



The Opioid Hydra: *Heterogeneity in Opioid-Use Disorder Mortality and Implications for Public Health*

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Iowa Department of Public Health
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David Peters

Sociology, Iowa State U.

Shannon Monnat

Maxwell School, Syracuse U.

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MOTIVATION AND CONCEPTUAL APPROACH

The problem ...

- Drug OD deaths have risen from 6.1 to 21.7 per 100k since 1999.
- 2/3rd due to opioids. ~350k OUD deaths since 1999, 430% gain.

The causes ...

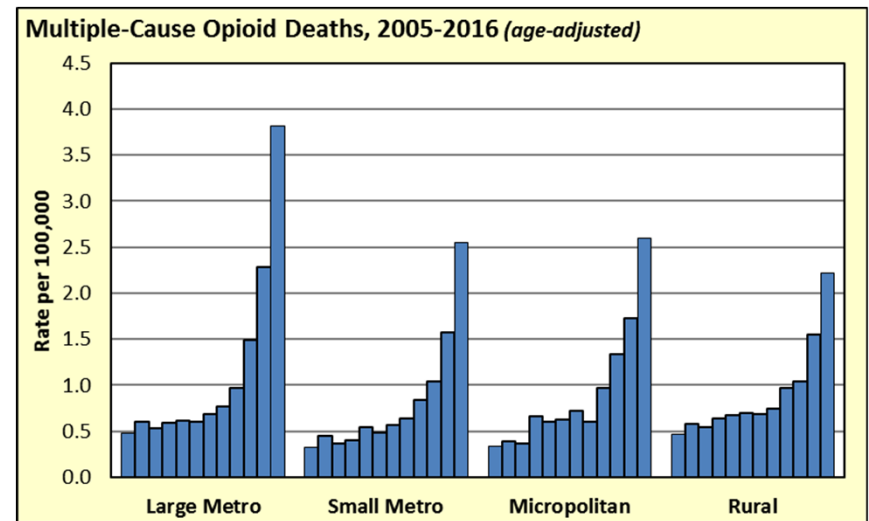
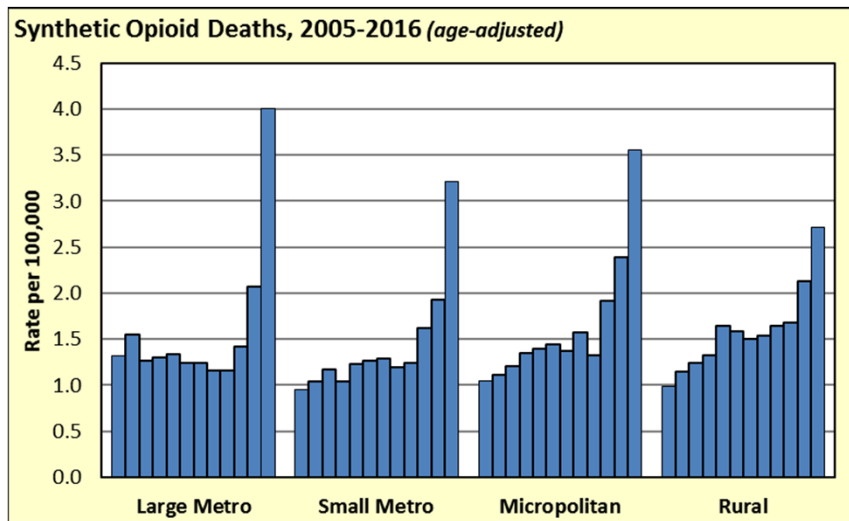
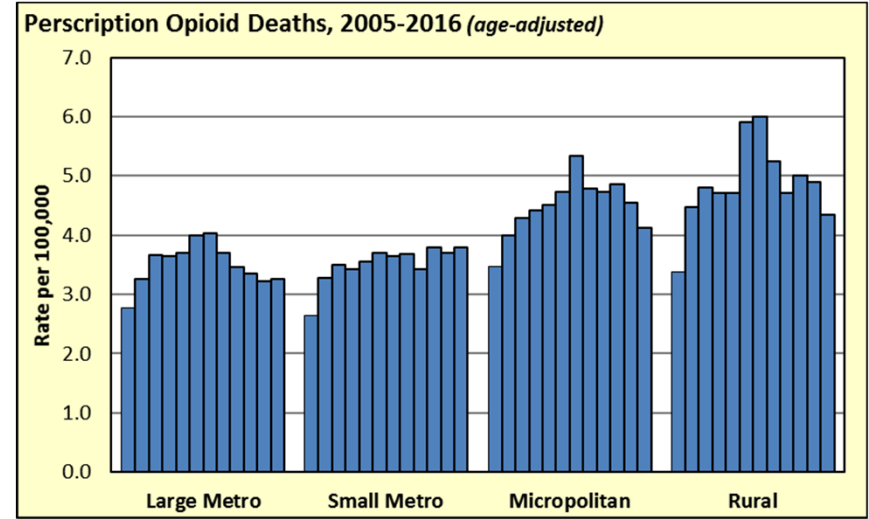
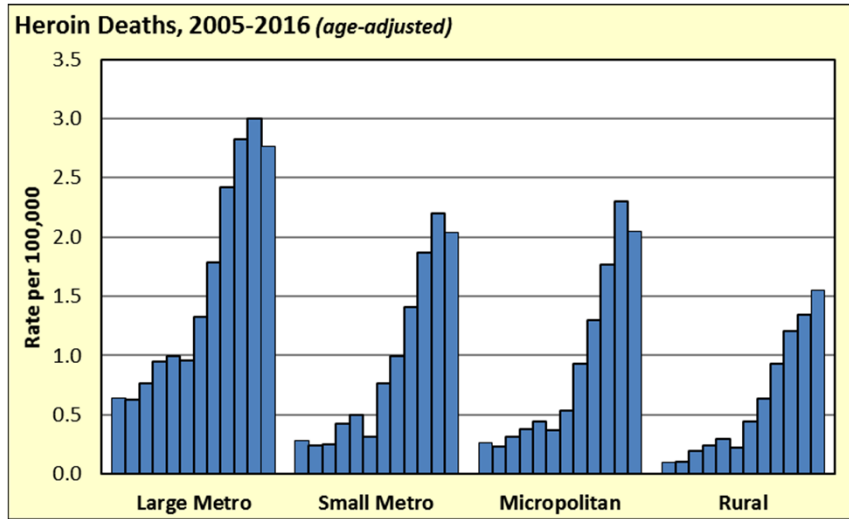
- Economic – waning Fordism, waxing post-Fordism.
- Social – physical and social disorganization.
- Psychological – general strain theory.
- Policy – lax regulation of Rx opioids.

Research questions ...

- Are there different clusters of OUD mortality by place?
- Do these clusters share different path trajectories?
- What are the implications for public health interventions?

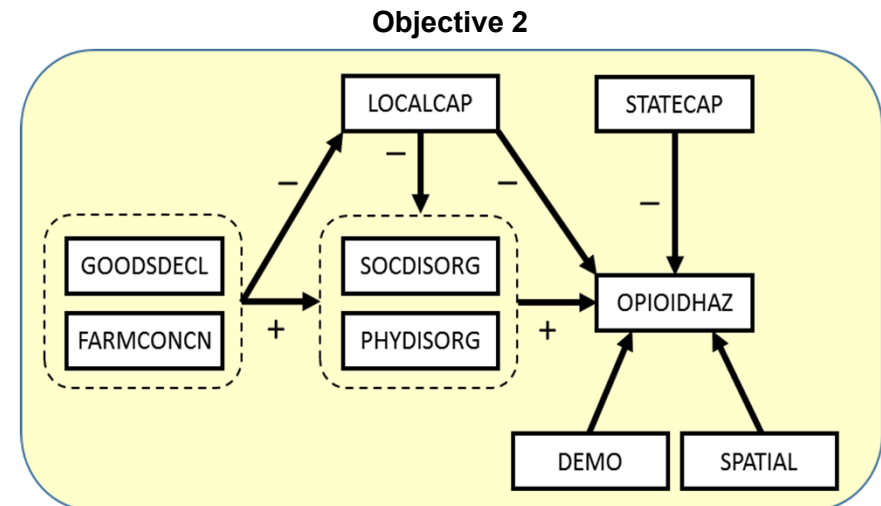
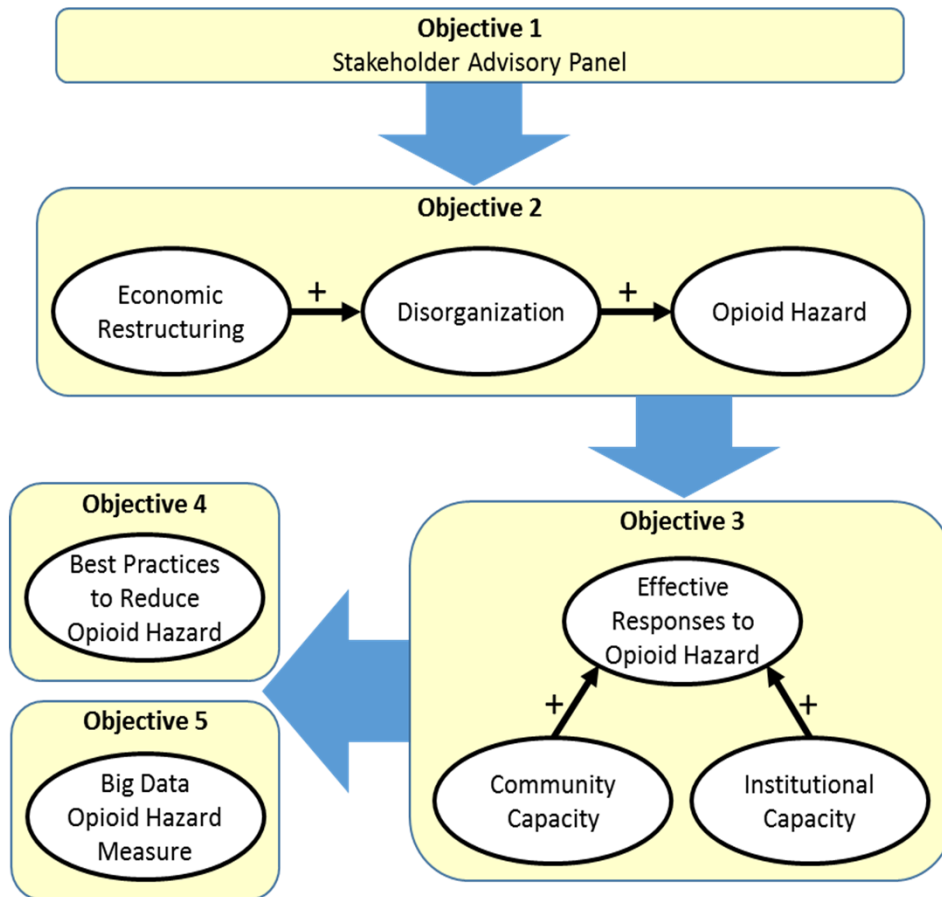
MOTIVATION AND CONCEPTUAL APPROACH

The crisis in four histograms ...



MOTIVATION AND CONCEPTUAL APPROACH

USDA-AFRI Rural Opioid Project



IOWA STATE
UNIVERSITY



SYRACUSE
UNIVERSITY

Multiple Cause of Death, NCHS CDC

Opioid-Use Disorder deaths by cause

- Heroin/opium alone
- Prescription opioids alone (including methadone)
- Synthetic opioids or unknown narcotics alone
- Multiple-Causes (2 or more opioids and/or behavioral causes)
- Non-opioid drug deaths (to address possible undercount)

ICD-10 ((40-44, X60-64, X85, Y10-14) and (T40.0-40.4 or T40.6)) or (F11.0-11.9)

By place of residence. N=3,079 counties in conterminous U.S. (with modifications)

Pooled OUD mortality rates for 2014-16 and change from 2005-07.

Winsorized at 0.5th and 99.5th percentile. Standardized (z) to compare across rates.

DATA AND METHODS

Decennial Census and ACS, U.S. Census

- Demographic, economic, and social covariates

Uniform Crime Reports, FBI

- Drug arrests and crimes known to police. MCMC imputed.

QuintilesIMS Transactional Data Warehouse

- Rx opioid prescribing rates. MCMC imputed.

Latent Profile Analysis

$$f(x_i | \theta) = \sum_1^K \lambda_k f_k(x_i | \theta_k)$$

- Multivariate distributions are mixtures of distinct classes with unique distributions with $\theta_k = (\mu_k, \Sigma_k)$
- LPA/LCA seeks to identify classes in a distribution. Several advantages over other classification techniques.
- Free parameters identified. EM used to obtain MAP estimators using 5,000 initial starting values to avoid local maxima.

Results

- LPA finds evidence for 7 classes. However, classes 6 and 7 are similar in shape but different in elevation.
- For interpretation, a 6 class solution was favored.
- Counties with Bayes posterior probabilities $Pr < 0.6$ excluded.

DATA AND METHODS

Latent Profile Analysis

Results of the Latent Profile Analysis on Opioid-Use Disorder Mortality Rates per 100k in 2014-16 and Change from 2005-07.

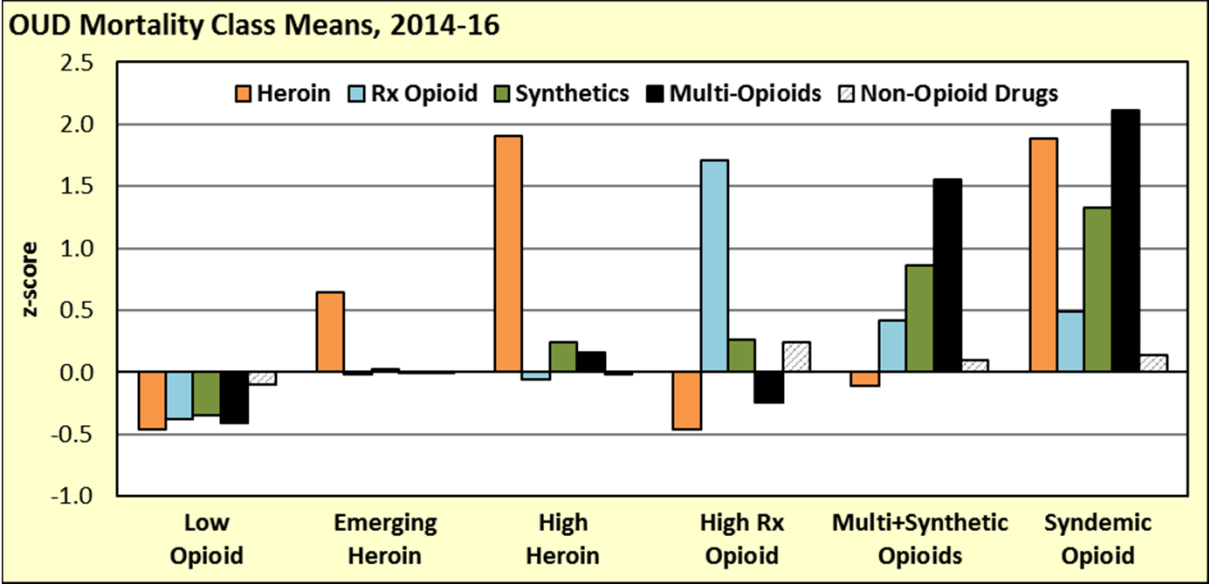
Class	BIC	BIC-SSA	Relative Entropy	LMR Test	LMR p
1	75,460.03	75,396.48	n.a.	n.a.	<.001
2	67,852.61	67,754.11	0.969	7,609.66	<.001
3	65,141.08	65,007.63	0.952	2,768.55	<.001
4	62,687.81	62,519.41	0.966	2,513.19	<.001
5	61,285.18	61,081.83	0.960	1,474.30	<.004
6	60,060.55	59,822.25	0.943	1,298.29	<.001
7	58,823.22	58,549.97	0.947	1,272.13	<.001
8	57,857.77	57,549.56	0.954	1,042.02	0.127
9	56,903.32	56,560.16	0.944	951.94	0.355
10	55,978.41	55,600.29	0.945	890.214	0.711

BIC = Bayesian information criteria.

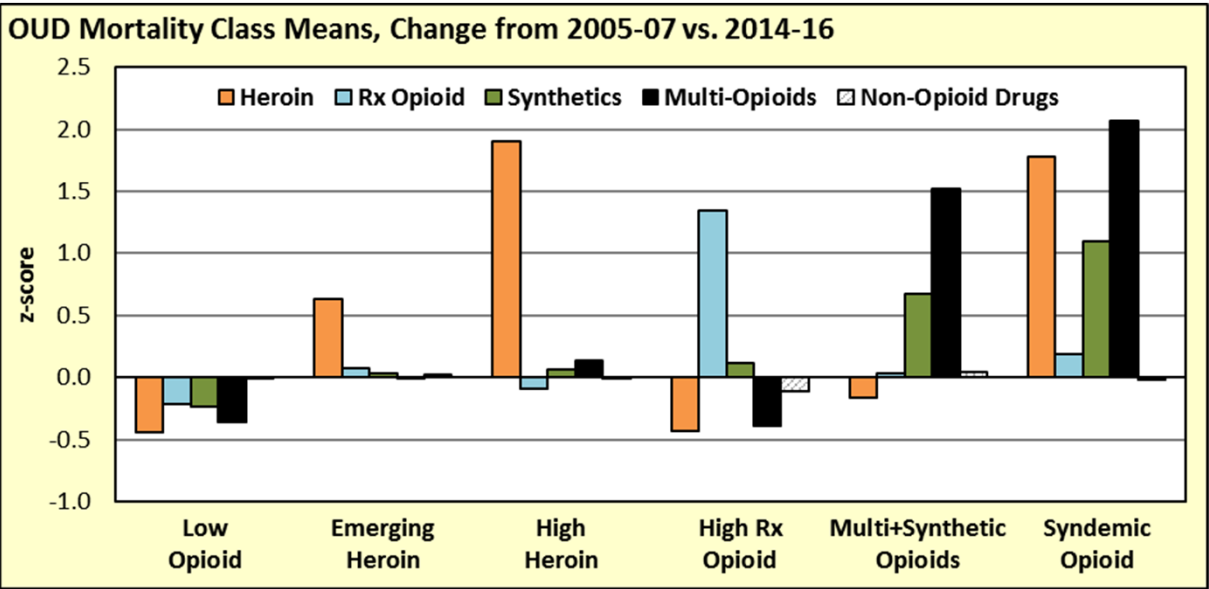
BIC-SSA = sample-size adjusted BIC.

LMT = Lo-Mendell-Rubin test.

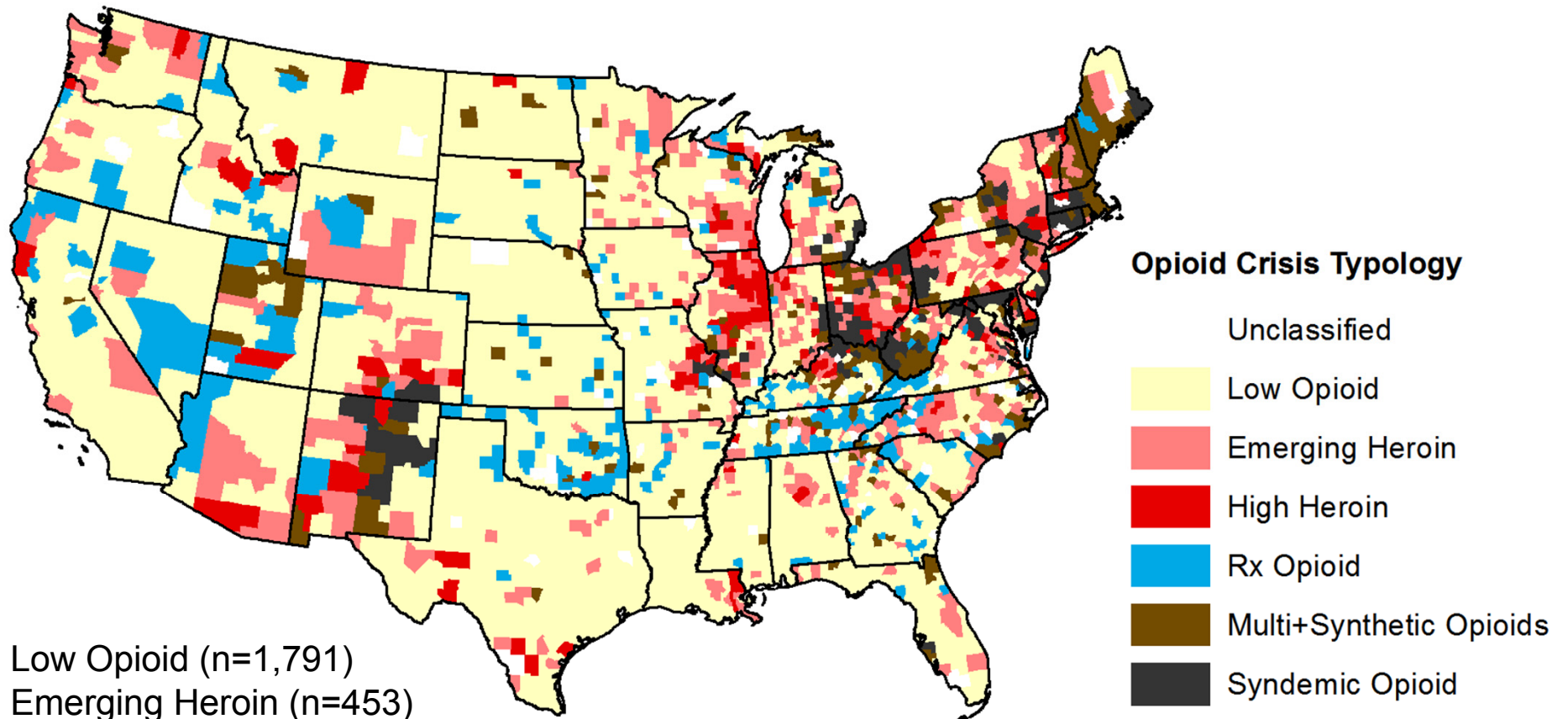
OPIOID MORTALITY CLASSES



Low Opioid (n=1,791)
 Emerging Heroin (n=453)
 High Heroin (n=150)
 Rx Opioid (n=232)
 Multi+Synthetic Opioids (n=213)
 Syndemic Opioid (n=141)
Unclassified (n=99)

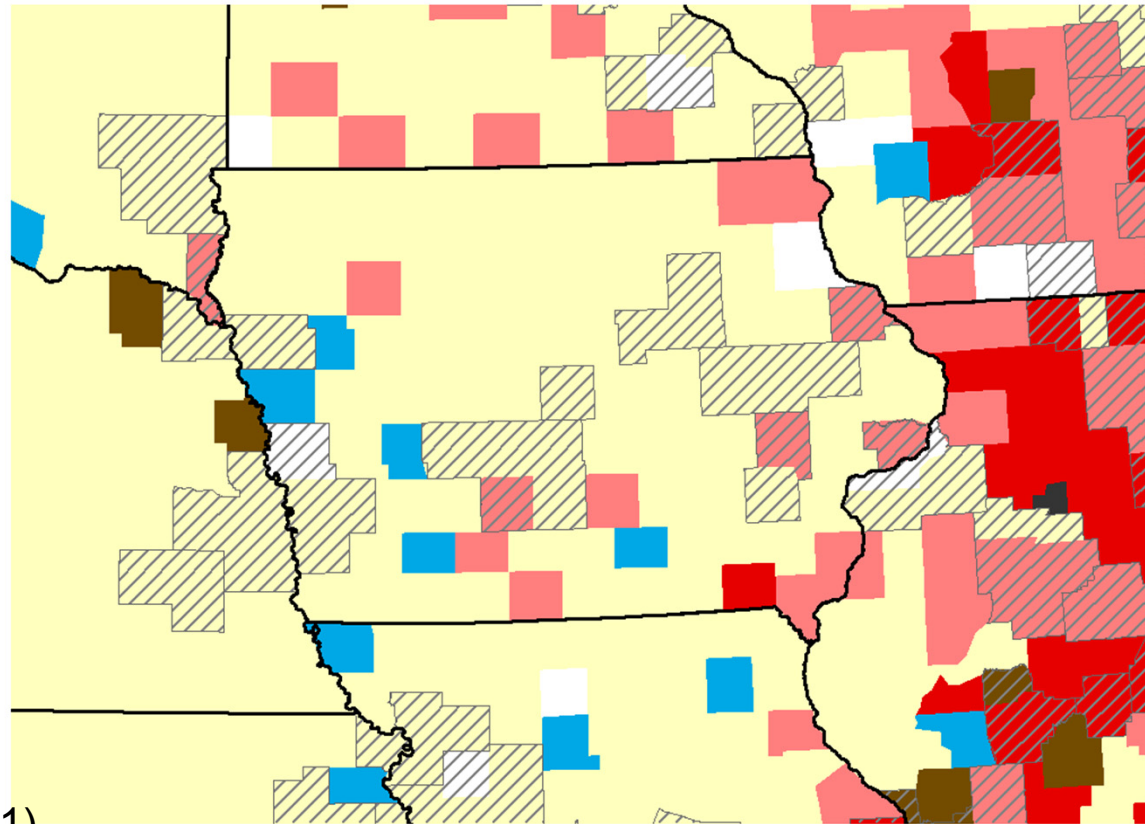


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SOCIOECONOMIC CHARACTERISTICS

Emerging Heroin Class

Demographics ...

- High density, growing populations.
- Well educated.
- More metro 49.7%, less rural 26.3%. Urbanized.

Economy and Income ...

- Higher LFP.
- More employment in professional* & leisure/retail services (growing).
- Few agriculture* jobs.
- High MHHI, but growing poverty.

Other Covariates ...

- No differences.

SOCIOECONOMIC CHARACTERISTICS

High Heroin Class

Demographics ...

- Aging population.
- Mix of metro 43.3% and rural 38.7%. More urbanized.

Economy and Income ...

- Few agriculture jobs. Declines in good-producing jobs.
- Growing poverty & inequality.

Other Covariates ...

- High yet falling property crime rates.

SOCIOECONOMIC CHARACTERISTICS

High Rx Opioid Class

Demographics ...

- Small populations.
- Mostly white non-Hispanics.
- More elders over age 65. Poorly educated.
- Majority rural 59.9%, few metro 20.3%.

Economy and Income ...

- Low & falling LFP.*
- Declines in goods-producing jobs.
- Few professional services.
- Low MHHI* and high poverty.

Other Covariates ...

- High opioid Rx rates.

SOCIOECONOMIC CHARACTERISTICS

Multiple+Synthetic Opioid Class

Demographics ...

- Mostly white non-Hispanics.
- Aging populations.
- Mix of rural 42.7% and metro 37.1%.

Economy and Income ...

- More jobs in leisure/retail services. Few agriculture jobs.
- Declines in good-producing & TCPU jobs.

Other Covariates ...

- High opioid Rx rates.

SOCIOECONOMIC CHARACTERISTICS

Syndemic Opioid Class

Demographics ...

- High density, highly urbanized.
- Mostly white non-Hispanics.
- Well educated.
- Majority metro 63.8%, few rural 19.9%.

Economy and Income ...

- More employment in professional* & leisure/retail services.
- Few agriculture* jobs. Declines in goods-producing & TCPU jobs.
- High MHHI, but growing poverty & inequality (gains at the top).

Other Covariates ...

- High opioid Rx rates.
- High opioid arrest rates.

SOCIOECONOMIC CHARACTERISTICS

	Emerging Heroin		High Heroin		High Rx Opioid		Multi+Synthetics		Syndemic Opioid	
	Change		Change		Change		Change		Change	
	2014-16	2005-07	2014-16	2005-07	2014-16	2005-07	2014-16	2005-07	2014-16	2005-07
Demographics (%)										
Population (#)	160,698	10.58	159,753	5.23	30,324	3.65	106,296	4.54	174,207	4.08
Population Density (sq.mi.)	447.50	43.01	280.81	13.99	57.89	4.58	296.31	18.85	494.08	10.38
Minority Population	21.35	4.56	21.53	4.37	16.67	3.32	15.76	2.93	17.91	3.27
<i>African-American</i>	8.00	0.51	6.37	0.63	5.12	-0.14	6.28	0.02	7.34	0.12
<i>Hispanic any race</i>	8.76	2.80	11.14	2.71	5.89	2.29	5.12	1.74	6.87	1.87
Population 17 and under	22.14	-2.95	22.06	-3.41	21.98	-2.76	21.59	-3.30	21.74	-2.93
Population 65 and over	16.94	3.13	17.77	3.51	19.56	3.58	18.05	3.46	17.16	3.07
High School Non-Completers	12.33	-7.46	13.33	-7.92	15.80	-10.12	13.78	-9.28	12.81	-8.46
College Graduates	23.80	4.95	21.18	4.46	17.01	3.61	20.94	4.65	22.63	5.34
Geographic										
Rural-Urban Continuum (1-9)	3.81	-0.13	4.51	-0.03	5.89	-0.17	4.80	-0.12	3.17	-0.12
<i>Metro</i>	49.67		43.33		20.26		37.09		63.83	
<i>Micropolitan</i>	24.06		18.00		19.83		20.19		16.31	
<i>Rural</i>	26.27		38.67		59.92		42.72		19.86	

SOCIOECONOMIC CHARACTERISTICS

	Emerging Heroin		High Heroin		High Rx Opioid		Multi+Synthetics		Syndemic Opioid	
	<i>Change</i>		<i>Change</i>		<i>Change</i>		<i>Change</i>		<i>Change</i>	
	<i>2014-16</i>	<i>2005-07</i>	<i>2014-16</i>	<i>2005-07</i>	<i>2014-16</i>	<i>2005-07</i>	<i>2014-16</i>	<i>2005-07</i>	<i>2014-16</i>	<i>2005-07</i>
Employment (%)										
Employment Over Population	45.08	-1.08	43.83	-1.33	39.96	-2.38	42.71	-1.06	44.33	-1.15
Agriculture & Natural Resources	2.58	-2.95	3.69	-7.34	5.24	-14.71	2.97	-16.21	1.57	-9.64
Goods-Production	21.49	-9.52	22.22	-13.31	22.23	-16.25	21.28	-14.15	20.14	-17.80
Transport, Telecomm, Utilities	6.69	-1.09	6.84	-1.64	6.87	-2.02	6.67	-7.97	6.92	-8.71
Professional Services	13.05	24.69	12.03	20.59	10.23	23.52	12.15	21.19	13.55	16.60
Leisure Services & Retail	25.31	14.40	24.40	7.81	24.83	3.27	25.26	8.05	25.47	5.24
Income (%)										
Median HH Income (\$)	\$52,435	32.28	\$49,629	32.20	\$41,687	34.44	\$48,586	35.40	\$50,819	30.14
Poverty Rate	14.77	3.09	15.40	2.96	18.48	2.84	16.30	2.43	15.38	3.30
Income Inequality (gini)	43.86	2.10	44.07	2.64	44.79	1.27	44.19	1.30	44.66	2.40
Income owned bottom 20%	3.82	-0.32	3.80	-0.34	3.74	-0.06	3.76	-0.16	3.65	-0.35
Income owned top 20%	47.61	1.70	47.37	1.86	48.35	0.99	47.86	1.04	48.23	2.03
Drugs (per 100k)										
Non-Opioid Drug Deaths	7.81	1.82	7.78	1.56	9.48	0.83	8.50	2.01	8.81	1.48
Rx Opioid Prescribing	76.38	-0.74	71.84	-6.30	94.25	-8.74	83.19	-10.41	84.02	-10.27
Crime (per 100k)										
Non-Cannabis Drug Arrests	188.48	-24.51	241.28	6.89	243.31	-0.33	203.42	5.05	233.59	-17.78
Opioid Arrests	90.85	-42.91	108.46	-18.72	106.71	-30.07	104.25	-12.11	144.73	-35.99
Violent Crime	124.85	-33.75	131.15	-36.58	114.53	-33.49	103.05	-24.21	113.59	-29.85
Property Crime	511.87	-46.41	650.88	-122.57	397.88	19.19	433.20	14.25	477.06	5.50

SUMMARY AND CONCLUSIONS

Not a single “opioid epidemic” ...

- Three *epidemics* – prescriptions, heroin, multi+synthetics.
- One *syndemic* that includes all three.

Different place trajectories ...

The Left Behind (Rx opioid) ...

- Rural & white, poor & low human capital, blue-collar decline, and long-term drug & Rx problem.

Polarized Cities (syndemic opioid) ...

- Prosperous & educated cities, fewer minorities, services economy but declining blue-collar jobs, growing poverty & inequality, and Rx problem.

Small Towns, City Problems (multiple+synthetic opioids) ...

- Mix of rural and urban, mostly white, declining blue-collar jobs, and Rx problem.

Suburban Drug Use (emerging & high heroin) ...

- Growing mix of metro & rural places, economically advantaged, and no drug problems.

SUMMARY AND CONCLUSIONS

Public health interventions must be place-specific ...

- Presence or absence of addiction services.
- Local government capacity (funding, enforcement, etc.)
- Labor market opportunities or despair.
- Segment vs. entire community.
- Addiction vs. economic security programs.
- Prescription regulation vs. drug enforcement.
- Regional collaborations within opioid classes.

Future work ...

- Disaggregate by metro, micro, and rural.
- Place vs. residence of death?
- Include multiple opioid pairings and race*age breakouts.
- Model over time using latent transition analysis or lagged regression.

Questions or comments?