Spatial and Temporal Accessibility of Pharmacies and Urgent Care in Polk County, Florida

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APPLIED MATHEMATICS

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Introduction

Motivation

Access to healthcare remains a persistent challenge in the United States, driven in part by the limited availability of primary care services outside standard working hours. As a result, many individuals rely on urgent care centers as their primary source of care during evenings and weekends, which is a suboptimal solution given the higher cost and episodic nature of urgent care services. The situation is further compounded by workforce projections; the Florida Medical Association anticipates a shortfall of 17,924 physicians by 2035. To address these growing gaps, it has been proposed that pharmacies play an expanded role in providing limited direct patient care, thereby improving access in underserved communities.

Research Goals

This study seeks to quantify disparities in access to pharmacies and urgent care services across Polk County by examining geospatial proximity (measured by travel time) and the availability of services during extended hours, as well as to study the relationship between geospatial accessibility and socioeconomic determinants of public health risk.

Data

Population Data

Tract-level population data (see Figure 1a), as well as TIGER/Line shapefiles for Census tracts, were obtained from the 2020 US Census [2]. All accessibility metrics were computed on the tract-level for 173 Census tracts in Polk County.
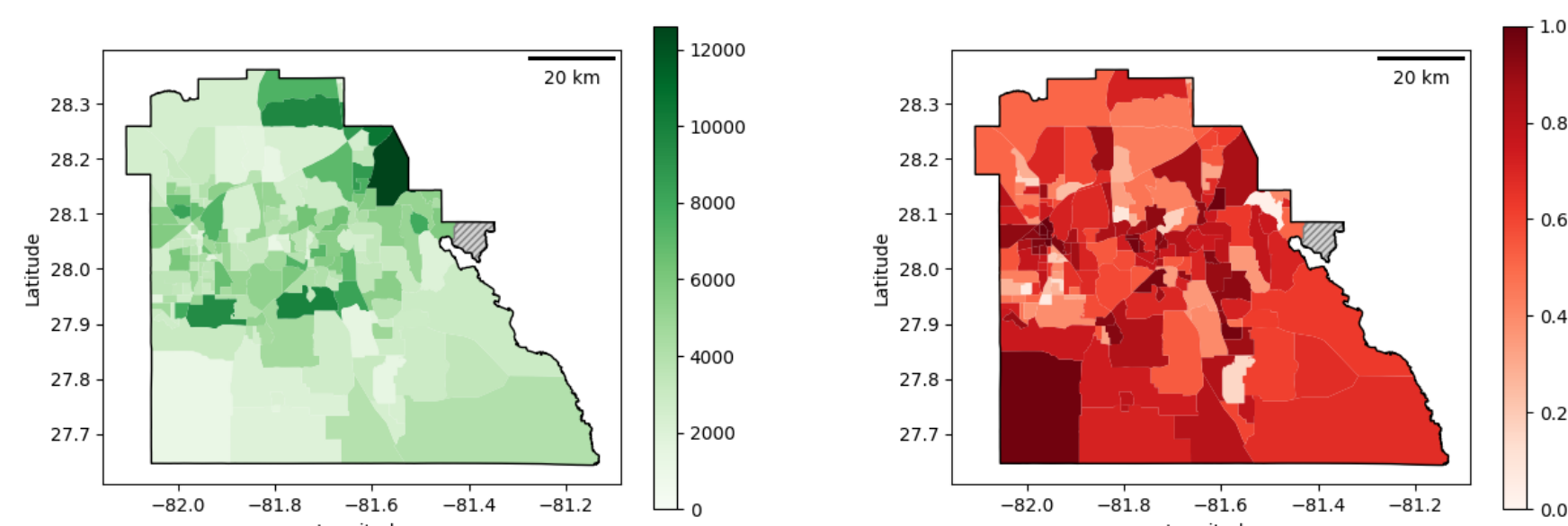

(a) 2020 population by Census tract.

(b) 2020 SVI by Census tract. A higher index indicates greater vulnerability.

Figure 1: Population and Social Vulnerability Index (SVI) data by Census tract. Gray tracts indicate missing data.

Social Vulnerability Index (SVI) is a tract-level metric compiled by the CDC/ATSDR for identifying communities most at risk before, during, or after a disaster [3] (see Figure 1b). It incorporates a variety of socioeconomic factors typically used in identifying pharmacy deserts [4] such as income, unemployment, race, ethnicity, education, and vehicle access.

Facility Data

Pharmacy and urgent care facility locations and store hours were gathered manually. To account for travel outside the borders of Polk County, facilities in all neighboring counties were also collected. As of February 2024 there were 684 pharmacies and 60 urgent care facilities in Polk and neighboring counties (see Figure 2). Store hours were collected directly from each facility's online listings.
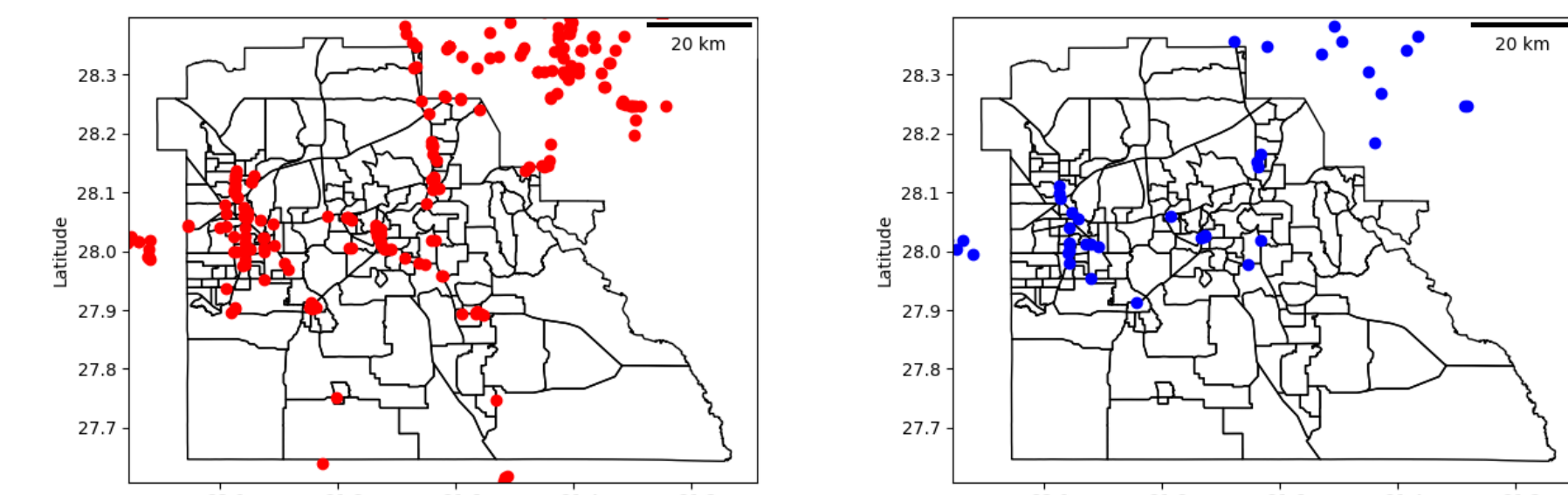
(a) Pharmacy locations.

(b) Urgent care locations.

Figure 2: Locations of the pharmacies and urgent care facilities in and around Polk County (as of February 2024).

Travel Times

Street network shapefiles and speed limits were collected from OpenStreetMap and used to construct a weighted graph representation of the Polk County road network. Each census tract i was added as an origin node located at the tract's population-weighted centroid, while each pharmacy and urgent care facility j was added as a destination node based on its geocoded coordinates. The weighted graph was then used to compute all pairwise origin-destination travel times $T_{i,j}$ as driving times based on each road link's speed limit.

Accessibility Metrification

Tract-level accessibility metrics were defined to provide a representative measure of a person's ability to reach a pharmacy or urgent care facility at a given time of day, with higher a higher level of geospatial and temporal "access" corresponding to having more facilities available in less travel time during a larger fraction of the day. Special significance was given to after-work hours, represented by the time slot Wednesday 5:00–10:00pm.

Most metrics defined for a tract i depended on a count $c_{i,k}^m$ of the number of facilities j available within travel time cutoff $T_{i,j} \leq m$ during a particular time slot k, defined as

$$c_{i,k}^m := \sum_{j=1}^{J} H_{j,k} \mathbb{1}_{\leq m}(T_{i,j}) \qquad (1)$$

where $H_{j,k}$ is an indicator of facility j being open during time slot k and $\mathbb{1}_{\leq y}(x)$ is a binary indicator function equal to 1 if $x \leq y$ and 0 otherwise. Among other things this was used to compute the average number of facilities available during a range of time slots $k \in [k_I, k_F]$

$$\frac{1}{k_F - k_I + 1} \sum_{k=k_I}^{k_F} c_{i,k}^m \qquad (2)$$

as displayed in Figure 3, and the fraction of time period $k \in [k_I, k_F]$ during which a tract had access to at least n facilities

$$\frac{1}{k_F - k_I + 1} \sum_{k=k_I}^{k_F} \mathbb{1}_{\geq n}(c_{i,k}^m) \qquad (3)$$

as displayed in Figure 4. All code produced to collect data and to generate these metrics and their corresponding graphics is available online [1].

Results

Geospatial Accessibility Metrics

(a) Average number of pharmacies accessible within 15 minutes.

(b) Average number of urgent cares accessible within 15 minutes.

(c) Average number of pharmacies accessible within 30 minutes.

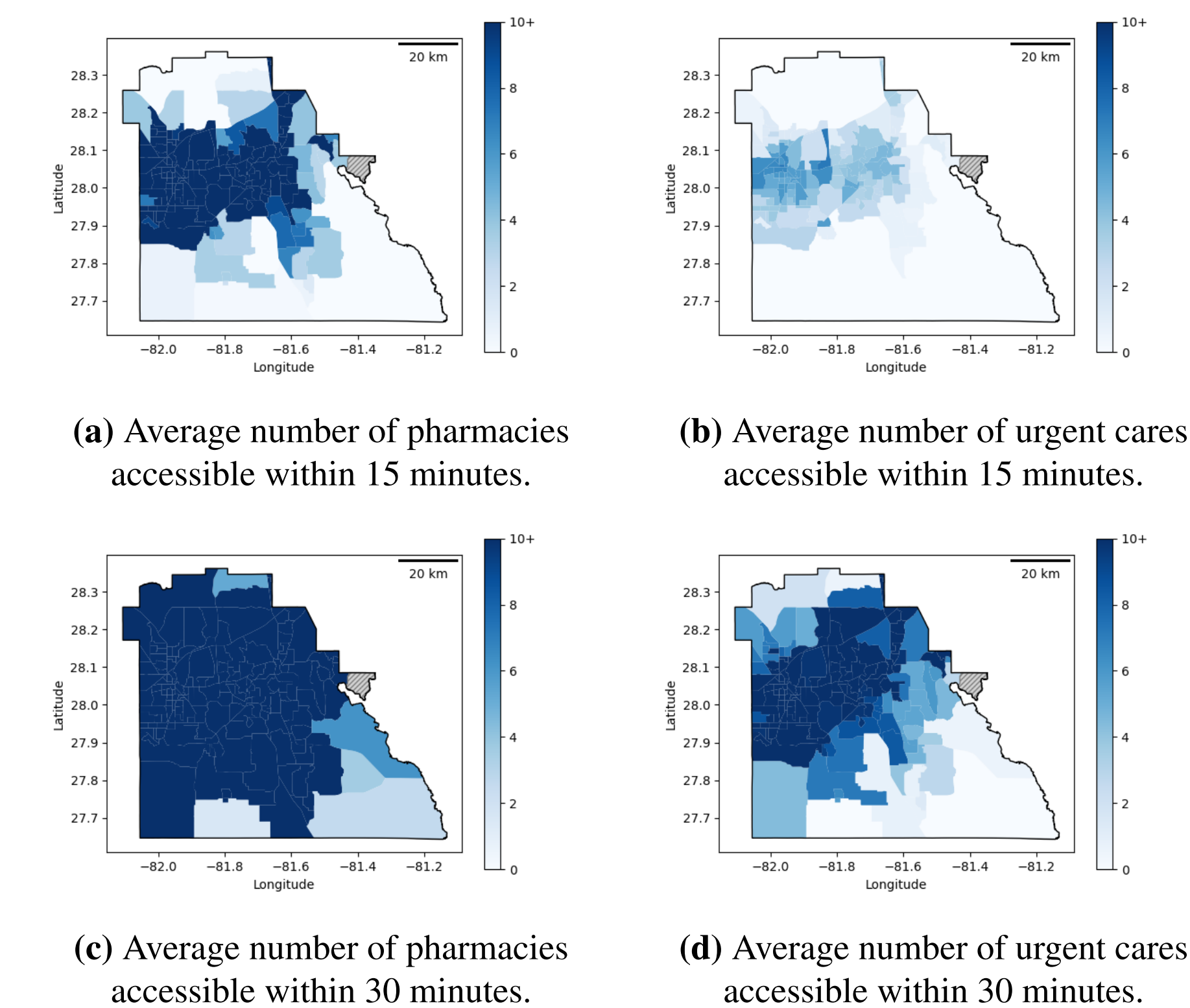**(d)** Average number of urgent cares accessible within 30 minutes.

Figure 3: Average number of facilities of each type accessible during Wednesday 5:00–10:00pm within a 15 or 30 minute travel time cutoff (capped at 10 facilities), as defined in (2).
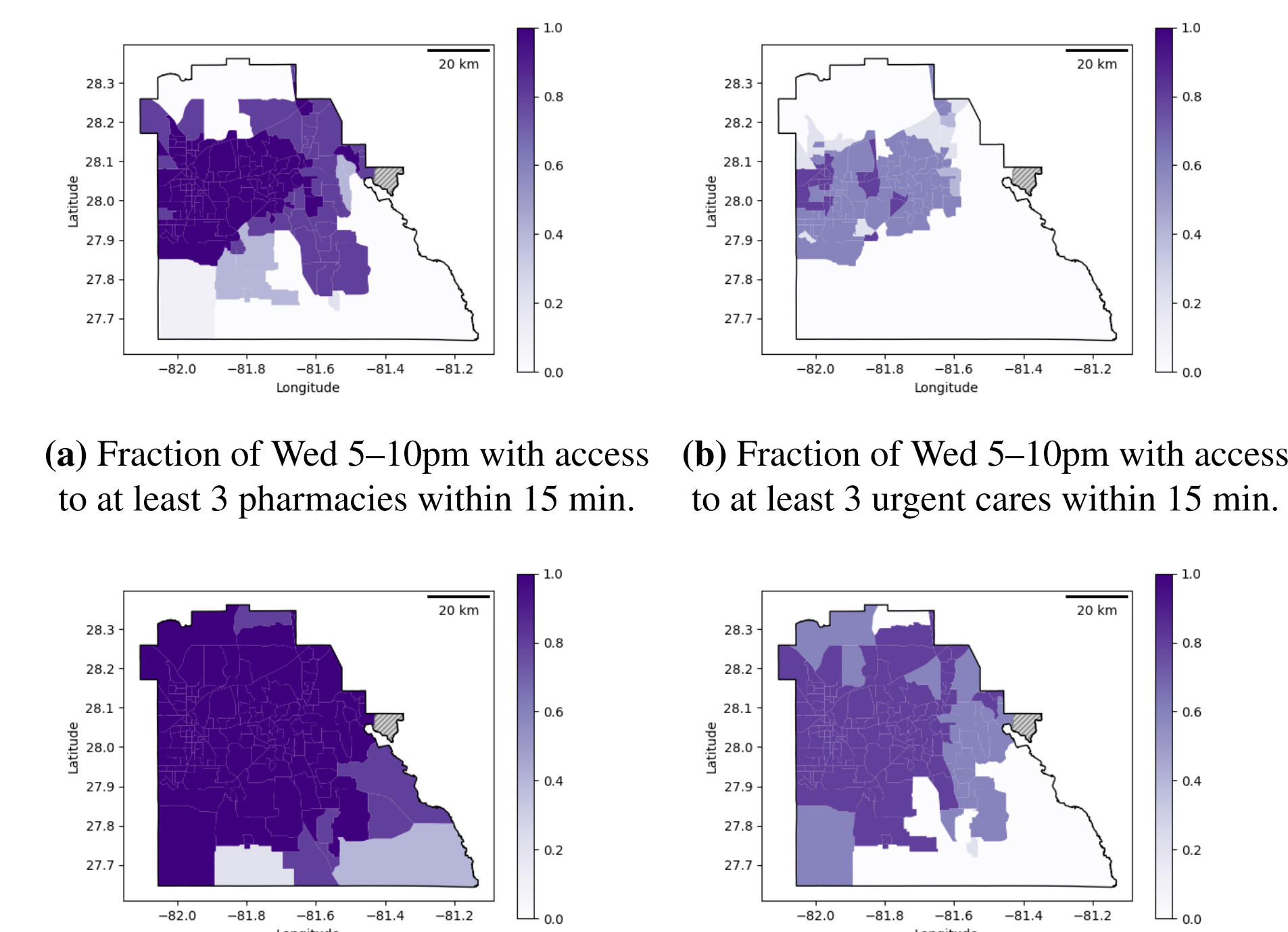

(a) Fraction of Wed 5–10pm with access to at least 3 pharmacies within 15 min.

(b) Fraction of Wed 5–10pm with access to at least 3 urgent cares within 15 min.

(c) Fraction of Wed 5–10pm with access to at least 3 pharmacies within 30 min.

(d) Fraction of Wed 5–10pm with access to at least 3 urgent cares within 30 min.

Figure 4: Fraction of Wednesday 5:00–10:00pm during which there is access to at least 3 facilities within a 15 or 30 minute cutoff, as defined in (3).

n	Pharm 15 min	Pharm 30 min	UC 15 min	UC 30 min
1	29,813 (4.1%)	0 (0.0%)	88,705 (12.2%)	9,407 (1.3%)
3	45,373 (6.3%)	0 (0.0%)	171,056 (23.6%)	19,782 (2.7%)
5	50,314 (6.9%)	0 (0.0%)	239,040 (33.0%)	30,271 (4.2%)

Table 1: Total (and percentage) Polk County population without access to at least 1/3/5 pharmacies/urgent care facilities within 15/30 minutes.

Metric Statistics

All geospatial metrics defined in (1)–(3) were highly correlated with each other (corr ≥ 0.86) but poorly correlated with SVI rankings and its individual socioeconomic components (corr ≤ 0.18; see Figure 5 for representative examples). Nearly all metrics indicated substantially higher levels of access to pharmacies than to urgent care facilities, and by a larger margin when restricted only to after-work hours.
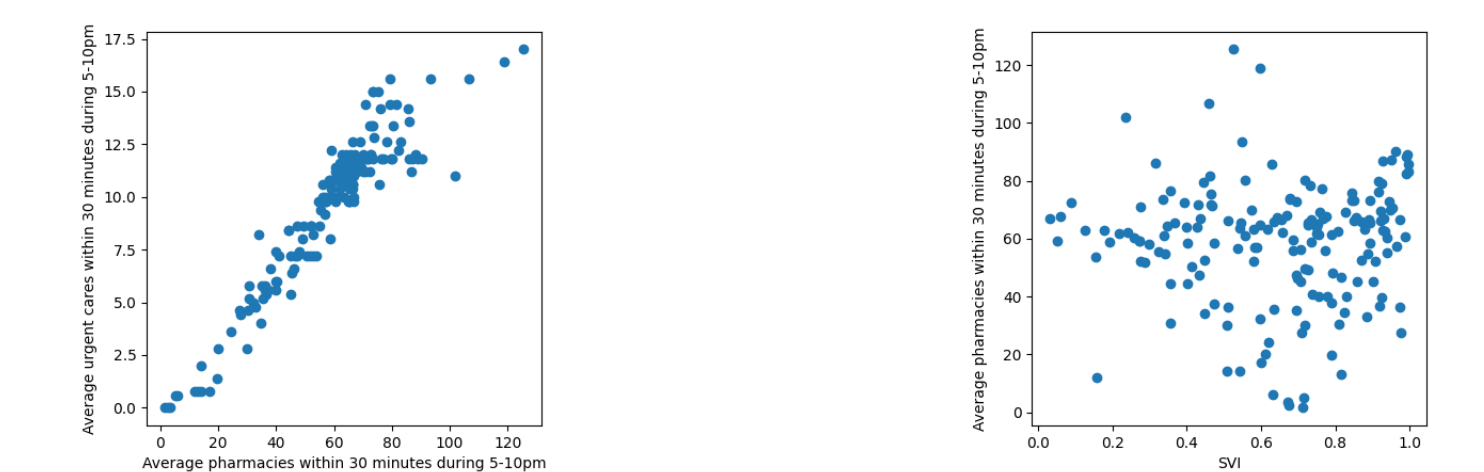

(a) Urgent care versus pharmacy count (30 min, after-work).

(b) Pharmacy count (30 min, after-work) versus SVI ranking.

Figure 5: Scatter plots of tract-level geospatial accessibility and socioeconomic metrics.

Linear regression showed that each tract had access to an average of 4.96 times as many pharmacies as urgent care facilities within 15 minutes of travel during Wednesdays 5:00–10:00pm, rising to 6.24 times as many within 30 minutes of travel. This is not explained solely by the larger number of pharmacy locations, since Polk County contains only 4.64 times as many pharmacies as urgent care facilities.

Discussion

These findings demonstrate that pharmacies are generally much more accessible than urgent care facilities across most communities, particularly during after-work hours. This supports the assertion that pharmacies may naturally be positioned to fill a gap in direct care accessibility, especially in rural areas.

The lack of correlation between geospatial proximity to primary care options and socioeconomic measures of vulnerability implies that socioeconomic factors, alone, do not fully describe a person's practical ability to access medical care. This highlights the need for multidimensional approaches to healthcare accessibility.

Future work includes utilizing block-level Census data for higher levels of fidelity in describing accessibility and utilizing travel time models that take traffic variability and public transit into account. The data and metrics used in this study can also be incorporated into an optimization-based framework to make policy recommendations about facility placement and home care.

References

[1] A. Rumpf. Pharmacy accessibility study. GitHub repository, 2025. URL: https://github.com/adam-rumpf/pharmacy-access

[2] Census Redistricting and Voting Rights Office. Decennial Census P.L. 94-171 redistricting data, September 16, 2021.

[3] Centers for Disease Control and Prevention/ Agency for Toxic Substances and Disease Registry/ Geospatial Research, Analysis, and Services Program. CDC/ATSDR Social Vulnerability Index 2020 Database US.

[4] R. Wittenauer, P. D. Shah, J. L. Bacci, and A. Stergachis. Pharmacy deserts and COVID-19 risk at the census tract level in the State of Washington. *Vaccine: X*, 12:100227, 2022. doi:10.1016/j.jvacx.2022.100227.