Modeling the Effect of Public Transit Accessibility on Diabetic Health Outcomes in Georgia

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INTRODUCTION

BACKGROUND

- An estimated 5.8 million Americans have delayed medical care due to transportation barriers, with the South being among the most adversely impacted regions.[1,2]
- Urban built environments that prioritize mobility and transit accessibility can help improve overall health and alleviate the burden of chronic conditions.[3]
- Diabetic foot ulcers (DFU's) are frequent and debilitating side effect associated with diabetes and commonly precede amputations.[4]

PRIMARY OBJECTIVE

- With DFU-related lower extremity amputations as the adverse outcome, we aimed to model geographic associations between amputations and measures of public transit usage and accessibility.

METHODS

DIABETIC OUTCOMES DATA

- Data for 31,873 hospital visits involving patients with DFU's in Georgia, 2016 were sourced from the Healthcare Cost and Utilization Project (HCUP).
- 999 total ZIP code tabulation areas (ZCTA's) were represented, with 735 in the state of Georgia, and 117 within metro-Atlanta.

ZCTA-LEVEL EXPOSURE VARIABLES

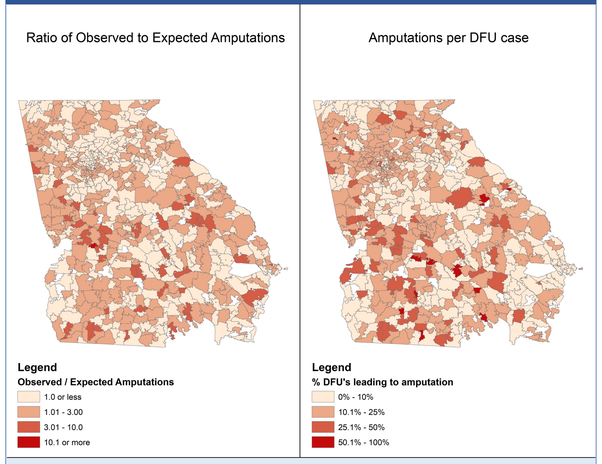
- Population demographics and health characteristics were quantified via data products from CDC, U.S. Census, Georgia Tech Health Analytics Project.
- Metrics for transportation vulnerability were compiled from American Community Survey, MARTA, EPA National Walkability Index

STATISTICAL ANALYSIS

- Quasi-Poisson models of ZCTA amputation counts: $\log(E(Y|x)) = \log(\text{offset}) + \beta^T x_{confounders} + \beta_p x_{transportation}$
- Offset = # expected ZCTA-specific amputations
- 4 Confounders: Proportion in poverty, without a car, without health insurance, and estimated travel distance (miles) to reach a primary care provider
- Associations with each transportation metric were assessed individually.
- e^{β} is the rate of change in the number of amputations relative to the expected counts.
- Models were fit across all of Georgia and within the 5-county (Cobb, Fulton, DeKalb, Gwinnett, Clayton) metro-Atlanta area.

RESULTS

Geographic distribution of amputation outcomes by ZCTA

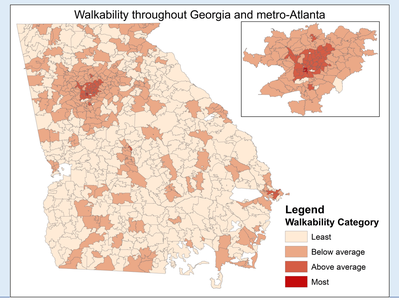


- Each ZCTA averaged 3.4 DFU-related amputations.
- Statewide distributions for outcome counts and most exposure variables were strongly right skewed and over-dispersed.

Summarization of selected exposure variables

	Outside metro-Atlanta (N=882)	Within metro-Atlanta (N=117)	All ZCTA's (N=999)
Number of MARTA stops			
Median [Q1, Q3]	0 [0, 0]	28 [0, 96]	0 [0, 0]
[Min, Max]	[0, 0]	[0, 617]	[0, 617]
Transit access rank			
Median [Q1, Q3]	1 [1, 1]	7.86 [2.05, 13.6]	1 [1, 1]
[Min, Max]	[1, 17.1]	[1, 18.8]	[1, 18.8]
Walkability index			
Median [Q1, Q3]	5.01 [4.01, 5.97]	9.57 [7.53, 11.9]	5.38 [4.29, 6.70]
[Min, Max]	[1.84, 13.7]	[5.52, 16.5]	[1.84, 16.5]
Walkability index categorization‡			
Least	376 (42.6%)	2 (1.7%)	378 (37.8%)
Below average	159 (18.0%)	66 (56.4%)	225 (22.5%)
Above average	4 (0.5%)	43 (36.8%)	47 (4.7%)
Most	0 (0%)	3 (2.6%)	3 (0.3%)

‡ Categorized from 1 through 4: 1 to 5.75 = Least walkable, 5.76 to 10.5 = Below average walkable, 10.51 to 15.25 = Above average walkable, 15.26 to 20 = Most walkable



MODEL RESULTS

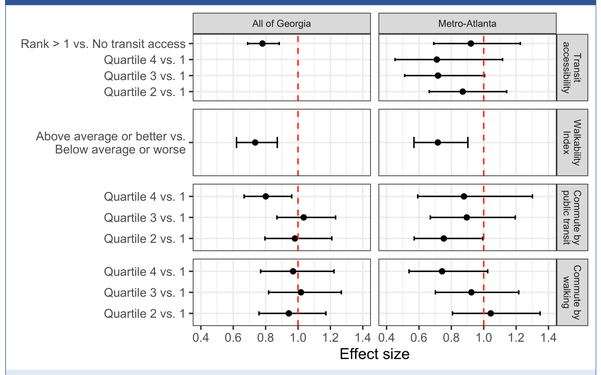
- Increased walkability and transit access were each significantly associated with observing fewer amputations than expected by ZCTA.
- Walkability index yielded a stronger protective effect within metro-Atlanta.
- Proportion of commute mode was not predictive of lower levels of amputations within metro-Atlanta.
- Number of MARTA stops per ZCTA was not a significant predictor neither statewide nor within metro-Atlanta.

Model estimates for rate of change in number of amputations relative to expected

	STATE OF GEORGIA		METRO-ATLANTA	
	e^{β} [95% CI]	P-value	e^{β} [95% CI]	P-value
Number of MARTA stops*	0.991 [0.979,1.002]	0.113	1.010 [0.993,1.028]	0.263
Average transit access rank†	0.978 [0.966,0.990]	<0.001	0.966 [0.935,0.997]	0.034
Average walkability index‡	0.930 [0.906,0.955]	<0.001	0.890 [0.839,0.945]	<0.001
Walkability: Above average or better vs. Below average or worse	0.735 [0.620,0.872]	<0.001	0.716 [0.569,0.902]	0.005
Work commute mode proportion§				
Public transportation	0.984 [0.971,0.998]	0.02	1.078 [0.891,1.305]	0.442
Walking	0.946 [0.890,1.006]	0.076	0.959 [0.889,1.034]	0.282

All models assess each transportation metric individually, controlling for poverty levels, vehicle availability, uninsured rate, and primary care travel distance per ZCTA.
* Number of MARTA stops scaled per 20-unit increase
† Range from 1 to 20. Higher is considered better accessibility. Rank of 1 means there is no public transit available.
‡ Categorized from 1 through 4: 1 to 5.75 = Least walkable, 5.76 to 10.5 = Below average walkable, 10.51 to 15.25 = Above average walkable, 15.26 to 20 = Most walkable
§ These variable coefficients and standard errors were scaled by their respective IQR's.

95% confidence intervals for effect estimates of categorized transportation variables



Transit accessibility rank could not be categorized into quartiles for all of Georgia

CONCLUSIONS

Across both the whole state of Georgia and within metro-Atlanta, accessibility of public transit and overall walkability of communities were significant predictors for observing fewer amputations, after adjusting for each ZCTA's poverty level, personal vehicle availability, health insurance coverage, and primary care travel distance.

TRANSIT ACCESS

- We did not observe consistent associations on amputations with the use of transit mode prevalence or number of MARTA stops.
- Presence of stops alone may not be sufficient to increase transportation accessibility, leading to reduced amputation occurrences.
- In contrast, comprehensive metrics that incorporate density of stops, proximity of employment to transit, and frequency of service may be better measures of accessibility and its potential benefits.

WALKABILITY

- Public transportation increases walkability. In the US, development of walkable infrastructure is often in tandem with gentrification.
- Thus, while we adjusted for ZCTA-level SES characteristics, it may be difficult to disentangle transportation accessibility from other amenities associated with walkability.

LIMITATIONS

- ZCTA's may introduce the modifiable areal unit problem due to the aggregation of count variables.
- We cannot establish causality for a cross-sectional study design.

REFERENCES

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