Virginia: Relationship Between Distance to Medical Facilities and Demographic Composition of Census Tracts

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Abstract

Access to medical facilities is important for the immediate care of injuries or illness as well as preventative care. Regardless of an individual's ability to pay for medical care, distance from nearby facilities can influence medical outcomes. According to an article published in the Journal of Community Health “transportation barriers lead to rescheduled or missed appointments, delayed care, and missed or delayed medication use. These consequences may lead to poorer management of chronic illness and thus poorer health outcomes” (Syedetal., 2013)[1]. In this analysis I will explore the relationship between the distance to the nearest urgent care clinic or hospital and the center of each census tract in Virginia and compare it to the demographic composition of the census tract (race, income, education, ect.). My analysis will seek to identify trends in medical access and if advantageous or disadvantageous trends exist. This is important because it may help to answer questions such as:

- *Are there racial/ethnic demographic drivers of distance to medical facilities in Virginia? Do they put these groups at an advantage or disadvantage?*
- *Are there demographic drivers such as education or income that provide advantageous access(shorter distances) to medical facilities in Virginia?*
- *Is the rural/urban population divide fairly represented in access to medical facilities in Virginia? If not, who is advantaged vs. disadvantaged?*

[1] Syed, S. T., Gerber, B. S., Sharp, L. K. (2013). Traveling Towards Disease: Transportation Barriers to Health Care Access. Journal of Community Medicine(38), 976 993.https://doi.org/10.1007/s10900-013-9681-1

Hypothesis

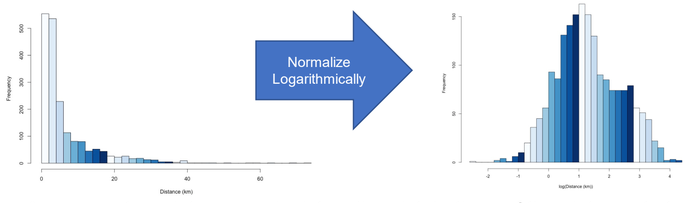
H_0: There is no relationship between the distance to the nearest medical facility from the center of a census tract and the demographic makeup of that census tract in Virginia.

H_A: There is a relationship between the distance to the nearest medical facility from the center of a census tract and the demographic makeup of that census tract in Virginia.

Data Sources

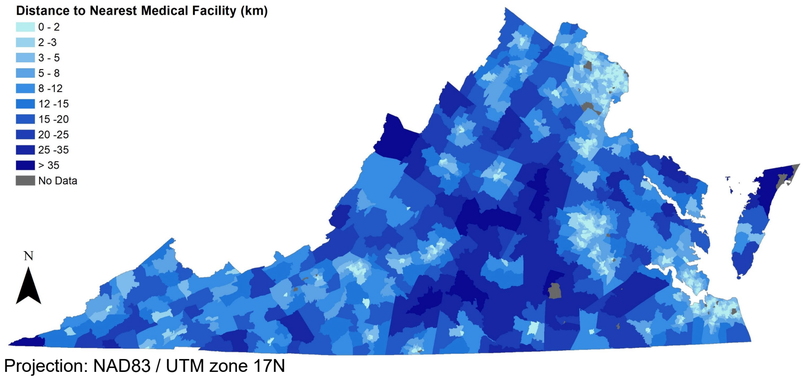
Layer Name	Description	Data Type	Source	Projection
VA_Census_Tracts 2019	Polygon of census tract boundaries in VA	Shapefile	United States Census Bureau Cartographic Boundaries	GCS NAD83
VA_Hospitals 2018	Point file of all Hospitals in VA	Shapefile	Virginia Economic Development Partnership	WGS 1984
VA_Urgent_Care_Facs 2018	Point file of all urgent care facilities in VA	Shapefile	CA Governor's Office of Emergency Services Data Library / Urgent Care Association of America	WGS 1984
VA_25plus_Ed_Inc 2019 Est. from ACS	Education attainment and income by pop in VA by census tract	CSV	United States Census Bureau	N/A
VA_Race_Breakdown 2019 Est. From ACS	Racial Breakdowns by pop in VA by census tract	CSV	United States Census Bureau	N/A

Data Transformation



Above are two histograms depicting the distributions of the distance to the nearest medical facility in kilometers for each census tract in Virginia. Before statistical analysis could be performed the data had to be normalized so the distribution resembled a normal distribution. This was achieved by taking the log of the distances, the distribution can be seen on the left and this is ultimately what data was used as the dependent variable.

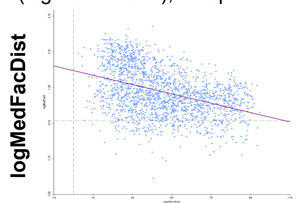
VA: Distance to Nearest Medical Facility



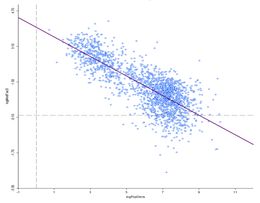
Projection: NAD83 / UTM zone 17N

Relationships Between Variables and Distance to Nearest Medical Facility

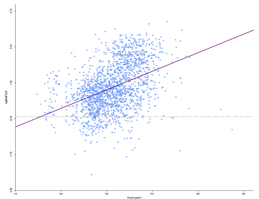
Before analysis was done to compare all the independent variables against the dependent variable (logMedFacDist); Independent variables' relationships with the dependent variable were individually measured:



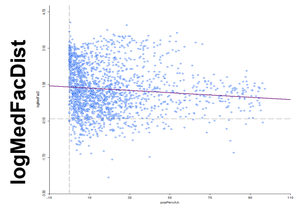
Education
The more educated a census tract is the shorter the distance to the nearest medical facility.



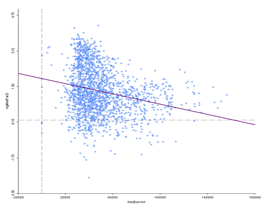
Population Density
The more densely populated a census tract is the shorter the distance to the nearest medical facility.



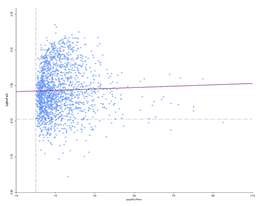
Age
The higher the median age of a census tract, the greater the distance to the nearest medical facility.



Race
The higher the percent of the population that is African American, the greater the distance to the nearest medical facility.



Income
The higher the median income of a census tract, the shorter the distance to the nearest medical facility.



Poverty
The higher the poverty rate of a census tract, the greater the distance to the nearest medical facility.

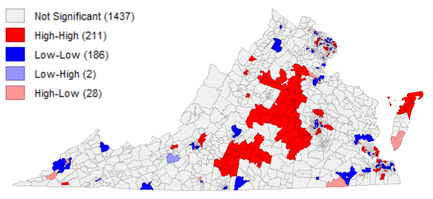
Though some of these independent variables' relationships to the dependent variable are not typically indicative of strong positive or negative correlation, they were ultimately chosen because together they produced the highest R-squared value in the multiple regression analysis.

Spatial Regression Analysis

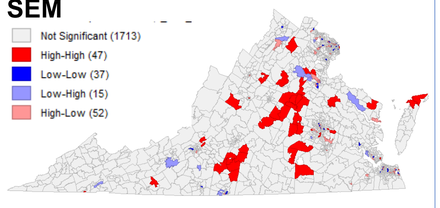
	Ordinary Least Squared		Spatial Error Model	
Variable	**Coefficient**	**P-Value**	**Coefficient**	**P-Value**
popPercEdu	-0.00532725	0.00052	-0.00354597	0.01377
logPopDens	-0.44355800	0.00000	-0.31440000	0.00000
MedAgeInt	-0.00481546	0.06889	-0.00489429	0.02163
popPercAA	0.00188504	0.03613	-0.000984191	0.35390
MedEarnInt	4.00249e-006	0.00197	2.10466e-006	0.09134
popPovPerc	-0.00197889	0.27836	-0.0015747	0.33576
R^2	0.642240		0.80319	
Log Likelihood	-1773.37		-1369.74	
Schwarz Criterion	3599.45		2792.21	
Morans I (Residuals)	0.411		0.024	

Residuals

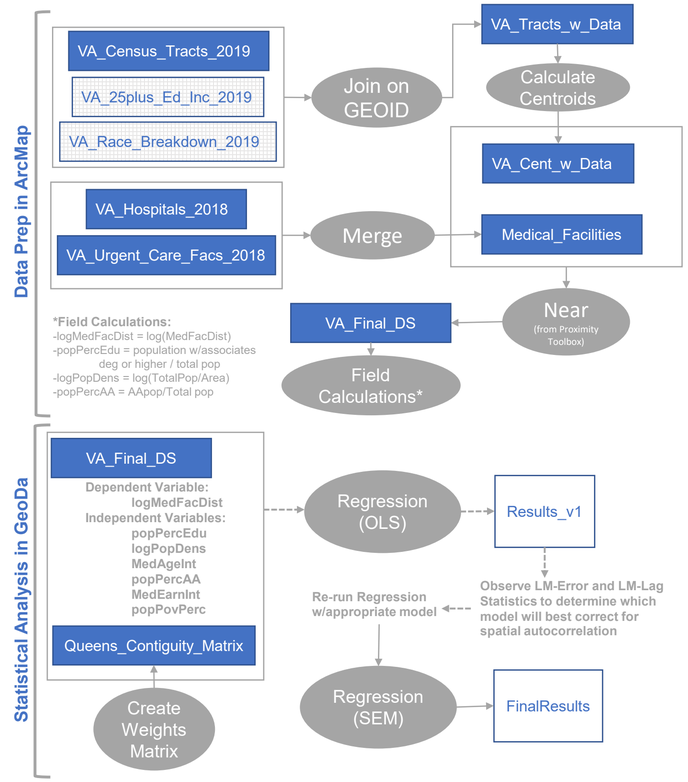
OLS



SEM



Methodology



Conclusion

Using an ordinary least squared regression model with a queen's contiguity weights matrix to analyze the relationship between the distance to the nearest medical facility and demographics including: the Percent of the population with an associates degree or higher, the population density, the median age of the tract, the population percentage of African Americans, the median household income of the tract, and the percent of population in poverty I found all variables except for poverty and age to be statistically significant. The R^2 for this model was 0.64, meaning that 64% of the variation was explained by my variables. When I ran a Moran's I analysis on my residuals I found them to have a moderate positive spatial autocorrelation. Because of these model performance issues I switched to a Spatial Error Model (SEM).

The SEM regression model performed much better. The new R^2 was .80 meaning the model explained 80% of the variation in the distance to the nearest medical facility. The log-likelihood was higher, and the schwarz criterion was lower also indicating the model was a better fit. Finally, the residuals' Moran's I came back at 0.024 indicating this model better addressed issues of spatial autocorrelation. Therefore, this model was accepted for final analysis.

After reviewing the analysis, I believe there is sufficient evidence to reject the null hypothesis. There are relationships between the demographics of a census tract and the distance to the nearest medical facility in Virginia.

Key drivers of distance to medical facilities appear to be the percent of the population with college education, the population density, and the median age. African American population, median earnings, and poverty were not statistically significant, but I believe further analysis is needed before a definitive conclusion about their affect can be made.

Implications of this analysis are that decisions on where new medical facilities are built can be more thoroughly thought through to ensure communities are being equally served based on their population and demographic composition.