squares		F-statistic:	66.55		
Date:	Tue, 18 Apr 2023		Prob (F-statistic):	1.40e-12		
Time:	18:49:48		Log-Likelihood:	-188.67		
No. Observations:	97		AIC:	381.3		
Df Residuals:	95		BIC:	386.5		
Df Model:	1					
Covariance Type:	nonrobust					
	coef	std err	t	P> t	[0.025	0.975]
const	6.3397	0.230	27.584	0.000	5.883	6.796
POP_SQMI	0.0007	8.82e-05	8.158	0.000	0.001	0.001
Omnibus:	2.810	Durbin-Watson:	1.934			
Prob(Omnibus):	0.245	Jarque-Bera (JB):	2.166			
Skew:	0.323	Prob(JB):	0.339			
Kurtosis:	3.345	Cond. No.	3.45e+03			

OLS Regression Results						
=====						
Dep. Variable:	accessibility	R-squared:	0.473			
Model:	OLS	Adj. R-squared:	0.462			
Method:	Least Squares	F-statistic:	42.27			
Date:	Tue, 11 Apr 2023	Prob (F-statistic):	8.06e-14			
Time:	19:09:42	Log-Likelihood:	-183.31			
No. Observations:	97	AIC:	372.6			
Df Residuals:	94	BIC:	380.3			
Df Model:	2					
Covariance Type:	nonrobust					
=====						
	coef	std err	t	P> t	[0.025	0.975]

const	12.6120	0.850	14.845	0.000	10.925	14.299
Percent_66	0.0676	0.016	4.304	0.000	0.036	0.099
distance	-0.3104	0.038	-8.193	0.000	-0.386	-0.235
=====						
Omnibus:	21.625	Durbin-Watson:	1.563			
Prob(Omnibus):	0.000	Jarque-Bera (JB):	31.964			
Skew:	1.006	Prob(JB):	1.15e-07			
Kurtosis:	4.965	Cond. No.	153.			
=====						

Dependent variable: accessibility		
	(1)	(2)
POP_SQMI	0.001*** (0.000)	0.001*** (0.000)
Percent_66	0.105 (0.072)	0.105 (0.072)
Percent_76	-0.203 (0.176)	-0.203 (0.176)
Percent_85	0.127 (0.170)	0.127 (0.170)
const	11.088*** (0.779)	11.088*** (0.779)
distance	-0.246*** (0.034)	-0.246*** (0.034)
Observations	97	97
R ²	0.629	0.629
Adjusted R ²	0.608	0.608
Residual Std. Error	1.388 (df=91)	1.388 (df=91)
F Statistic	30.835*** (df=5; 91)	30.835*** (df=5; 91)
Note:	*p<0.1; **p<0.05; ***p<0.01	

- As we ran more OLS regressions with additional independent variables, we notice that seniors is no longer statistically significant in relation to the dependent variable of accessibility.
- However, we also see an unexpected correlation with population density

Conclusion

- We anticipated an analysis entirely focused on the relationship between seniors and accessibility
- However, we found that accessibility has a stronger correlation to population density than seniors.

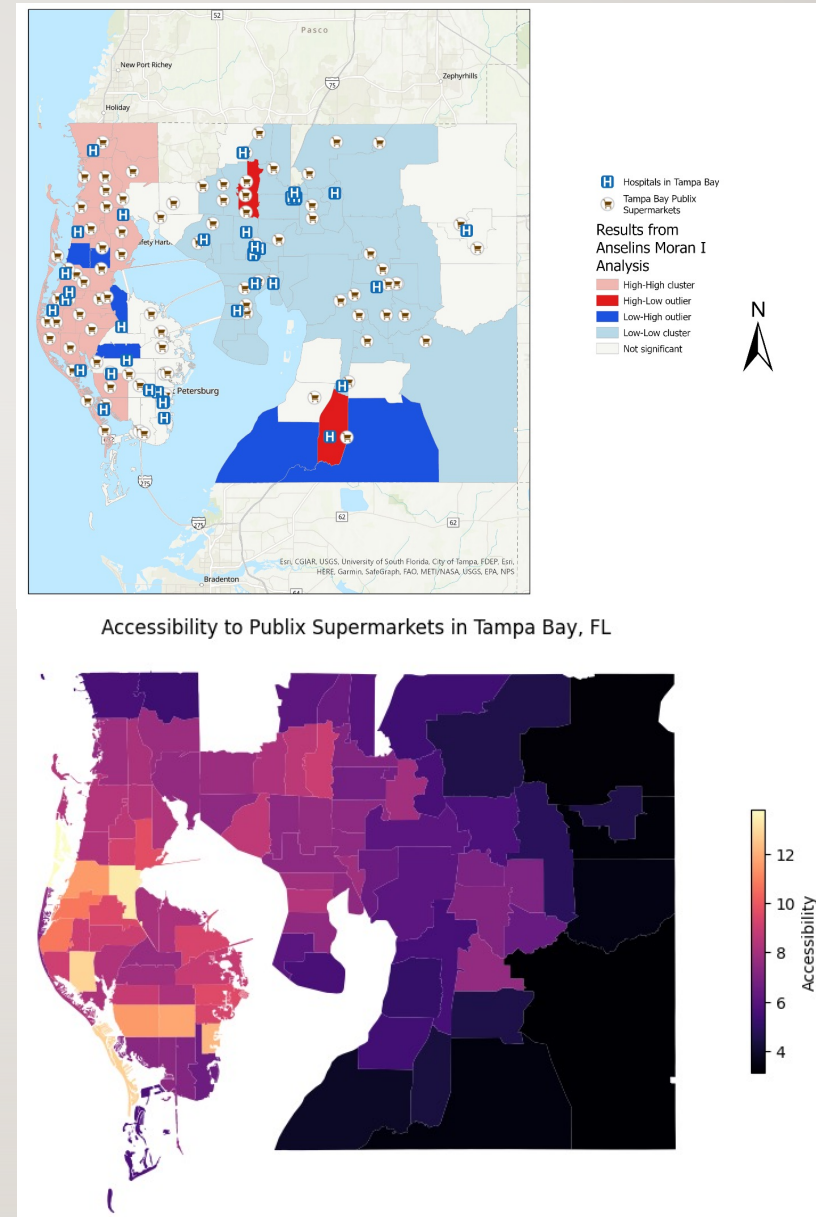
Limitation and Recommendations

- Simplistic gravity model- Doesn't capture metropolitan Publix Supermarket demand patterns.
- For future studies, develop complex models that incorporate demand and population density in analyses focused on the relationship between seniors and accessibility.

High Accessibility/High Percentage Seniors (Pinellas County Beaches) HIGH POPULATION DENSITY Incorporate Demand	High Accessibility/Low Percentage Seniors (No Perfect Example, but Downtown Clearwater is close enough) HIGH POPULATION DENSITY Incorporate Demand
Low Accessibility/High Percentage Seniors (Sun City Center) LESS POPULATION DENSITY Incorporate Demand	Low Accessibility/Low Percentage Seniors (Southeast Hillsborough County) LESS POPULATION DENSITY Incorporate Demand

Discussion

- Despite the gravity model's limitations, our findings can potentially build on relevant prior research.
- Ex. Determine whether the extent to which there is overlap between clustering and outlier patterns of the spatial distribution of seniors in relation to metropolitan accessibility trends.
- We believe our comprehensive analysis can assist local officials in addressing senior food insecurity challenges.



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