Using Synthetic Populations to Understand Geospatial Patterns in Opioid Related Overdose and Predicted Opioid Misuse

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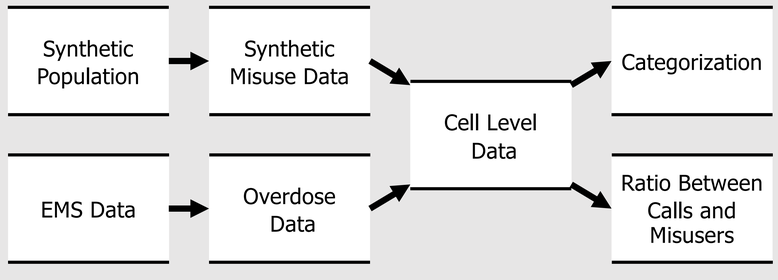
Research Objective

The aim of this study is to identify and map areas with extreme ratios of opioid overdoses to misuse using a model that links
- overdose data from Cincinnati EMS,
- the RTI-developed synthetic population,
- reports of opioid misuse from the NSDUH.

Methods



- We represent every household and person in a population using a synthetic population [1,3].
- We apply the statistical misuse model

$$Logit(P_{misuse}) = b_0 + b_1X_1 + \cdots + b_9X_9$$

where $X_1 \ldots X_4$; X_5; X_6; and X_7, X_8, X_9 are categorical variables for age, sex, high school education, and race, respectively, in order to generate misuse data.
- We categorize cells according to the presence or absence of EMS calls, misusers, and dwellers (see Figure 1).
- We find a ratio between calls and misusers in a cell

$$r_1 = \frac{c+1}{m+1}$$

where c is the number of calls and m is the number of misusers in a cell.

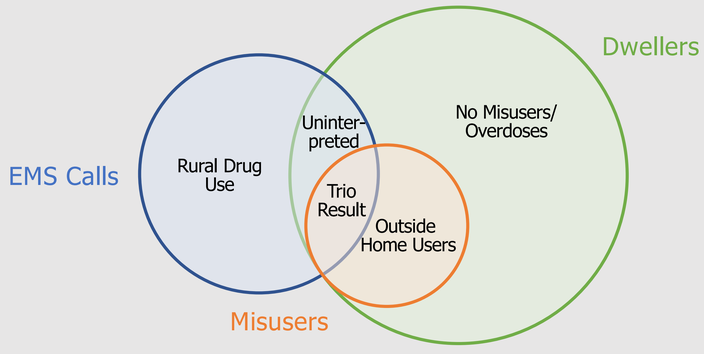


Figure 1: Venn diagram of cell data categories.

Finding Cells with Exceptional r_1 Values

- Plot $\log_{10}(r_1)$ on the map of Cincinnati (see Figure 2).
- List the objects situated within cells with high and low r_1 (see Tables 1 and 2).

Table 1: Cells with the lowest r_1 values and their contents.

r_1	Type	Cell Contents
0.0313	Residential	Victor St, Stratford Ave, Chichasaw St
0.0385	Residential	Ohio Ave
0.0417	Residential	Senator Pl
0.0417	Residential	Hardisty Ave and Delta Ave
0.0435	Residential	Torrence Ln, a possible new construction or damaged home
0.0435	Residential	Strand Ln, an elementary school

Table 2: Cells with the highest r_1 values and their contents.

r_1	Type	Cell Contents
71.000	Non-residential	A public library, a parking garage, an empty building, public transportation and parking
35.000	Non-residential	A homeless shelter, parking, shipping containers, a seemingly abandoned building
26.000	Non-residential	An electric company, a warehouse, shipping containers, covered parking for large trucks
24.000	Non-residential	A visitor center, a library, a parking garage, hotels, restaurants
20.000	Non-residential	An employment agency, a gas station, a veterans center, a certain fast food restaurant
20.000	Non-residential	Train tracks, a manufacturing company, a halfway house, a certain fast food restaurant (nearby)
20.000	Non-residential	A corporate office, parking garage, a credit union, a certain fast food restaurant

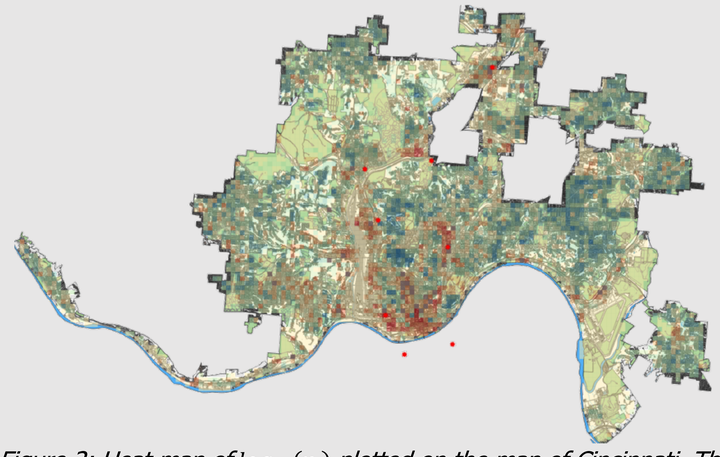


Figure 2: Heat map of $\log_{10}(r_1)$ plotted on the map of Cincinnati. The locations of a certain fast food restaurant are shown by red stars.

The Relationship Between r_1 and Zoning

To examine if all cells with high or low values have similar contents, we
- plot $\log_{10}(r_1)$ with the Cincinnati zoning borders (see Figure 3).
- simplify Cincinnati's zoning codes to plot zones as commercial, industrial & parks, or residential (see Figure 4) [2,4].

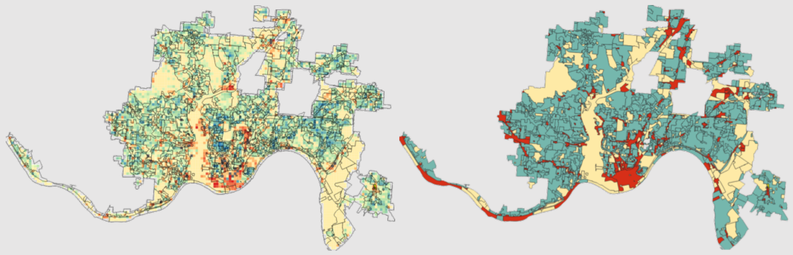


Figure 3: (Left) A heat map of $\log_{10}(r_1)$ is plotted with the Cincinnati zoning borders. (Right) A simplified zoning map of Cincinnati is shown. Red areas represent commercial zones, yellow represent industrial areas and parks, and blue represents residential areas.

Results

- We assessed the ratio r_1 between the density of EMS calls and proportion of predicted opioid misusers in Cincinnati.
- We discovered places with exceptional r_1 values (red and blue cells).
- This work allows for targeted intervention strategies. For example:
  - Include special training for employees in red cells to respond properly to suspected drug exchanges or drug overdose
  - Perform educational campaigns to reduce the number of opioid misusers in residential areas in blue cells.

Acknowledgements

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References

[1] Cajka, James C., Philip C. Cooley, and William D. Wheaton. "Attribute assignment to a synthetic population in support of agent-based disease modeling." *Methods report (RTI Press)* 19.1009 (2010): 1.

[2] "Chapter 1703 Form-Based Code" *Cincinnati Zoning Codes*, City of Cincinnati, 15 Feb. 2013, www.cincinnati-oh.gov/planning/assets/File/CFBC_1703_FBC_FinalDraft_021513_web(1).pdf.

[3] Wheaton, William D., et al. "Synthesized population databases: A US geospatial database for agent-based models." *Methods report (RTI Press)* 2009.10 (2009): 905.

[4] "Zoning Map." *CAGISOnline*, City of Cincinnati, cagisonline.hamilton-co.org/cagisonline/index.html?zoning=cincinnati.