Analyzing the United State's Nationwide Opioid Crisis and Socio-economic Factors using K-Means Clustering

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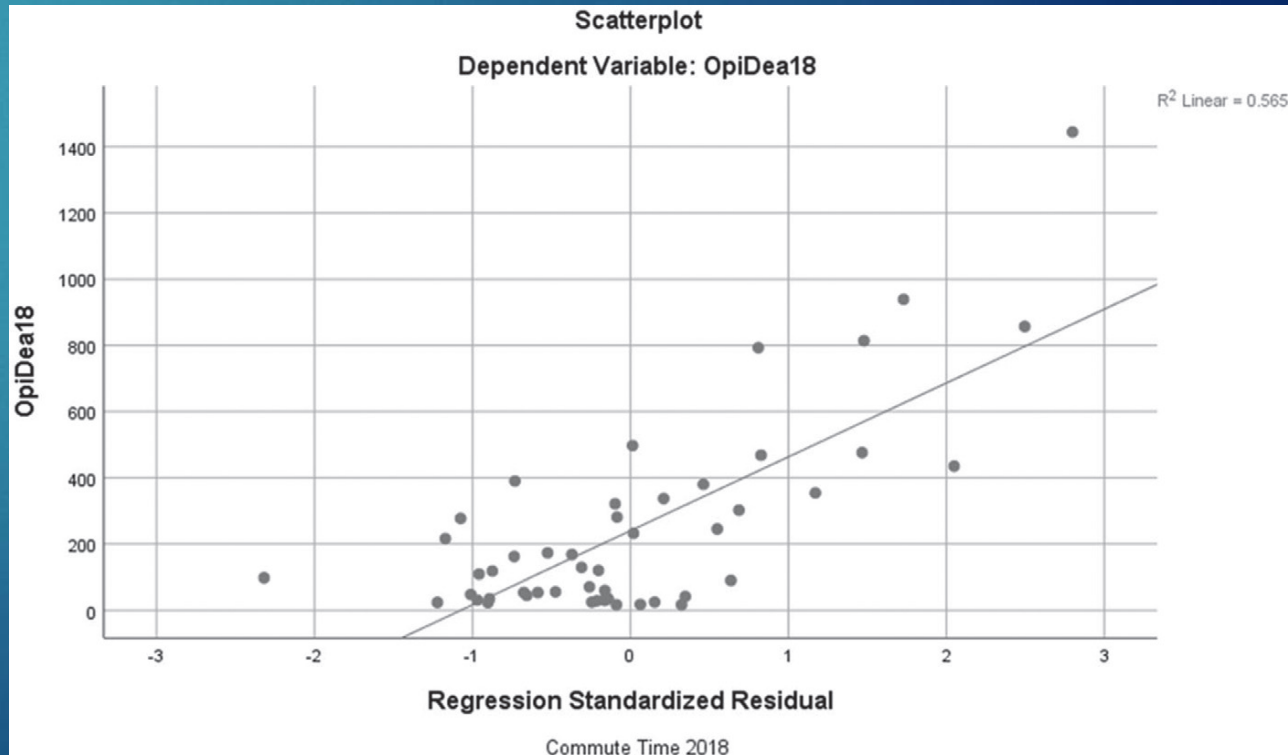
Ryan McGinnis

EDUCATION
- B.S. Biopsychology, Philadelphia University
- M.S. Biomedical Sciences, Jefferson University

PROFESSIONAL EXPERIENCE
- Jefferson Hospital fMRI lab tech
- Health System Clinical Sales Consultant, ThermoFisher Scientific
- Published research in Neuroscience, unconscious processing
- Published research in Big Data Analytics of Opioid Epidemic

Prior to this study, Dr. Sztandera and I have published another paper using Logistical Regression to find opioid death predictors.

We found commute times had nearly a 1 to 1 ratio with rise and falls of city opioid death tools.



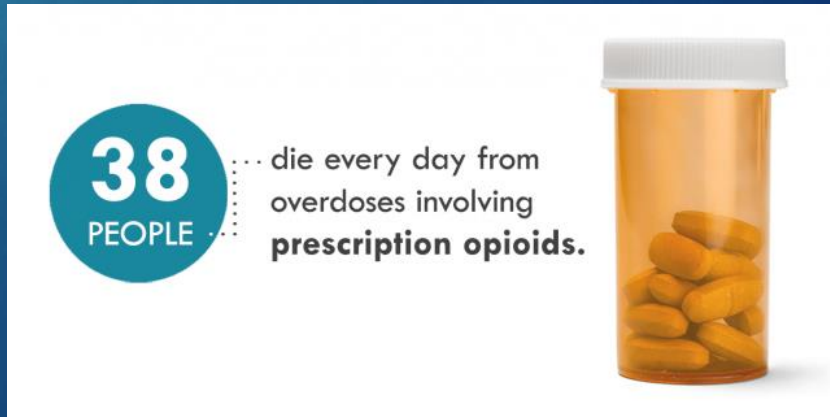
McGinnis R, et al.: Analyzing the relationships between city opioid deaths and socioeconomic factors. J Opioid Mgmt. 2021; 17(5): 363-382. (to be published October edition, confirmed by publisher)

Opioid background

- Opioids are common pain management medication used for patients with moderate to severe pain.
- They are typically for those with chronic pain or recovering from an injury.
- Opioid deaths have been continually rising over the past decade, surpassing motor vehicle accidents, gun violence and HIV combined.
- This has become a complicated epidemic that often goes without media attention. Some reasons for this are,
  - It's the most effective medication currently available for moderate to severe pain.
  - Opioid deaths can fall into several categories (accidental poisoning, suicide, etc.) separating its true death toll.

Opioid Background

- One of the leading killers in the US



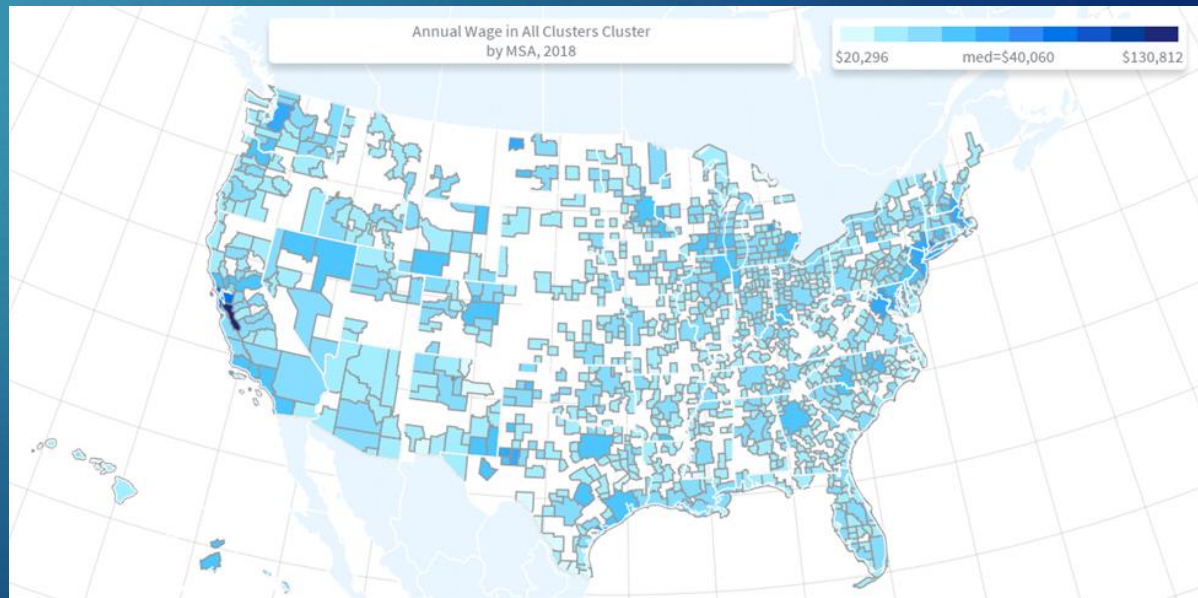
Ciccarone D. Fentanyl in the US heroin supply: A rapidly changing risk environment. The International Journal on Drug Policy. 2017 Aug; 46:107-111. DOI: 10.1016/j.drugpo.2017.06.010.
https://www.cdc.gov/opioids/data/analysis-resources.html

Medical Background

- Opioid prescriptions range widely in price but can be some of the more expensive prescriptions to maintain. We see that areas of high opioid abuse are also areas of with roughly >$55,000 annually.
- In the elderly community, it's not uncommon for patients to take the wrong dosage or forget they took their medication and take a second dose and accidently overdose.
- Those that finish their opioid prescription often become dependent. Some studies show that >50% opioid related deaths either have or had an opioid prescription within 90 days of their death.

Opioid Background

- One of the leading killers in the US
- Increased likelihood in high income areas
- Accidental overdose common in elderly
- Prescription history is a strong contributor



(SOURCE: U.S. CLUSTER MAPPING PROJECT, INSTITUTE FOR STRATEGY AND COMPETITIVENESS, HARVARD BUSINESS SCHOOL. DATA SOURCES)
Dilokthornsakul P, et al.: Risk factors of prescription opioid overdose among Colorado Medicaid beneficiaries. J Pain. 2016; 17 (4): 436 - 443. DOI: 10.1016/j.jpain.2015.12.006.
Baird J, et al.: A retrospective review of unintentional opioid overdose risk and mitigating factors among acutely injured trauma patients. Drug Alcohol Depend. 2017; 178: 130 - 135. DOI: 10.1016/j.drugalcdep.2017.04.030.

Illegal Opioid Background

- Opioids can be sold illegally in many forms.
  - Natural: Morphine, codine, etc.
  - Semi-synthetic: Oxycodone, hydrocodone, etc.
  - Synthetic: Fentanyl and tramadol
  - Illegally made: Heroin
- Fentanyl and Heroin being the most common sold illegally.
  - These drugs can be diluted and cut with different drugs to make them cheap, highly addictive, and extremely dangerous.
- Many studies have already looked at ethnicity, age, education, and marital status to find trends in overdose rates. White/non-Hispanic males with only a high school diploma tend to be the highest.

Opioid Background

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- Street versions are highly accessible
- Demographic factors play a large role

Nechuta S, et al.: Sociodemographic factors, prescription history and opioid overdose deaths: A statewide analysis using linked PDMP and mortality data. Drug Alcohol Depend. 2018; 190: 62 - 71. DOI: 10.1016/j.drugalcdep.2018.05.004.
https://www.cdc.gov/drugoverdose/deaths/index.html

Experimental Design

- 1 major city per state (n=50)
- Data collected from these cities in 2018
  - Opioid death toll
  - Average commute time
  - City Budget for Roads
  - City Budget for Arts and Culture
- Software used: IMB SPSS statistical software version 25
- All variables were standardized into Z scores so they could be comparable.
- Each variable was then compared to Opioid death toll via a K Means Cluster Analysis.

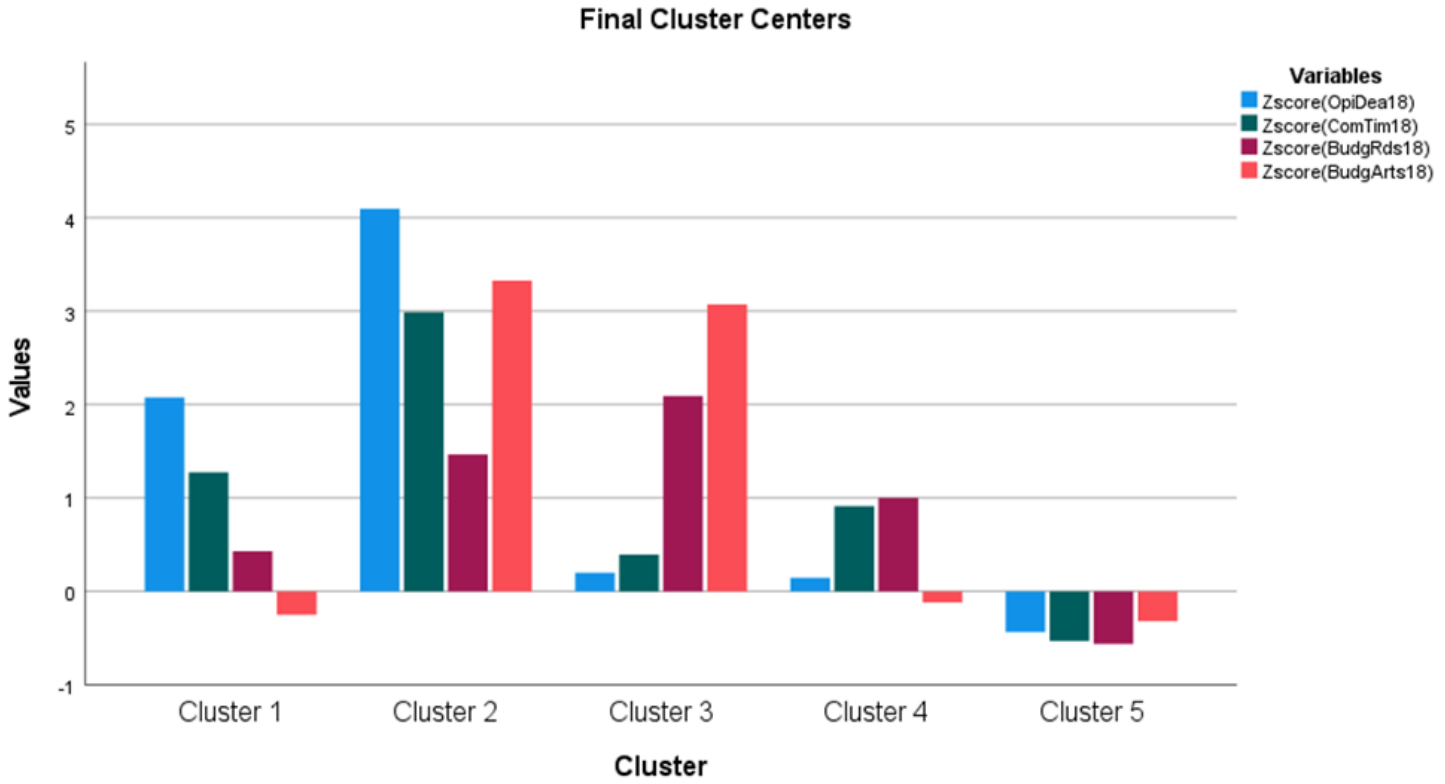
Findings

- Each city was grouped into 1 of 5 clusters.
- We can see that areas with the highest opioid deaths are in clusters 1 and 2.
  - New York being so bad that is the only city in cluster 2

City	Cluster
Philadelphia	1
Chicago	1
Phoenix	1
Baltimore	1
New York City	2
Detroit	3
Portland	3
Houston	3
Los Angeles	4
Boston	4
Providence	4
Newark	4
charlotte	4
Indianapolis	4
Las Vegas	4
Atlanta	4
Seattle	4
Orlando	5
Charleston	5
Manchester	5
Louisville	5
Columbus	5
Albuquerque	5
Salt Lake City	5
Nashville	5
Portland	5
Wilmington	5
Hartford	5
Burlington	5
Milwaukee	5
St Louis	5
Columbia	5
Richmond	5
Anchorage	5
Oklahoma City	5
Denver	5
New Orleans	5
Birmingham	5
Cheyenne	5
Minneapolis	5
Des Moines	5
Little Rock	5
Jackson	5
Boise	5
Wichita	5
Fargo	5
Sioux Falls	5
Billings	5
Honolulu	5
Omaha	5

Findings

- We can see every time opioid deaths are high, so are the commute times. And vise versa.
- Budget for roads compliments this.
- Budget for arts and cultures holds no consistency with opioid deaths



Discussion

- Commute times has a strong relationship with opioid deaths in each city.
  - Commute times can be used a predictor model to better prepare for opioid casualties.
  - Increase naloxone supplies, prioritize patrols in long commute zip codes.
- Commute time playing a serious role in opioid deaths is reinforced by budget for roads being similarly consistent.
- This enforces the understanding that addiction is just as much external influenced as it is internally. A matter of quality of life.

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Discussion

- The significance that analyzing external factors, is that it offers ways to better predict addiction without or congruent with demographic factors.
- By combining demographic factors with all the potential external factors, we can develop precision accuracy in managing the opioid epidemic, as well as understanding the psychology of addiction.

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Implications

- We know areas >$55,000 annual income have higher opioid deaths but most of the deaths come from those with only a high school diploma
  - Are those above $55,000 affording opioid prescriptions and their illegal counterparts?
- Are the high school diploma deaths tied to the elderly age group without college degrees or is low education a risk for the younger generation?
- How will new pharmaceuticals effect the epidemic?
  - How will it change the supply/quality of their illegal street versions?
- What other external factors could we measure?

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Conclusion

- This study could be a novel approach in the way we manage addiction.
- Quality of life plays a critical role in one's likelihood to develop an addiction.
- Opens the door for new preventative measures to me taken.
- By uncovering what factors are tied to opioid deaths or other addiction related casualties, we can make new strides in understanding and managing addiction.

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